



Rungta Mines Limited

UMD/123
9.1.15

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Ref: RML/Coal/27/14-15/50

January 8, 2015

To,
Sri A. K. Rana,
General Manager (UMD),
CMPDIL, Kanke Road,
RNACHI

युएमडी/UMD,
सीएमपीडीआई (गुंटा), राँची
CMPDI (HQ), Ranchi
संख्या/No. 131
दिनांक/Date 09/01/15

Sub:- The coal Mines (Special Provisions) Ordinance, 2014 seeking information in respect of 27 Coal Blocks of extended Schedule-III of the Coal Mines (Special Provisions) Ordinance, 2014 – Radhikapur (West) Coal Block.

Dear Sir,

Kindly refer to your fax dated 07/08-01-2015 & subsequent telephonic discussion with you on the subject under reference.

As desired enclosed is the hard copy of the Mining Plan of Radhikapur (West) Coal Block in original in two volumes - Text & Plates.

You would also kindly appreciate that soft signed copy of the Mining Plan is not available, as the same was not delivered by the Ministry of Coal after approval and Signature on the body of the Mining Plan.

Hope this meets the requirement.

Thanking You,

Yours Faithfully,



(D.K.Jain)

Head-Coal Mining
Rungta Mines Ltd &
Chairman -cum-MD
Radhikapur (West) Coal Mining Pvt. Ltd

Encl: Mining Plan in two volumes.

- Cc: - 1. Joint Secretary/Nominated Authority, MoC, New Delhi.
2. Shri S. K. Shahi, Director CA-I, MoC, New Delhi.
3. The Coal Controller, CCO, Kolkata

RADHIKAPUR (WEST) COAL MINING PRIVATE LIMITED

Plot No. 52, Shaheed Nagar; Bhubaneshwar-751007;

Phone: 0674-2546661; Fax: 2674-2540061;

Email : rungtas@satyam.net.in

MINING PLAN FOR RADHIKAPUR (WEST) COAL BLOCK TALCHER COALFIELD DISTRICT ANGUL, ORISSA

{Under Rule 22 (4) of Mineral Concessions (Amendment) Rules, 1994}

**[EXTENT : 1048 HA (2589.606 ACRES) OUT OF
WHICH 209.53 ACRES IS REVENUE FOREST LAND]**

(VOLUME I : TEXT & ANNEXURES)

APRIL, 2011

Prepared by:

**B.D.SHARMA
(Recognised Qualified Person)
(No. 13016/18/2004-CA Dt. 24th August, 2004)**

B.D.SHARMA

REP



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IAS-ANZ



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 RQP
 S.P.

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RQP

VOLUME II

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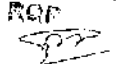
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RQ^s
[Signature]

ABBREVIATIONS

EIA	- Environmental Impact Assessment
EMP	- Environmental Management Plan
RQP	- Registered Qualified Person
ROM	- Run of Mine
IMD	- India Meteorological Department
OC	- Opencast
UG	- Under Ground
OB	- Overburden
TS	- Topsoil
IB	- Interburden
Ltd.	- Limited
Cum	- Cubic metre
UHV	- Useful Heat Value
K.Cal/kg	- Kilo Calorie per Kilogram
MTPA	- Million Tonne Per Annum
MCPA	- Million Cubic Metre Per Annum
LTPA	- Lakh Tonne Per Annum
TPD	- Tonne Per Day
PA	- Per Annum
Mil. cum.	- Million cubic metre
MBCM	- Million Bank Cubic Metre
Mil. te.	- Million Tonne
ML	- Mining Lease
NH	- National Highway
GT	- Grand Trunk
GSI	- Geological Survey of India
RH	- Relative Humidity
VM	- Volatile Matter
FC	- Fixed Carbon
CSM	- Continuous Surface Miner
PT	- Pandwa Top
HEMM	- Heavy Earth Moving Machinery
LHV	- Load Haul Dump
SDL	- Side Discharge Loader
FE Loader	- Front End Loader
HFL	- High Flood Level
E&M	- Electrical and Mechanical
DRI	- Direct Reduction Iron
RPM	- Respirable Particulate Matter
SPM	- Suspended Particulate Matter
m	- Metre
AMSL	- Above Mean Sea Level
bgl	- Below ground level
SC	- Scheduled Cast
ST	- Scheduled Tribe


 श्री. एच. डी. शन्मा
 अध्यक्ष, राष्ट्रीय मंत्रालय
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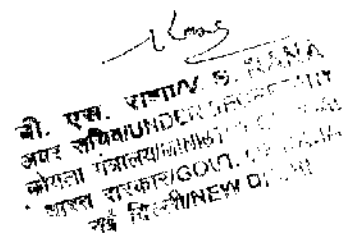
EXECUTIVE SUMMARY OF MINING PLAN

A. SUMMARISED DATA

1. GENERAL		
a)	Name and address of the Applicant Company	Radhikapur (West) Coal Mining Pvt. Ltd. Plot No. 52, Shaheed Nagar Bhubaneswar-751 007 Orissa, India Phone : 0674-2546661 Fax : 0674-2540061 Email : rungtas@satyam.net.in
b)	Name and address of the Block Allottee	1. M/s Rungta Mines Ltd., Rungta House, Chaibasa-833 202, Jharkhand 2. M/s OCL, India Ltd., 11th Floor, Narain mandal, 23, Barakhamba road, New Delhi 3. M/s Ocean Ispat Pvt. Ltd., 203, Kushal bazaar, 32-33, Nehru place, New Delhi
c)	Relationship between the applicant and allottee company	The "Radhikapur (West) Coal Block" has been allotted jointly to M/s Rungta Mines Ltd., M/s OCL, India Ltd. and Ocean Ispat Pvt Ltd for working through a Joint Venture Company named as Radhikapur (west) Coal Mining Pvt. Ltd.
d)	Status of the Applicant Company : Central /Public Sector Undertaking/State Government Undertaking/JV Company/ Pvt. Company/Public Co/Others (Specify)	Private Limited Company by Shares.  श्री. एस. राना / S. RANA अवर सचिव / UNDER SECRETARY कोयला मंत्रालय / MINISTRY OF COAL भारत सरकार / GOVT. OF INDIA नई दिल्ली / NEW DELHI
e)	Name of the Coal Block together with name of Coalfield & State where located	Radhikapur (West) Coal Block in Talcher Coalfield of Orissa
f)	Date of allotment	Letter No. 13016/33/2005-CA-I and modification letter No. 13016/77/2006-CA-I, Dated 21-12-2009.
g)	End Use of Coal/Lignite as per Approval by the Competent Authority	As per the allocation letter by the MoC, the distribution of total coal reserves of Radhikapur (West) block to the end users is as given in e below.

		<table><tr><th>Name of Shareholder</th><th>Proportionate share of coal reserve (MT)</th><th>Coal Entitlement (%)</th><th>End User of the coal</th></tr><tr><td>Rungta Mines Ltd.</td><td>142.38</td><td>67.671</td><td>DRI Plant at Jharband, Dhenkanal & FBB TPP at Komando, Sundergarh</td></tr><tr><td>Ocean Ispat Pvt Ltd.</td><td>37.1</td><td>17.633</td><td>DRI Plant & FBB TPP at Basantpur, Dist.Keonjhar</td></tr><tr><td>OCL India Ltd.</td><td>30.92</td><td>14.696</td><td>DRI Plant, FBB TPP & Cement Clinker Plant at Lalmoi & Rajgangpur in Orissa</td></tr><tr><td>Total</td><td>210.4</td><td>100</td><td></td></tr></table>	Name of Shareholder	Proportionate share of coal reserve (MT)	Coal Entitlement (%)	End User of the coal	Rungta Mines Ltd.	142.38	67.671	DRI Plant at Jharband, Dhenkanal & FBB TPP at Komando, Sundergarh	Ocean Ispat Pvt Ltd.	37.1	17.633	DRI Plant & FBB TPP at Basantpur, Dist.Keonjhar	OCL India Ltd.	30.92	14.696	DRI Plant, FBB TPP & Cement Clinker Plant at Lalmoi & Rajgangpur in Orissa	Total	210.4	100		
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h)	ROM Quantity proposed to be produced as per Mining Plan	Maximum up to 6MTPA																					
i)	Norms adopted for calculating ROM quantity requirement in case it differs from the quantity indicated in the Allotment Order.	<table><tr><th>Name of Share holder Company</th><th>Particulars</th><th>Norms adopted for coal requirement</th></tr><tr><td rowspan="2">Rungta Mines Ltd.</td><td>DRI Plant</td><td>1.6 (T/T) washed coal (27% ash)</td></tr><tr><td>FBB Power Plant</td><td>9307.5 T/MW, Rejects (50.25%)</td></tr><tr><td rowspan="3">OCL India Ltd.</td><td>Clinker Plant</td><td>0.225 (T/T) Washed Coal(27% ash)</td></tr><tr><td>DRI Plant</td><td>1.6 (T/T) Washed coal(27% ash)</td></tr><tr><td>Thermal power Plant</td><td>9307.5 T/MW, Rejects (50.25%)</td></tr><tr><td rowspan="2">Ocean Ispat Pvt Ltd.</td><td>Sponge Iron</td><td>1.6 (T/T) Washed Coal(27% ash)</td></tr><tr><td>Power Generation (FBB)</td><td>9307.5 T/MW, Rejects (50.25%)</td></tr></table>	Name of Share holder Company	Particulars	Norms adopted for coal requirement	Rungta Mines Ltd.	DRI Plant	1.6 (T/T) washed coal (27% ash)	FBB Power Plant	9307.5 T/MW, Rejects (50.25%)	OCL India Ltd.	Clinker Plant	0.225 (T/T) Washed Coal(27% ash)	DRI Plant	1.6 (T/T) Washed coal(27% ash)	Thermal power Plant	9307.5 T/MW, Rejects (50.25%)	Ocean Ispat Pvt Ltd.	Sponge Iron	1.6 (T/T) Washed Coal(27% ash)	Power Generation (FBB)	9307.5 T/MW, Rejects (50.25%)	
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j)	Beneficiation required – Yes/No	Yes																					
k)	Requirement of Beneficiated Coal & expected availability thereof.	<table><tr><th>Name of Share holder Company</th><th>Total raw coal requirement MT</th><th>Washed coal available, MT</th><th>Total raw coal available as per allotment letter, MT</th><th>%age satisfaction</th></tr><tr><td>Rungta Mines Ltd.</td><td>4.704</td><td>2.352</td><td>4.06</td><td>86.31</td></tr><tr><td>OCL India Ltd.</td><td>1.6848</td><td>0.64</td><td>0.88176</td><td>52.34</td></tr><tr><td>Ocean Ispat Pvt Ltd.</td><td>1.19845</td><td>0.6785</td><td>1.05798</td><td>88.28</td></tr></table>	Name of Share holder Company	Total raw coal requirement MT	Washed coal available, MT	Total raw coal available as per allotment letter, MT	%age satisfaction	Rungta Mines Ltd.	4.704	2.352	4.06	86.31	OCL India Ltd.	1.6848	0.64	0.88176	52.34	Ocean Ispat Pvt Ltd.	1.19845	0.6785	1.05798	88.28	
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l)	Period for which Mining Lease has been granted/is to be renewed/ is to be applied for.	30 years
m)	Date of Expiry of earlier Mining Lease, if any	N/A
n)	RQP who has prepared the Mining Plan Name Address Phone No Fax Email ID Registration No & date till valid Date of grant/Renewal of RQP Status Validity	Mr. B. D. Sharma A-121, Paryavaran Complex, IGNOU Road, New Delhi – 110030 29534777, 29532236, 29535891 091-011-29532568 min_mec@vsnl.com; minmec@bol.net.in; minmec@gmail.com 13016/18/2004-CA 10 years from last recognition dated 01.06.2004

B. INFORMATION REGARDING EARLIER APPROVED MINING PLANS, IF ANY. N/A (FIRST SUBMISSION)		
a) Approval Letter no. and Date	Not applicable as this is the 1 st Mining plan for submission 	
b) Lease Area		
c) Date of grant of Lease		
d) Date of Expiry of Lease		
e) Targetted Production		
f) Proposed date of start of Production		
g) Proposed date of achieving the targeted production level		
h) Envisaged life of the mine (in years)		
i) Date of actual commencement of Mining Operations, if operations already started		
j) Likely date of Mining Operations, if operations not yet started & reasons for non-commencement of operations		
k) Planned production and actual levels achieved in last 3 years		
l) Coal :- U/G O/Cast OB		
m) Reasons for difference between the planned and actual production levels		
n) Reason for revision of the Mining Plan	Old Plan	New Plan

o) Details of changes in the new mining plan compared to earlier approval (i) Lease Area (ii) Block Boundary (iii) Production level (iv) Reserves (v) Mining Technology (Additional sheets to be used, if required)	
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C. LOCATION	
a) Location of the Block Taluka/ Village/ Khasra/ Plot / Block Range / etc. District / State	Village- Barapada, Kusakila, Naupada, Kusakila jungle bar, Jhintipal, Putagaria, Balipata, Kosala., Taluka- Nuapada, Barapada, Kuskila District- Angul, Orissa
b) Name of the Coalfield/ Coal belt	Talcher Coalfields
c) Particulars of adjacent blocks: North, South, East, West	North: Southern bank of Singhada Jhor South: Arbitrary boundary demarcated roughly on coinciding the line joining borehole no. CMTR-062 and the trace of incrop of seam Local 2/ Nuapada Block. East : Western bank of Naubanda nala / Utkal F block. West: Eastern bank of Singhada Jhor/ Balipata Block
d) Area of the Allotted Block (hectares) i Geological block area ii Mining Block Area	1048 ha 1048 ha
e) Reference no. of plan of block boundary issued by CMPDI/ SCCL/ NLC (A copy of the Plan also to be annexed)	Block boundary is taken from GR supplied by CMPDIL vide their plate No. DRG. No. R-7/GEO/RP/GR/05/2 dated 20.03.2005 enclosed as Annexure No. S-1
f) Whether the lease boundary/ required boundary is same as demarcated by CMPDI/ SCCL/ NLC for delineating block/sub-block	Yes <i>[Signature]</i> श्री. एस. राजा/ S. RANA अवर सचिव/ UNDER SECRETARY कोयला मंत्रालय/ MINISTRY OF COAL भारत/ INDIA नई दिल्ली/ NEW DELHI
g) Existing mining Lease Area in case of existing mines, (hectares)	
h) Applied/ required Lease Area as per the Mining Plan under consideration (hectares)	1048 ha
i) Whether the applied lease area falls within the allotted block	Yes
j) Area (hectares) of lease which falls outside the block/sub-block delineated by CMPDI/SCCL/NLC.	Nil

k) Details of outside area: - Whether forms part of any other coal block - Whether it contains any coal/lignite reserves - Purpose for which it is required, e.g. roads/ OB dumps/ service buildings/ colony/ safety zone/ others (specify)	N/A																																																																																					
l) Whether some part(s) of the allotted block has not been applied for mining lease. - Total area in Ha. of such part(s). - Total reserves in such part(s). - Brief reasoning for leaving such part(s).	Applied for 1048 ha of the block, which is total area.																																																																																					
m) Type of Land involved in Hectares	<table border="1"> <thead> <tr> <th>Name of the Village</th> <th>Agriculture including habitation (Private) (Acres)</th> <th>Community, leasable & Gochar (Govt.) (Acres)</th> <th>Village Forest (Acres)</th> <th>Total Govt. & Village forest (Acres)</th> <th>Grand Total (Acres)</th> </tr> </thead> <tbody> <tr> <td>Barapada</td> <td>584.26</td> <td>151.423</td> <td>55.919</td> <td>207.34</td> <td>791.61</td> </tr> <tr> <td>Kusakila</td> <td>609.17</td> <td>124.32</td> <td>34.42</td> <td>158.74</td> <td>767.91</td> </tr> <tr> <td>Naupada</td> <td>330.1</td> <td>101.22</td> <td>21.37</td> <td>122.59</td> <td>452.69</td> </tr> <tr> <td>Kusakila</td> <td>225.58</td> <td>137.88</td> <td>69.96</td> <td>207.84</td> <td>433.42</td> </tr> <tr> <td>Jungle Bar</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Jhintipal</td> <td>25.267</td> <td>39.646</td> <td>4.362</td> <td>44.008</td> <td>69.275</td> </tr> <tr> <td>Putagadia</td> <td>38.68</td> <td>0.48</td> <td>22.21</td> <td>22.69</td> <td>61.37</td> </tr> <tr> <td>Balipata</td> <td>9.211</td> <td>0.213</td> <td>1.289</td> <td>1.502</td> <td>10.713</td> </tr> <tr> <td>Kosala</td> <td>2.621</td> <td>0</td> <td>0</td> <td>0</td> <td>2.621</td> </tr> <tr> <td>TOTAL</td> <td>1824.9</td> <td>555.182</td> <td>209.53</td> <td>764.71</td> <td>2589.6</td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td></td> <td>1048 Ha</td> </tr> </tbody> </table>	Name of the Village	Agriculture including habitation (Private) (Acres)	Community, leasable & Gochar (Govt.) (Acres)	Village Forest (Acres)	Total Govt. & Village forest (Acres)	Grand Total (Acres)	Barapada	584.26	151.423	55.919	207.34	791.61	Kusakila	609.17	124.32	34.42	158.74	767.91	Naupada	330.1	101.22	21.37	122.59	452.69	Kusakila	225.58	137.88	69.96	207.84	433.42	Jungle Bar						Jhintipal	25.267	39.646	4.362	44.008	69.275	Putagadia	38.68	0.48	22.21	22.69	61.37	Balipata	9.211	0.213	1.289	1.502	10.713	Kosala	2.621	0	0	0	2.621	TOTAL	1824.9	555.182	209.53	764.71	2589.6						1048 Ha													
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o) Proximity of public road / railway line/major water body if any and approximate distance	The block is well connected by road and rail. The district headquarter Angul is located on National Highway No. 42 (Manguli Chowk to Sambalpur). The nearest railway station is Angul 23 KM & Jarpada 10 KM from southern boundary of the block.																																																																																					

	The Angul-Rengali metalled road is around 2 km away from the eastern boundary of the block. Pitch, Mud and morrum roads are the medium of accessibility within and between the villages in this block.
p) Toposheet No. with latitude and longitude	It is covered by S.O.I Toposheet No. 73 D/13 on R.F. 1:50000, and special toposheet nos. M-1, M-2, L-1 and L-2 on R.F. 1:10,000 and is bounded by the following coordinates. Lat : 20° 57' 28" & 20° 59' 42" North Long : 84° 51' 00" & 84° 54' 47" East

D. GEOLOGY AND EXPLORATION

a) Name of the Geological Block and area in hectares	Radhikapur(West) Coal Block of 1048 ha. in Talcher Coalfield																
b) Name of the Geological Report (GR) with year of preparation	Geological report on Radhikapur block, Talcher Coalfield,. Distt. - Angul, Orissa. March, 2005																
c) Name of the agency which conducted exploration and prepared GR	CMPDI Ltd.																
d) Period of conducting exploration	July 2003 to April, 2004																
e) Details of drilling (by all agencies)	<table><tr><th rowspan="2">Type of Exploration</th><th colspan="2">Drilling</th></tr><tr><th>No. of boreholes</th><th>Meterage</th></tr><tr><td>Promotional</td><td>28</td><td>5,795.50</td></tr><tr><td>Detailed</td><td>81</td><td>11,526.00</td></tr><tr><td>Total</td><td>109</td><td>17,321.50</td></tr></table>			Type of Exploration	Drilling		No. of boreholes	Meterage	Promotional	28	5,795.50	Detailed	81	11,526.00	Total	109	17,321.50
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f) No. of boreholes drilled within the block	109 Nos																
g) Overall borehole density within the block (no./ sq. km)	9.62																
h) Area covered by 'detailed' exploration within the block (hectares)	1048																
i) Area covered by 'detailed' exploration outside the block (hectares) - No. of boreholes drilled outside the block - Bore hole density for outside area (no./sq. km)	वी. एस. राना/V. S. RANA अवर सचिव/UNDER SECRETARY कोयला विभाग/MINISTRY OF COAL भारत N/A/GOVT. OF INDIA NEW DELHI																
j) Whether entire lease area has been covered by 'detailed' exploration.	Yes																

k) Whether any further exploration is required or suggested and timeframe in which it is to be completed	No		
l) Number of coal/lignite seams/horizons - Thickness range of coal seams - mean Thickness of total coal horizon - Standard Deviation of thickness - Minimum & maximum depth of coal seams	Seam/ parting	Thickness (m)	
		Minimum	Maximum
	Soil	0	18
	WM	0	37.83
	XI	0.11	5.92
	PA11	2.01	16.97
	LOC1	0.09	1.55
	PA12	7.05	20.09
	X	0.12	6.2
	PA13	23.24	50.37
	IX	1.08	41.84
	PA14	0.79	23.59
	VIII TOP	0.1	2.66
	PA15	1.08	10.24
	VIII BOT	0.07	1.09
	PA16	1.04	22.65
	VII B	0.08	4.06
	PA 17	2.63	18.14
	VII A	0.04	3.68
	PA 18	4.58	15.57
	VI B	0.05	0.47
	PA 19	5.33	18.6
	V B	0.13	1.16
	PA 20	3.68	16.01
	V A	0.05	1.4
	PA 21	0.72	10.92
	IV B	0.15	1.37
	PA22	7.39	2.05
	LOC 2	0.05	3.12
	PA 23	6.9	26.17
	III E	0.1	8.9
	PA 24	15.66	32.4
	III D	0.11	2.11
	PA 25	3.57	14.5
	III A TOP	0.15	2.04
	PA 26	1.07	12.28
	IIIA (BOT)	0.34	7.99
	PA27	19.9	27.45
	II C	0.3	1.65
	PA 28	38.36	28.36
	II B	0.42	4.71
	PA 29	4.57	4.57
	II A	1.67	1.67


 श्री. एन. एन. व. एस. राना
 जूनियर सचिव/UNDER SECRETARY
 कोयला मंत्रालय/MINISTRY OF COAL
 भारत सरकार/GOVT. OF INDIA
 नई दिल्ली/NEW DELHI

m) Gross Calorific Value (GCV in K Cal/kg) and Useful Heat Value (UHV in K.Cal / Kg), of coal as per GR : Range Mean	Seam	Grade Range	UHV K.Cal/Kg.	GCV K.Cal/Kg.		
	XI	G-G	1351-2235	3120-3670		
	X	G-F	1324-3049	3040-4174		
	IX	E-F	1034-3366	2807-4375		
	VIII Top	F-G	1517-3090	3000-4203		
	VII B	E-G	1351-3973	3092-4751		
	IV B	E-G	1365-2442	3125-4877		
	Local 2	G-G	1889-2248	3315-3760		
	III E	F-G	1338-2028	2995-4040		
	III D	E-G	2083-3739	3680-4345		
	III A Top	F-UNGR	1945-3145	2050-4093		
	III A Bot	E-F	2248-3725	3630-4882		
	n) Quality (Grade) of coal as per GR : Range Mean	Seam	Grade-wise Net Proved Reserves in million tonnes			
		D	E	F	G	
XI		0	0	0.023	4.105	4.128
X		0	0	0	1.291	1.291
IX		0	0	0.368	194.47	194.835
VIII Top		0	0.005	0.109	1.726	1.84
VII B		0	0.709	5.901	12.183	18.793
IV B		0	0.183	1.55	0.476	2.209
Local 2		0	0	0	3.687	3.687
III E		0	0	0	12.473	12.473
III D		0.005	0.294	1.686	1.964	3.949
III A Top		0	0	1.901	5.399	7.3
III A Bot.		0	5.183	30.14	2.611	37.935
Total		0.005	6.374	41.68	240.38	288.44
o) Total geological reserves in the block	288.44 MT					
p) Depletion of reserves (in case of running mine)	N/A					
q) Additional reserves established (if any for running mine)	N/A					
r) Geological reserves considered for mining:						
by opencast	200.254MT					
by Underground	88.186MT (50.85MT in thickness >1.80m)					
s) Corresponding Extractable reserves:						
by opencast	140.293 MT (I ₁₀₀)					
by Underground	26.48 MT					
t) Percentage of recovery w.r.t. geological reserves:						
by opencast	70.06%					
by Underground	30.03%					

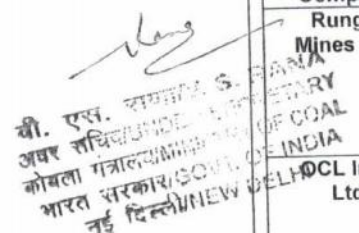
E. MINING	
a) Existing and proposed method of mining (Opencast for OB & coal separately with dragline/shovel/ surface miners/ manual/ etc.) (underground by longwall/ bord & pillar/ continuous miners/LHD/ SDL/ manual/ etc.)	Continuous Surface Miner along with Shovel and dumper Combination for Open cast Mining of Coal and Shovel Dumper Combination for OB removal. Mechanised bord and pillar underground mining with two numbers of Continuous Miner with shuttle cars.
b) Targeted capacity in MTPA when the mine is fully developed and the year in which proposed to be achieved	1) Target capacity of block achieved as 6.00 MT in 5th year as follows: OC=6.00 MT UG=0.00 MT Total= 6.00 MT 2) Target capacity maintained in 13th year as follows: OC=5.30 MT UG=0.70 MT Total= 6.00 MT
c) Life of the mine Underground workings Opencast workings Overall	41 Years 25 Years 49 Years

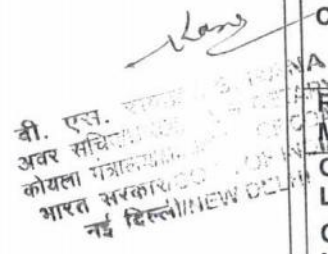
d) Indicate quantum of production and expected grade as in table below :-								
Year	UG Production Mt		Opencast			ROM coal/ lignite (Mt)	Saleable/ Benificiated coal/ lignite (Mt)	Washery Rejects (Mt)
			Production Mt	OB (Mcum)	Stripping ratio (cum/t)			
Year wise till targeted production is reached	1 st Year	0.00	0.30	3.08	10.26	0.30	0.15	0.15
	2 nd Year	0.00	1.80	7.67	4.26	1.80	0.90	0.90
	3 rd Year	0.00	3.30	14.29	4.33	3.30	1.65	1.65
	4 th year	0.00	4.80	26.26	5.47	4.80	2.4	2.4
	5 th year	0.00	6.00	25.94	4.32	6.00	3.00	3.00
Total for full lease period	49 th Year	26.48	125.03	523.48	4.19	151.51	75.755	75.755

Furnish the detailed calendar programme of coal production year wise and seam wise along with OB removal in the relevant chapter	Detailed calendar programme of coal production year wise and seam wise enclosed in Table 5.15 & 5.16 in Chapter 5
e) Whether the proposed external OB dump site is coal/ lignite bearing: - If so, whether coal/lignite below waste disposal area is extractable.	No

f) Whether negative proving for coal / lignite in the proposed site for OB dump/ infrastructure has been done.	Not required.
g) Proposed configuration of HEMM for OC (Coal & OB) & Major Equipment for UG.	For OC coal mining 0.9 -1.5 M3 shove l(3), 15/20 T.R.D. Trucks (12), R.B.H Drills 110/115 MM(3) and two Continuous Surface Miners (2200 W), For OC Overburden removal 8 -6 M3 shovel (12), 100 T.R.D (40 Nos.) & 50 TRD (8 Nos.). Trucks, R.B.H Drills 200/250 MM(11) For underground Mining Continuous Surface Miners (2200 W) – 2 Nos. LHD (2); Roof Bolters (2); 1200mm & 1000mm PVC belt Conveyor; main Pumps (4), Main Mechanical ventilator (2), Auxiliary fans (6).
h) Mode of entry for underground mines (shaft, incline, adit,):	One pair of Inclines as No. 1&2 for transport of coal and material including walkway and one ventilation shaft for peripheral ventilation.
i) Operations that are proposed to be outsourced	Security
j) Proposed coal evacuation facilities Face to Surface Surface to end use plants	System of belt Conveyors for underground transport up to pit head, tippers from pit head to railway siding and railways for final destination

F. END USE OF COAL/ LIGNITE

a) Capacity of the approved end use plants	Name of Share holder Company	Particulars of End Use Plant	Plant Capacity	Rate of Coal Consumption
	Rungta Mines Ltd.	DRI Plant	1.47 MTPA	1.6 (T/T) of washed coal
		FBB Power Plant	255 MW	9307.5 T/MW of reject coal with 50.25% Ash content
	OCL India Ltd.	Clinker Plant	1.1 MT	0.225 (T/T) of washed coal
		DRI Plant	0.27MT PA	1.6 (T/T) of washed coal
		Thermal power Plant	108 MW	9307.5 T/MW of reject coal with 50.25% Ash content
	Ocean Ispat Pvt Ltd.	Sponge Iron	0.40 MTPA	1.6 (T/T) of washed coal
		Power Generation (FBB)	60 MW	9307.5 T/MW of reject coal with 50.25% Ash content

b) Coal/ lignite requirement for end use plant with grade/quality	Particulars	Washed coal, MT	Rejects, MT	Total Raw coal, MT
	i. Rungta Mines Ltd.			
	DRI PLANT	2.352	2.352	4.704
	FBB Power plant	0	0	2.3734
	(-) Rejects available			2.352
	Balance requirement			0.0214
	ii. OCL India Ltd.			
	Clinker plant	0.2475	0.2475	0.495
	DRI Plant	0.432	0.432	0.864
	Sub total "A"	0.6795	0.6795	1.359
	Thermal power plant	0	0	1.0053
	(-Rejects generated at "A"			(-) 0.6795
	Sub Total "B" Balance		0	0.3258
	Grand total "A" + "B"			1.6848
	iii. Ocean Ispat Pvt Ltd.			
	Sponge Iron	0.64	0.64	1.28
	Power Generation (FBB)	0	0	0.55845
	Total			1.83845
	(- Rejects available			(-) 0.64
	Total balance			1.19845
c) % age of end use requirement to be met from this mine	Name of Share holder Company	Total raw coal requirement MT	Total raw coal available as per allotment letter MT	%age satisfaction
	Rungta Mines Ltd.	4.704	4.06	86.31
	OCL India Ltd.	1.6848	0.88176	52.34
	Ocean Ispat Pvt Ltd.	1.19845	1.05798	88.28
d) If washing / beneficiation of the coal/ lignite is planned to be conducted on site or adjacent to the extraction area, briefly describe the nature of the beneficiation and recovery rate.	Selective mining is proposed while mining of seam IX with the help of CSM by segregating dirt bands of more than 20 cm. Subsequently, the washery is planned at pit head to bring down the ash to 27(+/-) 1 %. The yield of clean coal adopted as 50% while the 2nd stream rejects will be also 50%. The clean coal will be used for DRI plants and the rejects (>50% ash) will be used for power generation using FBB technology.			
e) Proposed Use of Rejects/Middlings	Rejects are used in power plant.			

G. ENVIRONMENTAL MANAGEMENT		
a) Existing land use pattern	Given in Table No.12.1 of Chapter 12	
b) Land area indicating the area likely to be degraded due to mining, dumping, roads, workshop, washery, township etc.	Particular	Area in Ha
	OC Mine Pit-Area	750.92
	Washery	10.00
	OB Dump	100.00
	Top Soil Stack	5.00
	Raw Coal Stack	7.00
	Facility Area	OC 6.55
		UG 3.45
	CHP	1.00
	Washed Coal Stack	6.00
	Green Belt	16.75
	Settling Pond	5.50
	Washery Reject Stack	2.00
	Road	12.00
	Bund	15.70
	Magazine	0.20
	Undisturbed at surface (under UG mining)	105.93
	Total Block Area	1048.00
c) Surface features over the block area	Three Villages: Barpada, Kuskila and Nuapada	
d) No. of villages/Houses to be shifted	About 400 Households.	
e) Population to be affected by	About 2000 persons	
f) Year wise proposal for reclamation of land affected by mining activities	Reclamation programme is envisaged.	
g) Monitoring schedules for different environmental components after the commencement of mining and other related activities.	Ambient air quality twice a week, water once a season, soil once a year, noise once a year	

H. PROGRESSIVE AND FINAL MINECLOSURE PLAN: Separate Chapter No 15 given (A separate chapter is also to be incorporated)		
a) Estimated total capital expenditure for mine closure activities	Rs 5330.75 Lakhs	

Activities	Amount (Rs. Lakh)
A. OPENCAST	
I. Progressive Mine Closure Plan	
Barbed wire fencing around the dump	91.19
Barbed wire fencing around the pit	221.29
Garland drain around dump	30.27
Rehabilitation/ plantation	1135.64
Settling Pond	110.00
Toe wall around the dump	60.45
Top soil management	2040.00
Sub Total (I)	3688.83

Activities	Amount (Rs. Lakh)
II. Post Mine Closure Plan	
Rehabilitation/ plantation	312.42
Toe wall around the dump	0.00
Top soil management	225.00
Concrete wall (0.4m wide, 1.5m high) fencing around the pit	500.50
Rearranging water pipe line from earlier alignment to the dump top parks	20.00
Ghat No-1 for boating	20.00
Beautification of parks over the dumps	60.00
Environmental monitoring (air, water, noise, soil)	30.00
Construction of view point tower no.1	20.00
Rehabilitation/ plantation (TS dump)	20.00
Cost of boats and their parking	20.00
Ghat-2 for boating	20.00
Construction of view point tower No. 2	20.00
Ghat-3, 4 and 5 for boating	60.00
Construction of view point tower No. 3	20.00
Sub Total (II)	1347.92
Total OF Opencast (A)	5036.75
B. Underground Post Mine Closure Plan	
Barbed wire around inclines, around ventilation shaft (500m) @ Rs 1500/m	15.00
Under Ground stoppings and sealings for prevention of future fire etc (LS)	20.00
Dismantling ventilation fan	1.00
Dismantling of conveyors (inclines and in seam about 5000m @ 2000/m)	100.00
Dismantling of rail tracks 5000m @ Rs 500/M	25.00
Dismantling of Pumps (LS)	5.00
Dismantling of CHP (LS)	10.00
Dismantling of part of the facilities (buildings & workshop etc) (LS)	40.00
Dismantling of HTL/LTL	5.00
Plugging of 1 pair of incline @ Rs 4 lakh	4.00
Plugging of 1 ventilation shaft	2.00
Rehabilitation/ plantation (facilities)	47.00
Others (Miscellaneous)	20.00
Total OF Underground (B)	294.00
GRAND TOTAL FOR OC & UG (A+B)	5330.75

I. OTHERS	
a) Base date of Mining Plan.	February, 2011
b) Calendar year from which the production will start	21 May, 2014
c) Results of any investigation carried out for scientific mining, conservation of minerals and protection of environment; future proposals.	No
d) Signature of RQP Date Place	

CHAPTER 1

INTRODUCTION

1.1 NAME OF APPLICANT WITH COMPLETE ADDRESS

Registered Office:	Communication Address:
Radhikapur (West) Coal Mining Pvt. Ltd.	Radhikapur (West) Coal Mining Pvt. Ltd.
Plot No. 52, Shaheed Nagar	Rungta House
Bhubaneswar-751 007	Chaibasa - 833201
Orissa, India	Jharkhand, India
Phone : 0674-2546661	Phone : 06582-256321/621
Fax : 0674-2540061	Fax : 06582-257521
Email : rungtas@satyam.net.in	Email : rungtas@satyam.net.in

1.2 STATUS OF THE APPLICANT

Private Limited Company by Shares.

कोयला मंत्रालय, भारत सरकार
नई दिल्ली
NEW DELHI

1.3 BACKGROUND OF THE COMPANY

The "Radhikapur (West) Coal Block" has been allotted jointly to M/s Rungta Mines Ltd., M/s OCL, India Ltd. and Ocean Ispat Pvt Ltd for working through a Joint Venture Company vide letter No. 13016/33/2005-CA-I dt 25-04-2006 and modification letter No. 13016/77/2006-CA-I, Dated 21-12-2009. The allottees have formed a joint venture Company named as Radhikapur (west) Coal Mining Pvt. Ltd. The information about the three companies is given in following paragraphs.

M/S Rungta Mines Ltd. (RML) is a registered company under the Companies Act and is one of the oldest and active leading mining company in the eastern part of the country. RML is one of the major iron ore producer in the Easter India and is proud of producing high grade Iron ore from its own lease hold areas. Company is catering the iron ore needs of the eastern and the central parts of the country. RML is carrying the active mining operations in its lease hold areas for Iron ore, Manganese Ore, Limestone etc spread over the state of Jharkhand, Orissa, Chhattisgarh and Madhya Pradesh. RML is also carrying out the reconnaissance studies for Gold, Diamond, Copper, Lead etc (PG minerals) in the States of Orissa, Chhattisgarh and Madhya Pradesh.

Rungta Mines Ltd. has been allocated captive coal blocks in the States of Jharkhand & Orissa exclusively against its End Use Projects. Apart from the Radhikapur (west) Block which has been allocated jointly, company has been allocated three more coal blocks in the State of Jharkhand – one exclusively to RML and other two in Joint Venture mode.

Rungta Mines Ltd is carrying out both backward and forward integration in Mineral Sector, an important factor in case of mineral and mineral development sector of the country. RML has signed MOU with Govt. of Jharkhand and Govt. of Orissa for commissioning the Mineral value addition projects in the State of Jharkhand and Orissa. Accordingly, company has already commissioned a part of the project planned and are giving the commercial production at this juncture itself.

M/s Ocean Ispat Pvt. Ltd. belongs to a Profit making BFL group which is a reputed premier Global Information Technology Consulting and Services Group. Ocean Ispat Pvt. Ltd. proposed to set up an Integrated Steel Project in village Basantpur, Tehsil Joda, Keonjhar, Orissa based on Technology of Direct Reduced Iron (DRI) / Sponge Iron and Induction Furnace route with power generation. The details are as follows:

a. Sponge Iron	:	4 Lac MTPA
b. Steel Manufacturing	:	1.65 Lac MTPA
c. Power Generation(FBB)	:	25 MW

OCL India Limited, formerly "Orissa Cement Limited" and better known as "OCL" was established in the year 1949 at Rajgangpur, district Sundergarh, Orissa. OCL is in Business of manufacturing Cement, Refractories for last 6 decades. OCL entered into business of Steel in the year 2001-02 by setting up a coal based Sponge Iron manufacturing unit at its Rajgangpur works. It further forayed in to Steel making by setting-up Steel Melt Shop and Billet Casting facilities along with 18 MW Coal based Thermal Power plant for captive consumption. In the year 2009, OCL set up a Cement manufacturing unit at Kapilas Cement Works (KCW), near Cuttack (Orissa) and set-up a new Clinkering line at Rajgangpur.

OCL has following manufacturing capacities at present:

• Clinkerisation	:	2.9 Mil. TPA
• Cement	:	5.35 Mil. TPA
• Refractories	:	0.106 Mil TPA
• Sponge Iron	:	0.12 Mil TPA
• Steel	:	0.10 Mil TPA
• FBB TPP	:	18 MW

[Handwritten signature]
श्री. एम. शाहमा
अवर सचिव
ओबला नगरपालिका
भारत सरकार
नई दिल्ली
NEW DELHI

OCL is already in process of taking adequate steps necessary for setting up following facilities:

• Sponge Iron	:	0.15 Mil TPA
• FBB TPP	:	90 MW

OCL also has its own "Dalmia Institute of Scientific & Industrial Research" for carrying out R&D in the fields of Cement & Refractory manufacture.

1.4 MINERAL OR MINERALS WHICH ARE OCCURRING IN THE AREA AND WHICH THE APPLICANT INTENDS TO MINE

Coal

1.5 PERIOD FOR WHICH THE MINING LEASE IS REQUIRED

30 years.

1.6 REFERENCE NO. AND DATE OF LETTER FROM THE MINISTRY OF COAL

MOC allotment letter No. 13016/33/2005-CA-I and modification letter No. 13016/77/2006-CA-I dt 21-12-2009 from Government of India Under Option-I (Annexure 1-1) by forming a joint venture company.

Receipt No A-6188 dated 11-05-2006 for payment of Rupees 7,66,15,940 /- (Seven Crore Sixty Six lakh Fifteen Thousand Nine Hundred Forty only) as exploration cost paid by M/s Radhikapur (West) Coal Mining Private Ltd. to CMPDIL (Annexure 1-2).

Vide letter No DG/69(A)/1254 dt 11-5-2006, Central Mine Planning and Design Institute Limited handed over the Geological data to M/s Rungta Mines Ltd. (same Annexure as above).

1.7 END USERS

The "Radhikapur (West) Coal Block" has been allotted jointly to M/s Rungta Mines Ltd., M/s OCL, India Ltd. and Ocean Ispat Pvt. Ltd. for working through a joint venture company for meeting their proportionate share of requirement of coal. As per the allocation letter by the MoC, the distribution of total coal reserves of Radhikapur (West) block to end users is as given in Table 1.1.

**TABLE 1.1
DISTRIBUTION OF ALLOTTED RESERVES BY MOC**

Sl. No.	Shareholder	Proportionate share of coal reserve (MT)	Coal Entitlement (%)	End Use of the coal
1	Rungta Mines Ltd.	142.38	67.671	DRI Plant at Jharband, Dhenkanal & FBB TPP at Komando, Sundergarh
2	Ocean Ispat Pvt Ltd.	37.1	17.633	DRI Plant & FBB TPP at Basantpur, Dist.Keonjhar
3	OCL India Ltd.	30.92	14.696	DRI Plant, FBB TPP & Cement Clinker Plant at Lalmoi & Rajgangpur in Orissa
	Total	210.4	100	

The coal produced from the mine will be entirely for their captive use and it shall not replace any coal linkage given to them by the Coal India Ltd. or its subsidiary and/or by the Singareni Collieries Company Ltd.

All the coal produced from the mine will be directly transported to plants by Rail. Provision has been made to keep a stock of coal at the mine site to accommodate up to 7 day's production which will take care of feeding the down stream in case of any breakdown. The block is well connected by road.

The approximate distance of various EUPs is given in the following table:

Name of JV partner	Name of the EUP	Location	Distance from Radhikapur (West) Coal Block, Km	Mode of transport (Rail/ Road/ Conveyor)
Rungta Mines Ltd.	1. DRI Plant	a. Jharband, Dhenkanal	a. 50 km	Rail
	2. FBB TPP	b. Komando, Sundergarh	b. 300 km	
Ocean Ispat Pvt. Ltd.	1. DRI Plant	Basantpur,	300 km	Rail
	2. FBB TPP	Dist. Keonjhar		
OCL India Ltd.	1. DRI Plant	Lalmoi	260 Km	Rail
	2. FBB TPP	Lalmoi & Rajgangpur		
	3. Clinker Plant	Rajgangpur		

1.8

NORMS USED FOR COMPUTING COAL CONSUMPTION

(i) Rungta Mines Ltd.

Particulars	Capacity of EUP	Rate of Coal Consumption	Washed coal, MT	Rejects, MT	Total Raw coal, MT
DRI Plant	1.47 MT	1.6 (T/T)	2.352	2.352	4.704
FBB Power plant	255 MW	9307.5 T/MW	0.00	2.3734	
(-) Rejects available				2.352	
Balance requirement				0.0214	
Share of Rungta Mines Ltd as per allotment Letter		67.67%			4.06
% age satisfaction					86.31

The rest gap of washed coal will be filled from the E-auction, open market or linkage. The rejects to the tune of 4.704 MT-2.352 MT= 2.352 MT generated above will be used for power generation by FBB plant of about 255 MW capacity.

(ii) OCL India Ltd.

Plant	Capacity, Mil. T	Rate of washed coal consumption	Rate of raw coal consumption (T/T)	Total washed coal, Mil T	Rejects generated, Mil Te	Total raw coal required' Mil T
Clinker plant	1.1	0.225 T/T	0.45	0.2475	0.2475	0.495
DRI Plant	0.27	1.6 T/T	3.2	0.432	0.432	0.864
Sub total "A"				0.6795	0.6795	1.359
Thermal power plant	108 MW (60+30+18)	0.00	9307.5 T/MW	0.00	0.00	1.0053
(-Rejects generated at "A"						(-) 0.6795
Sub Total "B" Balance					0.00	0.3258
Grand Total "A" + "B"						1.6848
Share of OCL India Ltd as per allotment Letter	6.00 mil Te production from mine		14.696 %			0.88176
%age satisfaction						52.34 %

The balance requirement will be fulfilled from open market, E-Auction or linkage.

(iii) Ocean Ispat Pvt. Ltd.

Ocean Ispat Pvt. Ltd. proposed to set up the following product facilities:

Particulars	Capacity	Rate	Washed Coal, MT	Rejects, MT	Raw coal
Sponge Iron	0.40 MTPA	1.6 T/T	0.64	0.64	1.28
Power Generation (FBB)	60 MW	9307.5 T/MW	0.00	0.00	0.558450
Total					1.83845
(-) Rejects available					(-) 0.64
Total balance					1.19845
Share of Ocean Ispat Pvt. Ltd as per allotment Letter	6	17.633%			1.05798
%age satisfaction			97.20 %		88.28%

The balance requirement will be fulfilled from open market, E-Auction or linkage.

1.9 COAL BENEFICIATION

Coal beneficiation is proposed at the pit head by the company. The overall quality of all the mineable coal is mostly grade G followed by Grade F as elaborated in chapter 4. The washery is detailed in Chapter 10 in which 2 coal streams are proposed -clean coal with 27% ash for use in DRI plants and rejects with over 50% ash to be used for power generation.

1.10 NAME OF RQP PREPARING MINING PLAN

Name	: Mr. B. D. Sharma
Address	
(i) Office	: A-121, Paryavaran Complex, IGNOU Road, New Delhi – 110030
Phone	: 29534777, 29532236, 29535891
Fax	: 091-011-29532568
E-mail	: minmec@gmail.com
Web site	: http://www.minmec.co.in
Registration Number	: 13016/18/2004-CA dt 24-08-2004 valid upto 23-08-2014
Date of grant / renewal	: 01.06.2004
(ii) Residence	: A-121, Paryavaran Complex, IGNOU Road, New Delhi – 110030
Phone	: 29534777, 29535891

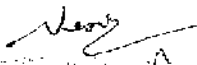
श्री. एच. बलराज रेड्डी
अवर सचिव (उत्पत्ति) - कोयला
कोयला मंत्रालय
भारत सरकार
नई दिल्ली
GOVT. OF INDIA
NEW DELHI

(Xerox copy of certificate is attached as Annexure 1-3)

CHAPTER 2

DETAILS OF EARLIER APPROVAL OF MINING PLAN

No Mining Plan has been prepared in the past. This is the 1st Mining Plan being submitted for this block.


वी. एन. राय/ V. N. RAY
अवर सचिव/UNDER SECRETARY
कोयला विभाग/MINISTRY OF COAL
भारत सरकार/GUVT. OF INDIA
नई दिल्ली/NEW DELHI

CHAPTER 3

LOCATION, TOPOGRAPHY AND COMMUNICATION

3.1 GENERAL LOCATION AND VICINITY

The Radhikapur (West) Coal Block spans over an area of 10.48 Sq.km between Latitude 20° 57' 28" & 20° 59' 42" North and Longitude 84° 51' 00" & 84° 54' 47" East. The block is covered under Survey of India Toposheet no. 73 D/13 on R.F. 1:50000, and special toposheet nos. M-1, M-2, L-1 and L-2 on R.F. 1:10,000 and falls within Angul district of Orissa state. The maximum extents of the block are about 5 km strike direction and about 3.5 km in dip direction.

The limits of Radhikapur (West) Coal Block are as given in Table 3.1:

TABLE 3.1
BOUNDARIES OF THE BLOCK

East	Western bank of Naubanda nala / Utkal F block.
West	Eastern bank of Singhada Jhor/ Balipata Block
North	Southern bank of Singhada Jhor
South	Arbitrary boundary demarcated roughly on coinciding the line joining borehole no. CMTR-062 and the trace of incrop of seam Local 2/ Nuapada Block

The location plan is given at Plate I. The latitudes and longitudes of all the points shown in the Key Plan (Plate II) are as shown in Table 3.2 below:

TABLE 3.2
LATITUDES AND LONGITUDES OF THE BLOCK

Point	Longitude	Latitude
A	84deg 51' 14"	20 deg 0 58' 27"
B	84 deg 53' 14"	20 deg 57' 46"
C	84 deg 53' 16"	20 deg 0 58' 27"
D	84 deg 54' 36"	20 deg 59' 17"
E	84 deg 53' 10"	20 deg 59' 42"

Dr. RANJAN K. RAMA
Geologist
Ministry of Coal, Government of India
New Delhi

3.2 DETAILS OF AREA

- District and state : District : Angul in Orissa
- Taluka : Nuapada, Barapada, Kuskila
- Village : Barapada, Kusakila, Naupada, Kusakila jungle bar, Jhintipal, Putagaria, Balipata, Kosala.

- Khasra No./Plot No./Block range/ : Refer Annexure 3-1 (Plate III)
felling series etc.
- Lease area (Ha) : 1048 Ha (2589.606 Acres)
- Whether the area is recorded to : Revenue forest (209.53
be in forest (Please specify Acres)
whether protected, reserved etc.)
- Ownership / occupancy : Refer Annexure 3-1.

3.3 OWNERSHIP/OCCUPANCY AND LAND USE INCLUDING FOREST

The details of ownership / occupancy and land use are given in Annexure 3-1. Summary of the land use details are given in Table 3.3.

TABLE 3.3
LAND SCHEDULE FOR MINING LEASE FOR COAL OVER AREA

Sl. No.	Name of the Village	Private Lands including Agriculture (In Acres)	Government Lands (in Acres)					Grand Total (In Acres)
			Communal	Leasable	Gochar	Village Forest	Total Govt.	
1	Barapada	584.263	75.249	32.342	43.832	55.919	207.342	791.605
2	Kusakila	609.170	37.570	39.240	47.510	34.420	158.740	767.910
3	Naupada	330.100	17.000	45.100	39.120	21.370	122.590	452.690
4	Kusakila Jungle Bar	225.582	3.550	98.150	36.180	69.960	207.840	433.422
5	Jhintipal	25.267	2.940	21.169	15.537	4.362	44.008	69.275
6	Putagadia	38.680	0.480	0.000	0.000	22.210	22.690	61.370
7	Balipata	9.211	0.173	0.000	0.040	1.289	1.502	10.713
8	Kosala	2.621	0.000	0.000	0.000	0.000	0.000	2.621
TOTAL		1824.894	136.962	236.001	182.219	209.530	764.712	2589.606

(Say 1048 Ha)

3.4 TOPOGRAPHY AND DRAINAGE PATTERN

The surface topography is generally flat around most of the area which is being used for cultivation purposes by the villagers around south central part. The surface topography is mildly undulating and slopes towards water body. The ground level rises towards south-central area with highest elevation above mean sea level and is at about 195m. The surface elevation gradually decreases towards north-eastern corner of the above

and is as low as about 130 metres near boreholes no. CMTR 085 located in proximity to Singhada Jhor.

Brahmani river, flowing approximately north to south direction along the eastern boundary of the Talcher coalfield, provides the main drainage of the region. This river is fed by seasonal nalas, viz., Tikra Jhor, Singhada Jhor, Bangaru Jhor, Nandira Jhor and a few other nalas. From the eastern boundary of Radhikapur (West) Coal Block, the Brahmani river lies eastwards at a distance of about 35 km.

Singhada Jhor flows eastwards in the eastern and northern extremities of the block and forms the eastern and northern boundary of the block as well. The Singhada Jhor merges in its down stream into Brahmani river at the north eastern part of the coalfield. Nuabanda nala, which forms the eastern boundary of the block, flows into Singhada Jhor at the north-eastern corner of the block and controls the drainage pattern of the block. Nuabanda nala originates from a large water body at the south-central part of the block. The water collected within the water body are being utilized for irrigation and other purposes by the local villagers during dry seasons. Small ponds and dug wells are common in this block and are utilized as well for irrigation and drinking purpose. Morrum and mud roads are very common in and around villages within the block, viz. Nuapada, Kuskila and Barpada.

3.5 CLIMATE AND RAINFALL

The area exhibits tropical to semi-tropical climate. The area falls within the daily mean temperature zone from 25°C to 27°C . The summers are extreme and the temperature shoots to around 45°C or even higher. Data on daily rainfall for 22 years (1960-81) shows that the annual rainfall varies between 71 cm and 186 cm. Humidity varies from 25% to 88%. Annual mean wind speed is 0.24 km/hour. Wind direction during pre-monsoon season is mainly east but in post-monsoon period it changes towards northwest and northeast.

3.6 COMMUNICATION & ACCESSIBILITY

Public road

District headquarter Jarapada, located on National Highway 10 (Manguli Chowk to Sambalpur), is the nearest town at a distance of about 24 km from the southern boundary of the block. The Angul-Rengali metalled road is around 2 km away from the eastern boundary of the block. Mud roads and morrum roads are the medium of accessibility within and between the villages in this block.

Railway line

The nearest railhead Jarapada is situated at a distance of about 10 km from the southern boundary of the block and is connected to Sambalpur-Bhubaneswar railway line of east coast railways.

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Sea port

The nearest port, Paradeep at Bay of Bengal, is situated at a distance of about 240 km towards the eastern direction from the block.

Air port

The Biju Pattanaik International Airport, located at the state capital Bhubaneswar, is the nearest air port from the Radhikapur (West) Coal Block located at a distance of about 200 km towards south-eastern direction from the block.

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CHAPTER 4

EXPLORATION, GEOLOGY, SEAM SEQUENCE,
COAL QUALITY AND RESERVES

4.1 EXPLORATION

4.1.1 Previous work

MECL, at the instance of CMPDI, carried out scout regional exploration in a large area of adjacent Utkal block, covering an area of 22 sq.km from 14-02-1983 to 11-02-1984. Twenty three scout boreholes were drilled by MECL, based on which "Geological report on exploration for coal in Utkal block" was submitted by MECL in April, 1985. Subsequently, based on the favourable findings in the said geological report, CMPDI initiated detailed exploration in Utkal block from April, 1989 onwards. Utkal block was subsequently divided into Utkal A, Utkal B1, Utkal B2, Utkal C, Utkal D, Utkal E and Utkal F blocks. Detailed exploration has since been completed by CMPDI in Utkal A, Utkal B1, Utkal B2, Utkal C and Utkal D blocks and respective geological reports has been submitted. The exploration is in final stage in Utkal E and Utkal F blocks.

MECL also undertook promotional exploration in west and north of Radhikapur (West) Coal Block i.e. Balipata area, during 1992-1994.

4.1.2 Present work

As per the available regional geological information around the area, the Radhikapur (West) Coal Block appears to be less disturbed from geological structural points of view. Prior to the detailed exploration of the block, there was an apprehension of thinning of coal seams towards western part of the block. The block was accordingly programmed for drilling in square grid pattern with 200 to 250 metres intervals for properly ascertaining the deterioration / splitting of coal seams. In the absence of surface exposure, entire efforts were oriented for obtaining maximum sub-surface data through boreholes as well as through indirect methods like geophysical surface resistivity survey and geophysical logging. The overall analysis for 50% boreholes was programmed through chemical laboratories and balance by computation using M_{100} value. Other special tests as required for power grade coal was also considered along with petrographic study of coal seams and physico-mechanical study of coal seams and associated strata. In addition to the above, as per latest directive, swelling index and coke type were also considered to be determined.

The block under consideration is largely covered by paddy fields and no important features, either of archeological interest or industrial importance are available in and around the block. The coal mining activity, power

generation and peripheral industrial development are observed around Talcher to Hingula, Angul and Kanihah areas.

As per the priority indicated by Screening Committee, Ministry of Coal, the investigation in Radhikapur (West) Coal Block was initiated in the month of July, 2003 and concluded in the month of April, 2004. Altogether, 10 nos. of Rigs were put in operation in phases during the period mentioned above. The Table 4.1 broadly indicates time frame and quantum of operation undertaken in Radhikapur (West) Coal Block.

TABLE 4.1
THE QUANTUM AND SCHEDULE OF EXPLORATION ACTIVITIES BY
CMPDI IN RADHIKAPUR (WEST) COAL BLOCK, TALCHER COALFIELD

Sl. No.	Activity	Duration		Quantum
		From	To	
1.	Reconnaissance / data collection	June, 2003	July, 2003	10.48 Sq.km
2.	Mobilization of CMPDI resources	July, 2003	Jan, 2004	
3.	a) Topographical survey			a) Available Survey of India special toposheets utilized.
	b) Borehole survey	July, 2003	May, 2004	b) 109 no. of boreholes
4.	Geological mapping			No exposure available
5.	Surface geophysical survey (Resistivity survey)	Jan, 2004	Mar, 2004	19.62 km
6.	Drilling	July, 2003	April, 2004	17,321.50 metres of drilling in 109 bhs
7.	Geological logging	July, 2003	April, 2004	17,321.50 metres
8.	Sampling and packing	Sept, 2003	May, 2004	3527.56 metres
9.	Geophysical logging	July, 2003	April, 2004	4,442.80 metres in 24 bhs
10.	Coal analysis	Oct, 2003	Mar, 2005	3479.80 metres

The total quantum of drilling carried out for Radhikapur exploration is provided in following Table 4.2.

TABLE 4.2
EXPLORATION-WISE NUMBER OF BOREHOLES DRILLED IN
RADHIKAPUR (WEST) COAL BLOCK, TALCHER COALFIELD

Agency	Type of Exploration	Period	Drilling	
			No. of boreholes	Meterage
CMPDI	Promotional	July'03 to Jan'04	28	5,795.50
	Detailed	Jan'04 to April'04	81	11,526.00
Total		July'03 to April'04	109	17,321.50

4.1.3 Geological mapping

Almost entire area of the block is under habitats or cultivation except for sporadic occurrence of non-cultivable tar land. Hence, practically no exposure is available in the area. However, weathered sandstone is exposed at few places along the Singhada jhor and near the water body at the south-central part of the block, which cannot be considered useful for geological mapping. As such, the reconnaissance survey could not provide any geological information for interpretation. Surface geophysical survey, however, was undertaken in few areas.

4.1.4 Drilling

The depth of boreholes drilled in Radhikapur (West) Coal Block was generally around 200 metres. Except surface constraints due to cultivated land, water reservoir and human settlement, there was no appreciable difficulty in drilling.

The core recovery within this block was generally more than 90% and 70% for coal and non-coal strata respectively except for soil / weathered mantle or any loose formations.

A sum total of 109 boreholes with total meterage of 17,321.50 metres were drilled from July'03 to April'04 by CMPDI in Radhikapur (West) Coal Block. The financial year wise annual quantum of drilling carried out since inception of exploration in this block is given in Table 4.3.

TABLE 4.3
FINANCIAL YEAR WISE ANNUAL QUANTUM OF DRILLING IN
RADHIKAPUR (WEST) COAL BLOCK, TALCHER COALFIELD

Agency	Financial Year	Nos. of closed boreholes	Annual meterage
CMPDI	2003-04	103	17,195.00
	2004-05	6	126.50
	Total	109	17,321.50

4.1.5 Geophysical logging

The objective of geophysical logging is to supplement borehole data obtained from drilling. It also helps in ascertaining exact position of various coal horizons. A total of 24 boreholes were logged with the help of "BPB" and "Stratalog" loggers in Radhikapur (West) Coal Block.

BPB logger manufactured by BPB Instruments, U.K., is a truck-mounted unit, capable of logging up to 1500 meters using a 4.5 kVA generator as power source. There is a combination probe (CCS) which can record Long Space Density (LSD), Bed Resolution Density (BRD), Natural Gamma and Caliper. Apart from this, the unit is capable of recording conventional SP, Resistivity, Sonic, Focused Electrical and Neutron logs.

The "Stratalog" logger, manufactured by Geo-sources Inc, Australia, is a portable unit, capable of recording logs upto a depth of 300 metres using a 12 Volt battery power supply. The unit is at present capable of recording only resistance log.

A total of 4,442.80 meters in 24 boreholes were logged using the above two loggers. The borehole-wise details of the geophysical logging in Radhikapur (West) Coal Block are given in Table 4.4.

TABLE 4.4
GEOPHYSICAL LOGGING IN RADHIKAPUR (WEST) COAL BLOCK
TALCHER COALFIELD

Sl. No.	Borehole No.	Depth Drilled (m)	Depth Logged (m)	Parameters
1.	CMTR-028	227.00	211.30	Density and natural Gamma
2.	CMTR-039	288.00	273.50	Density, natural Gamma & Resistance
3.	CMTR-030	252.00	248.00	Density, Natural Gamma & Resistance
4.	CMTR-032	224.00	224.00	Density, Natural Gamma & Resistance
5.	CMTR-034	127.00	126.00	Density, Natural Gamma & Resistance
6.	CMTR-035	158.00	151.00	Density, Natural Gamma & Resistance
7.	CMTR-039	303.00	177.70	Density, Natural Gamma & Resistance
8.	CMTR-042	118.00	118.00	Density, Natural Gamma & Resistance
9.	CMTR-044	155.00	152.70	Density, Natural Gamma & Resistance
10.	CMTR-047	250.00	242.10	Density, Natural Gamma & Resistance
11.	CMTR-049	155.00	139.60	Density, Natural Gamma & Resistance
12.	CMTR-052	98.00	98.00	Density, Natural Gamma & Resistance
13.	CMTR-060	119.00	117.80	Density, Natural Gamma & Resistance
14.	CMTR-068	218.00	206.60	Density, Natural Gamma & Resistance
15.	CMTR-073	291.00	288.30	Density, Natural Gamma & Resistance
16.	CMTR-075	164.00	158.60	Density, Natural Gamma & Resistance
17.	CMTR-077	203.00	199.20	Density, Natural Gamma & Resistance
18.	CMTR-081	252.00	250.80	Density, Natural Gamma & Resistance
19.	CMTR-100	203.00	203.00	Density, Natural Gamma & Resistance
20.	CMTR-103	127.00	119.90	Density, Natural Gamma & Resistance
21.	CMTR-104	104.00	101.10	Density, Natural Gamma & Resistance
22.	CMTR-110	267.00	255.00	Density, Natural Gamma & Resistance
23.	CMTR-131	183.00	179.60	Density, Natural Gamma & Resistance
24.	CMTR-132	131.00	201.00	Density and Natural Gamma
	Total Logging		4442.80	

4.1.6 Surveying

Survey of India prepared the special surface contour plans with contour interval of 2.5 m on R.F. 1:10000, Radhikapur (West) Coal Block spreading an area of 1048 Ha. The prominent surface features like, culverts, road junctions, ponds, river meandering, etc. were surveyed and plotted on the borehole location plan.

4.2 GEOLOGY

4.2.1 Regional geology of Talchir coalfields

Radhikapur (West) Coal Block is located in south-central part of the Talcher coalfield. The coalfield forms the south-easternmost part of the Lower Gondwana basins restricted within northwest-southeast trending Son-Mahanadi master basin belt. The coalfield spans over an area about 1860 sq. km with coal bearing area of about 665 sq. km. The basin is almost rectangular in shape, measuring almost 80 km along the strike length (East-west) and about 26 km along the dip direction (North-south). There is extensive mining activity of Karharbari as well as Barakar coal seams in southeastern part of the coalfield. The geological and topographic plan is given as Plate V & cross section as Plate VI.

Recent explorations in this region have extensively enhanced the geological knowledge of the coalfield, such as:

- i) Discovery of coal bearing Barakar Formation in the extreme north-western part of the basin.
- ii) Re-demarcation of Barakar -- Kamthi Formation boundary.
- iii) Extension of Barakar Formation towards further west of Radhikapur (West) Coal Block.
- iv) Confirmation of northerly dip right upto the northern limit of the basin and
- v) Confirmation of huge potential of power grade coal in the northern part of the basin.

A ROCK FORMATIONS

The Talcher coalfield is the south-easternmost part of the Lower Gondwana basins within Mahanadi Valley graben and is surrounded by the basement metamorphic rocks. Thick pile of bedded sedimentary deposits constituting sandstone, shale, conglomerate and boulder beds with sequence of thin and thick coal seams are found to have occurred within the basin. The Lower Gondwana rocks of upper Carboniferous to Lower Triassic age mainly constitute Talchir, Karharbari, Barakar, Barren Measure and Kamthi Formations.

A.1 Description of formation

The Gondwana sediments rest unconformably on the Pre-Cambrian basement rocks comprising granites with pegmatite veins, hornblende gneisses, porphyritic gneisses, leptynites, mica schists, phyllites and amphibolites. The Pre-Cambrian rocks comprise low ridges and isolated hillocks along the boundaries of the basin.

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The strike of the foliation varies from almost east west in the south-eastern part to NE-SW in the south-west and WNW-ESE in the north. The dip of the foliation planes is consistently high and attains near vertical at places. Quartz reefs are observed within Metamorphics along the northern boundary of the basin.

i. Talcher formation

The base of the Gondwana sediments is marked by a pile of glacial and periglacial deposits. They were originally recognized by Blanford *et al* (1856) and had been designated as the Talchir Formation after the type locality. These rocks are well exposed along the southern boundary of the basin, though outcrops do occur in other areas as well. In fact, tongue-like NW-SE trending extension of Talchir sediments occur in the western part of the basin along the Mahanadi Valley and almost join up with similar outcrops of the Ib-River basin situated further to the north west. The Talchir Formation comprises diamictites, sandstones, needle shales, turbidites, rythmites and varves which are all typified by a Khaki green colour. The vertical organization of lithofacies that diamictites (both tillite and outwash conglomerates) represent, usually overlie the basement unconformably. They are, in turn succeeded by a turbidite sequence comprising siltstone, shale, rythmite etc. The turbidite also display a wide range of sedimentary structure including flute castes, grove casts, flame structures, ripple marks, cross ripple lamination, etc. The turbidite sequence is followed upwards into cross bedded fine to medium grained sandstone. No estimate of the thickness of the Talchir Formation is available. However, in a borehole, drilled near Nisa by GSI, 110 metres of Talchir comprising fine to medium grained sandstone inter banded with shale underlain by 60 metres thick sandy shale bed was encountered.

ii. Karharbari formation

The Talchir Formation conformably overlain by the Karharbari Formation, which is exposed as a narrow strip both along the southern and northern margins of the basin. Karharbari Formation has a distinct lithological and palynological entity in this coalfield. The sandstones are characteristically pale brownish yellow in colour, massive, medium to coarse grained and contains clasts of Talchir shale, all held together loosely by a clay matrix bearing a slightly greenish tint. Besides, thin shale bands and some superior quality coal seams are developed. Sub-surface data indicates that the formation attains thickness around 270 metres in the west Nandira sector in the southern part of the coalfield.

iii. Barakar formation

The Barakar Formation, which overlies the karharbari, is characterized by a thick and conspicuous conglomerate horizon in at its base. The conglomerate is oligomictic in nature and contains well-rounded quartz and quartzite clasts of various sizes (upto 30 cm across) embedded in a sandy matrix. The conglomerate members form low ridges in the southern and

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northern parts of the coalfield. In the southern part, the ridges are persistent for considerable distances in the area between Deulbera collieries in the east to Nisa in the west. In the north, this member forms isolated ridges. The basal conglomerate unit is overlain by a thick sequence (more than 500 metres) of medium to coarse grained greyish feldspathic sandstone, grey to dark grey shale, carbonaceous shale, thick coal seams mostly interbanded with shale. In the western and northern part of the basin, the Barakar Formation is overlain by the Kamthi (formerly referred to as Raniganj / Panchet) Formation while in the north, the Barakar beds are lying in juxtaposition of the Pre-Cambrian basement rocks.

iv Barren measure formation

The Barren Measure Formation conformably overlies the Barakar Formation and the contact between the two is gradational. Lithologically, the two formations are very similar near the contact and identification and fixation of boundary between them pose problem. As the name indicates, the Barren Measures are devoid of any economical coal seams but a few thin coal and carbonaceous shale zones are present within it. The Barren Measures comprises fine to very fine grained sandstone, gray shale often with siderites, ferruginous sandstone, siltstone and occasionally thin coal and carbonaceous shale.

v Undifferentiated kamthi kormation

Kamthi formation is well exposed and stands out conspicuously as high hills and plateaus in western part of the coalfield. The formation has an unconformable relation with the underlying rocks and the unconformity is angular as is observed in the west and west-central part of the basin. Kamthi Formation can be subdivided into two members, the upper one dominantly coarse to very coarse grained sandstone with very little shale and the lower one is medium to fine grained sandstone with gray and brown shale.

The lower Member of Kamthi is around 200 m thick, dominantly green to light greenish gray in colour, medium to fine grained sandstone with numbers of green, gray and brown shale. The upper member, which is over 375 metres thick, conformably overlies the lower and is represented by a dominantly brown very coarse grained sandstone with numbers of pebbly horizons generally less than a meter thick. Pebbles are mostly rounded and sub-rounded, embedded in a coarse sand matrix and are made of mostly quartz and quartzite. Occasionally granites, gneiss, shale and sandstone pebbles are found. Thin red shale beds are also noticed.

The lower beds have yielded a plant fossil assemblage containing *Glossopteris Indica*, *G. Conspicua* and *G. Stricta*, which indicate an overall late Palaeozoic Raniganj aspect. The sandstone which overlie the lower beds with a local unconformity contain same plant fossils which are considered to have a Panchet (Lower Triassic) affinity. Thus, considering the stratigraphic position from the plant fossil content, it would be apparent

that the Kamthi Formation extends from the uppermost Permian to the Lower Triassic transgressing the Permo-Triassic boundary.

vi Stratigraphy of talchir coalfields

As stated earlier, the sedimentary strata of Talcher coalfield are Talchir, Karharbari, Barakar and Supra-Barakar Formations. The division of first three formations is well established and accepted. Initially Supra-Barakar Formation was sub-divided into Raniganj, Panchet and Mahadeva Formations. However, later on, the entire Supra-Barakar strata was considered as Kamthi Formation. This had subsequently been revised and further subdivided by GSI in 1997 into lower and upper part of Supra-Barakar as Barren Measure and Kamthi Formations respectively.

Stratigraphical sequence in Talcher Coalfield is described in the following Table 4.5.

TABLE 4.5
STRATIGRAPHIC SUCCESSION OF TALCHER COALFIELD

Group	Age	Formation	Thickness (m)		Lithology
			From	To	
	Quaternary	Quaternary deposits	-	40+	Colluvial fills, sand, silt deposits and clay of older alluvium, older and younger floodplain deposits, channel fills etc.
	Cenozoic	Laterite	-	-	Laterites, lateritised detrital pebble bed.
Gondwana	Upper Permian to Lower Triassic	Undifferentiated Kamthi Formation		575+	Fine to medium grained light grey to reddish sandstone and shale at the base and pale greenish sandstone with rare shale and pink clay bands, ferruginous coarse grained to pebbly sandstone at top.
Super Group	Upper Permian	Barren Measures	-	50+	Greenish grey to buff coloured pebbly, coarse to medium grained highly ferruginous sandstone with variable proportions of fresh K-feldspar.
	Lower Permian	Barakar Formtion	-	500+	Medium to coarse grained grayish feldspathic sandstone, grey to dark grey shale and coal seams.
	Lower Permian	Karaharbari Formation	-	270+	Pale brownish yellow coloured massive medium to coarse grained sandstone containing clasts of Talchir shale and coal seams.

Group	Age	Formation	Thickness (m)		Lithology
			From	To	
	Upper Carboniferous to Lower Permian	Talchir Formation		170+	Diamictite, sandstone, needle shale, turbidite, rythmites and varves.
.....Unconformity.....					
	Archaean (?) to Lower Proterozoic	Pre-Cambrian Metamorphics			Granites, gneisses and associated supracrustals.

A.2 Regional structure

The Talcher Coalfield comprises the southeastern-most end member of the basin belt, which occupies a zone of major down faulting along the alignment of the Mahanadi Valley. The NW-SE aligned Mahanadi graben, incidentally, occupies central position in respect of the radially arranged system of peninsular Gondwana grabens bound by the east-west trending Damodar Valley in the north and the NNW-SSE trending Wardha-Godavari in the south.

On a regional scale, the Talcher coalfield depicts a north-westerly plunging synclinal structure with the closure on the east. The younger horizons outcrop progressively towards west. The Gondwana Pre-Cambrian boundary in the north is marked by a WNW-ESE trending set of faults. It follows closely the alignment of the Mahandi Valley rift and is apparently *en echelon* with the faults, which marks the southern boundary of the IB-River basin, occurring towards northwest. The southern boundary of the basin, however, is more or less free from any major faulting.

The regional strike of the Gondwana sediments is more or less east-west, but varies from ENE-WSW to ESE-WNW. In the southern part, the beds have low northerly dips while on the north the beds dip at low angles towards south as well. Local variations in dip and strike are present and may be attributed to faulting.

However, western and south-western limits of the basin appear to be largely faulted and natural closure is yet to be established. Occurrence of anticlinal structures has been located in Kaniah-Neelachal-Chhendipada-Patrapada areas.

Thus, Talcher coalfield appears to be a part basin with natural closure in three sides and faulted in the north. The northern boundary is probably responsible for disappearance of the northern limb of the syncline. The present basin may therefore be only the southern half of the earlier full basin.

The coalfield is characterised by a system of intrabasinal faults, three sets of which have been recognised on the basis of surface and sub-surface data. One set trends parallel or subparallel to the strike of the Gondwana

sediments i.e. more or less in an east-west direction. A few of these faults have been recognised in the area west of Nandira colliery, where they have downthrow of 20 metres to 50 metres towards south and have resulted in repetition of northerly dipping coal seams, when crop out further north. In the working collieries, a number of faults with curvilinear trends have been recognised. Towards south, they have WNW-ESE trend but northwards, they assume a NNW-SSE direction. The downthrow is mostly towards south or west, though some have throw in the opposite directions.

A second set of faults trending in a NE-SW direction has been recognised along the southern margin of the coalfield. They have resulted in downthrow of the strata by amounts varying from 10 to 80 metres, both towards east and west. A third set of intrabasinal faults trending WNW-ESE have been mapped in the northern part of the basin.

4.2.2 Local Geology of Radhikapur (West) Coal Block

A Geological succession

Considering the information available through sub-surface exploration and the information collected from neighbouring blocks including geological mapping to the extent possible, following stratigraphic succession has been established in Radhikapur (West) Coal Block.

TABLE 4.6
STRATIGRAPHIC SUCCESSION, RADHIKAPUR (WEST) COAL BLOCK,
TALCHER COALFIELD

Group	Age	Formation	Lithology
Gondwana	Recent	Recent Deposit	Soil, Sub-soil etc.
	Lower Permian	Barakar Formation	Medium to coarse grained greyish feldspathic sandstone, grey to dark grey shale and coal seams.
	Lower Permian	Karharbari Formation	Pale brownish yellow coloured massive medium to coarse grained sandstone containing clasts of Talchir shale and coal seams.
	Upper Carboniferous to Lower Permian	Talchir formation	Diamictite, sandstone, needle shale, turbidite, rhythmites and varves.
Unconformity			
	Archaean (?) to Lower Proterozoic	Pre-Cambrian Metamorphosis	Granites, gneisses and associated supracrustals.

B Description of the formation

Radhikapur (West) Coal Block is almost totally covered by soil and therefore, is devoid of insitu exposures for geological mapping. Such soil and weathered mantle is followed by Barakar Formations as has been reported from borehole cores. None of the borehole has encountered

Talcher and Karharbari Formations. Karharbari Formation is known to contain better quality of coal seam (Seam I) as reported from southern eastern part of the coalfield as well as in the northern part of the coalfield. In the absence of direct evidence, the Karharbari Formation could not be established from the block. The same is true for Talcher and Metamorphic also. As such, the lithological and other characteristics of Metamorphic, Talcher and Karharbari formations are expected to be similar to those described under regional geological settings. The Barakar Formation occurring in the block contains seams II A to XI. The younger group of seams is comparatively more potential than older seams. The Barakar boundary zone is expected to be conglomeratic in nature and contains well rounded quartz and quartzite clasts of various sizes embedded in a sandy matrix. This however, is not encountered in any of the boreholes in this block. The lithology of Barakar Formation contains medium to coarse grained greyish feldspathic sandstone, grey to dark grey shale, carbonaceous shale, thick coal seams mostly interbanded with dirt bands of various thickness.

Seams XI to Local are incropping within block limits and rest of the lower seam are expected to incrop beyond south-eastern boundary of the block.

C Geological structure

C.1 General

The Radhikapur (West) Coal Block is located towards southern part of the syncline and represents the area of no major structural disturbances.

C.2 Strike and DIP

Within the Radhikapur (West) Coal Block, the strike is generally east-west varying to ENE-WSW. The beds have low northerly dip which varies from 8° in the eastern part to 3° in the western part. Local variations in dip and strike have been observed at places. The lithologs are shown in Plate VII.

C.3 Pattern of faulting

No faults have been interpreted within the block nor there is an indication in any of the boreholes regarding the evidence of occurrence of faults. As such, the block is simple from geological structure point of view. No igneous intrusive is present within the block nor reported from the coalfield.

D Coal seams of Radhikapur (West) Coal Block

D.1 General description

The carbonaceous horizons occurring within Barakar and Karharbari Formations have been designated as coal seams (horizons) depending upon its thickness, stratigraphic position quality and consistency in occurrence over considerable part of the coalfield. In Talcher coalfield,

Karharbari Formation contains only one coal seam i.e. seams I, whereas, in Barakar Formation, there are 13 nos. of regionally correlatable coal seams occurring from seams II to XIV. Radhikapur (West) Coal Block contains regionally correlatable coal seams from seam II to XI of Barakar Formation with numerous splits. The presence of seams I of Karharbari Formation has not been established within the block and there is possibility of non-development of seam I as evidenced from boreholes drilled in neighbouring areas.

D.2 Coal

The coal and carbonaceous horizons have been differentiated from each other on the basis of Moisture and Ash content as applicable in high moisture non-coking coal. Ash plus Moisture values, considered for different constituents of coal, are as follows:

Coal	- Ash% + Moisture% upto 40%
Shaly coal	- Ash% + Moisture% >40 upto 55%
Carbonaceous shale	- Ash% + Moisture% >55 upto 75%
Grey shale, sandy and sandstone	- Ash% + Moisture% exceeding 75%

D.3 Dirt band

The litho unit, which contains the A+M value more than 55% upto 75% is considered as combustible (carbonaceous shale) band and the units, which contain A+M value more than 75% is considered as non-combustible bands (grey shale, sandy shale, alternate bands of shale and sandstone, sandstone etc). Combustible or non-combustible litho units occurring within the seam are considered as in-seam dirt bands. Exclusion or inclusion of these bands is dependent on type of samples considered. The overall quality of coal seams are determined / calculated both on BCS sample basis, i.e. barring carbonaceous shale and non combustible dirt bands irrespective of thickness and L_{100} sample basis i.e. including less than 1 meter of carbonaceous shale and non-combustible dirt bands. The coal seams of Radhikapur (West) Coal Block are highly interbanded. Due to occurrence of dirt band in large numbers, there was difficulty in assigning roof and floor and also the in-seam dirt band for 1 meter and above in thickness. Normal 1:1 dirt band coal ratio yielded coal seams at places beyond reasonable limit of overall quality of coal. Some deviation from the prevailing norms were attempted to bring the coal horizons within reasonable quality limit of coal. Thus, few coal bands were left along with the dirt band either in roof, floor or along with in-seam dirt band of 1 meter and above in thickness. The floor contour plan of seams are shown in Plate VIIIA to VIID respectively.

D.4 Coal seam sequence of the block

In Radhikapur (West) Coal Block, Barakar Formation contains seams II A to XI in different splits. Altogether, 20 nos. of seams / split seams are reported

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in Barakar Formation. Among these, seam IX is the most potential coal horizon in this block. The sequence of coal seams is given in Table 4.7.

TABLE 4.7
SUCCESSION OF COAL SEAMS IN RADHIKAPUR (WEST) COAL
BLOCK INCLUDING BOREHOLE INTERSECTION

Name of Seam	Thickness (m)		Nos. of BH
	Min	Max	
Soil	0	18	109
WM	0	37.83	109
XI	0.11	5.92	22
PA11	2.01	16.97	21
LOC1	0.09	1.55	27
PA12	7.05	20.09	27
X	0.12	6.2	41
PA13	23.24	50.37	42
IX	1.08	41.84	68
PA14	0.79	23.59	88
VIII TOP	0.1	2.66	93
PA15	1.08	10.24	34
VIII BOT	0.07	1.09	35
PA16	1.04	22.65	33
VII B	0.08	4.06	93
PA 17	2.63	18.14	46
VII A	0.04	3.68	46
PA 18	4.58	15.57	9
VI B	0.05	0.47	15
PA 19	5.33	18.6	8
V B	0.13	1.16	26
PA 20	3.68	16.01	18
V A	0.05	1.4	27
PA 21	0.72	10.92	25
IV B	0.15	1.37	57
PA22	7.39	2.05	45
LOC 2	0.05	3.12	52
PA 23	6.9	26.17	44
III E	0.1	8.9	45
PA 24	15.66	32.4	29
III D	0.11	2.11	30
PA 25	3.57	14.5	25
III A TOP	0.15	2.04	28
PA 26	1.07	12.28	25
IIA BOT	0.34	7.99	26
PA27	19.9	27.45	26
II C	0.3	1.65	26
PA 28	38.36	28.36	26
II B	0.42	4.71	5
PA 29	4.57	4.57	1
II A	1.67	1.67	1

- Note :-
1. The above thickness of coal seams is inclusive of dirt bands.
 2. The majority of coal reserves of the block are contributed by seam IX, and to some extent, by seams III A Bottom, VII B, III E, and III A Top.

The seam wise borehole density is as under:

TABLE 4.7A
SEAM WISE BOREHOLE DENSITY IN RADHIKAPUR (WEST)
COAL BLOCK

Name of Seam	Nos. of BH	Area of the seam Sq.Km	Borehole density Nos of BH/Sq.Km
XI	22	3.67	5.99
LOC1	27	4.35	6.20
X	41	5.03	8.15
IX	68	7.85	8.66
VIII TOP	93	8.63	10.78
VIII BOT	35	8.86	3.95
VII B	93	9.39	9.90
VI B	15	9.89	1.52
V B	26	10.08	2.58
V A	27	10.26	2.63
IV B	57	10.29	5.54
LOC 2	52	10.46	4.97
III E	45	10.48	4.29
III D	30	10.48	2.86
III A TOP	28	10.48	2.67
IIA BOT	26	10.48	2.48
II C	2	10.48	0.19
II B	5	10.48	0.48
II A	1	10.48	0.10

E. Description of coal seams

Seam - XI

Seam XI is the topmost seam available in Radhikapur (West) Coal Block and was encountered in northern part of the block. It does in crop within the block and attains a thickness put 5.92 metres. The seam is developed towards eastern part of the block there it attains effective thickness of 1 meter to above 6 metres. The maximum depth of occurrence of the seam within the block, as encountered in the boreholes, is 91.75 metres. The combustible as well as non-combustible dirt bands within seam constituting maximum upto 50%. The proximate analysis on 60% RH and 40°C of the seam on I₁₀₀ sample shows moisture%, ash% and volatile matter% as 5.6-6.6, 44.9-49.1 and 23.4 respectively. Determined Gross CV on I₁₀₀ samples of the seam is 3200 kcal/kg with its corresponding DMMF value of 7419 kcal/kg. The UHV on I₁₀₀ samples of the seam varies from 1351 kcal/kg - 1848 Kcal/kg (Grade G). The grade of seam is generally G on I₁₀₀ samples.

Local - I

A local seam, Local 1, occur below seam XI with parting above ranging from 2.01 metres to 16.97 metres. This Local 1 seam is inconsistent and

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generally less than 1 metre in thickness. The effective thickness of the seam is found to be less than 1 metre in all the cases. As such, the seam Local 1 has not been considered for reserves estimation and other detailing.

Seam - X

Seam X is one of the younger seams available in Radhikapur (West) Coal Block and was encountered in 44 no. of boreholes. It does incrop within the block towards north. The seam develops workable thickness in the north-eastern part and sporadically in the north-central part of the block. Over majority area of the block, the effective thickness of the seam remains less than 1 metre. It attains maximum effective seam thickness of 2.15 metres in the western part of the block. The maximum depth occurrence of the seam within the block, as encountered in the boreholes is 109.51 metres. The combustible as well as non-combustible dirt bands within seam constituting maximum upto 20%. The proximate analysis on 60% RH and 40°C of the seam on I₁₀₀ samples shows moisture%, ash%, and volatile matter% as 5.8-6.7, 47.7- 48.2 and 22.7 respectively. The grade is generally G on I₁₀₀ samples.

Seam - IX

The seam IX is the most potential seam available in Radhikapur (West) Coal Block and was encountered as full seam in 68 no. of boreholes and as incrop in 26 no. of boreholes. The seam occurs in northern half of the block. It incrops within the block and attains a full seam thickness of maximum 41.84 metres. The maximum depth of occurrence of seam is 157.90 metres. The seam is highly interbanded and contains as much as 19.82 metres in-seam dirt bands in different sections. The in-seam dirt bands constitute upto 69% of the seam. The proximate analysis on 60% RH and 40°C of the seam on I₁₀₀ samples shows moisture%, ash%, and volatile matter as 5.2 - 7.8, 38.9 -51.7 and 21.6 - 24.8. The grade varies from F to un-graded.

Seam - VIII Top

Seam VIII Top occurs below seam IX in Radhikapur (West) Coal Block and was encountered in 93 nos. of boreholes in northern half of the block. It incrops within the block and attains maximum thickness of 2.66 metres. The maximum depth of occurrence is 201.94 metres as recorded in boreholes. The proximate analysis on 60% RH and 40°C of the seam on I₁₀₀ samples shows moisture %, ash % and volatile matter % as 5.8- 9.0, 37.9-49.1 and 22.0-27.1 respectively. The grade is ungraded to F to ungraded.

Seam - VIII Bottom

Seam VIII Bottom occurs below seam VIII Top with parting ranging from 1.08 metres to 10.24 metres. The thickness of VIII Bottom seam varies from 0.07 metro to 1.09 metres. This seam is inconsistent and less than 1 metre in thickness except in one borehole. As such, the seam VIII Bottom has not been considered for reserve estimated and other detailing. However, all the

available information, generated during the exploration of the block, are available.

Seam - VII B

Seam VII B occur below inconsistent seam VIII Bottom in Radhikapur (West) Coal Block. It incrops within the block and attains maximum thickness of 4.06 meters. The maximum depth of occurrence of seam is 206.29 meters. The proximate analysis on 60% RH and 40°C of the seam on I₁₀₀ samples shows moisture%, ash% and volatile matter% as 5.7-10.8, 24.9-49.0 and 23.2 –31.5 respectively. The grade on I₁₀₀ sample varies from E-G.

Seam - VII A

Seam VII A occurs below seam VII B with parting above ranging from 2.63 metres to 18.14 metres. The thickness of VII A seam varies from 0.04 metre to 3.68 metres. But, this seam is not only inconsistent, but also it never attains 1 metres and above effective thickness in this block. As such, the seam VII A has not been considered for reserve estimation and other detailing. However, all the available information, generated during the exploration of the block, are available.

Seam - VI B

Seam VI B occurs below seam VII A with parting above ranging from 4.58 metres to 15.57 metres. The seam VI B is not only inconsistent, its thickness varies from 0.04 metre to 0.47 metres. As such, the seam VI B has not been considered for reserve estimation and other detailing. However, all the available information, generated during the exploration of the block, are available.

Seam - V B

Seam V B occurs below seam VI B with parting above ranging from 5.33 metres to 18.60 metres. The thickness of V B seam varies from 0.13 metre to 1.16 metres. This seam is inconsistent and less than 1 metre in thickness, except in one borehole. As such, the seam V B has not been considered for reserves estimation and other detailing. However, all the information, generated during the exploration of the block, are available.

Seam - V A

Seam V A occurs below seam V B with parting above ranging from 3.68 metres to 16.01 metres. The thickness of V A seam varies from 0.05 metre to 1.40 metres. This seam is inconsistent and its effective thickness is less than 1 metre, except in one borehole. As such, the seam V A has not been considered for reserve estimation and other detailing. However, all the information, generated during the exploration of the block, are available.

Seam - IV B

Seam IV B is comparatively better developed seam below seam VII B in comparison to the coal seams in lying between. There are four no. of seams occurring between seams VII B & IV B, viz. VII A, VI B and V B and V A, which do not appear to have any potentiality. Seam IV B incrop within the block and attains a thickness of 1.37 metres as per borehole record within the block. However, considering borehole data of immediate neighboring block of Utkal E, the effective thickness upto 3 meters has been projected towards north-eastern part of the block. The proximate analysis on 60% RH and 40°C of the seam on I₁₀₀ sample shows moisture %, ash %, volatile matter % as 5.6 - 8.2, 26.4 - 49.0 and 23.3 - 25.0 respectively. The grade of the seam varies from E to G.

Local - 2

Seam Local 2 is a thin seam developed in northeastern corner of the block. It incrops within the block and attains a thickness of maximum 3.12 metres. The maximum depth of occurrence of seam is 256.65 metres. The proximate analysis on 60% RH and 40°C of the seam on I₁₀₀ sample shows moisture%, ash% and volatile matter% as 5.7 - 6.5, 41.7 - 46.4 and 22.1 - 24.9 respectively. The grade of the coal seam is generally G.

Seam - III E

Seam III E is developed in the north - eastern part of the block. It does not incrop within the block and thickness upto 8.90 metres. The seam occurs at depth range of 66.01 metres to 270.65 metres. The proximate analysis on 60% RH and 40°C of the seam on I₁₀₀ sample shows moisture%, ash% and volatile matter% as 5.2 - 6.0, 43.9 - 49.1 and 22.1 - 25.2 respectively. The grade of the coal seam is G.

Seam III D

Seam III D occurs between seams III E above and ~~III A Top~~ ^{III A Top below} below. The seam is developed towards north-eastern and north-central part of the block. It does not incrop within the block and attains thickness upto 2.11 metres. The seam occurs at depth range of 143.68 metre to 300.00 metres. The proximate analysis on 60% RH and 40°C of the seam on I₁₀₀ sample shows moisture %, ash % and volatile matter % varies from 5.2 - 6.7, 30.7 - 49.6 and 22.2 - 26.7 respectively. The grade of the coal seam varies from E to G.

Seam - III A Top

Seam III A Top is developed towards northern & north-eastern part of the block. It does not incrop within the block and attains a thickness of maximum 2.04 metres. The seam occurs at depth range of 152.44 metres to 307.36 metres. The proximate analysis on 60% RH and 40°C of the seam on I₁₀₀ sample shows moisture %, ash % and volatile matter % as varies

from 2.8 - 9.1, 38.6 - 64.8 and 22.0 - 26.2 respectively. The grade of the coal seam varies from F to ungraded.

Seam - III A Bottom

Seam III A Bottom is the lowermost potential seam proved to be exploited within the Radhikapur (West) Coal Block. The seam is generally well developed within the block and has over 1 m thickness over the entire area except extreme southern part. The seam occurs at depth range of 162.17 metres to 310.35 metres. It does not incrop within the block. The proximate analysis on 60% RH and 40°C of the seam on I₁₀₀ sample shows moisture %, ash % and volatile matter % as 5.4 - 9.1, 30.6 - 42.8 and 22.4 - 28.6 respectively. The grade of the seam varies from E-G.

Seam - II C

Seam II C occurs below seam III A Bottom with parting above ranging from 19.90 metres to 27.45 metres. Seam II C was encountered in only two boreholes and was found to be not developed in seven other boreholes. Rest of the boreholes were not deepened enough to drill upto the seam due to depth limitation and other obvious constraints. The thickness of II C seam in these two boreholes as 0.03 metres and 1.65 metres. Due to lack of sufficient information, seam II C has not been considered for reserves estimation and other detailing. However, all the information generated during the exploration of the block, are available.

Seam - II B

Seam II B is the oldest potential seam indicated in Radhikapur (West) Coal Block and was encountered in 5 numbers of boreholes only in northeastern part of the block. It does not incrop within the block and attains maximum thickness of 4.71 metres. The seam occurs at depth range of 212.14 metres to 269.50 metres. The depth of occurrence of seam varies from 212.14 metres to 269.50 metres. The proximate analysis on 60% RH and 40°C of the seam on I₁₀₀ sample shows moisture %, ash % and volatile matter % as 5.8 - 6.1, 38.4 - 39.1 and 25.3 respectively. The average grade is F. In the absence of adequate data on thickness and quality, the reserves of coal seam has been placed under 'Indicated' category.

Seam - II A

Seam II A is the lowermost known coal horizon in Barakar Formation in this part of the coalfield. It occurs below seam II B separated with a parting above of about 5 metres. Seam II A was encountered in only one borehole and was found to be not developed in two other boreholes. Rest of the boreholes were not deepened enough to drill upto the seam due to depth limitation and other obvious constraints. The thickness of II A seam is found in this one borehole as 1.67 metres. Due to lack of sufficient information, seam II A has not been considered for reserves estimated and other

detailing. However, all the information generated during the exploration of the block, are available.

F Soil & weather mantle

The thickness of soil is varying from 0.00 m to 18.00 m whereas weather mantle thickness varies from 0.00 to 37.8 m.

G Scope and limitations

- 1) At the instance of Ministry of Coal, Radhikapur (West) Coal Block with a total area of 16.45 sq km was taken up for exploration on priority.
- 2) Exploration in Radhikapur (West) Coal Block was taken up in the month of July, 2003.
- 3) Based on available information of thickness and quality, gross geological reserves of about 455 MT was tentatively estimated in November 2004.
- 4) Subsequent to the submission of the interim report in November 2004, a decision was taken by CMPDI (HQ) to reduce the extent of the block. The western bank of Nuabanda nala was considered dividing line between Radhikapur (West) Coal Block towards west and Utkal F including eastern part of earlier Radhikapur (West) Coal Block towards east. The revised area of the Radhikapur (West) Coal Block becomes 10.48 Sq.km.
- 5) As per revised boundary of Radhikapur (West) Coal Block, a quantum of 17321.50 metres of drilling was carried out in 109 boreholes. The present report, therefore, deals only on the revised area and the information of boreholes falling in this revised block.
- 6) Since the data of total Radhikapur (West) Coal Block was considered for drawing floor contour plans, OB/parting plans, seam folio plans, etc., the influence of the boreholes falling immediate east of the present Radhikapur (West) Coal Block boundary could be felt in all the plans. There are instance where the contour lines are in deviation from the range of thickness, parting, etc. mentioned in the corresponding seam description due to influence of immediate surrounded blocks.
- 7) The coal seams of Radhikapur (West) Coal Block are highly interbanded. Due to occurrence of dirt band in large numbers, there was difficulty in assigning roof and floor and also the in-seam dirt band of 1 metre and above in thickness. Normal 1:1 dirt band and coal ratio yielded coal seams at places beyond reasonable limit of overall quality of coal. Some deviation from the prevailing norms were attempted to bring the coal horizons within reasonable quality limit of coal. Thus, few coal bands were left along with the dirt band either on roof, floor or along with in-seam dirt band of 1 metre and above in thickness.

- 8) There are limited intersection in lower seams, namely III A Top, III A Bottom and II B. While there are comparatively better representation in seams III A Top and IIIA Bottom, the seam II B has very little intersection. Therefore, reserves of seams IIIA Top & IIIA Bottom have been considered under "Proved" category but the same of seam II B has been placed under "Indicated" category.
- 9) Since all the seams of Radhikapur (West) Coal Block are highly interbanded and present density is only about 10 boreholes per sq. km, there is a scope for further drilling of boreholes to the tune of about 50 boreholes in this area. This may be required to be drilled during planning and execution of mine. This will also take care of conversion of "Indicated" reserves to "Proved" reserves as well. These proposed boreholes indicated above will be required also for incrop sitting along initial box cut as well as increasing the confidence level of interpretation.
- 10) The geophysical logging carried out in boreholes was matched with the drilling log to the extent possible. Wherever there are discrepancies beyond limit, the drilling log only was considered. Resistivity survey data was also considered for interpretation. Although some amount of deviation was observed due to equipment limitations, the final interpretation was made based on borehole details. The result of resistivity survey was also provided along with the incrop plan of the block for proper understanding.

H Geological Sections

For the purpose of geological correlation and assessment of reserves, geological cross sections have been prepared with the help of adjoining bore holes from north to south. Different number of boreholes considered for making cross section is given in Table 4.8.

TABLE 4.8
SECTION WISE NUMBERS OF THE BORE HOLES

Sections	Bore hole nos.
A-A'	CMTR-057, CMTR-017, CMTR-056, CMTR-012, CMTR-127, CMTR-027, CMTR-079
B-B'	CMTR-041, CMTR-045, CMTR-115, CMTR-095, CMTR-103, CMTR-061, CMTR-073
C-C'	CMTR-006, CMTR-021, CMTR-109, CMTR-040, CMTR-039
D-D'	CMTR-084, CMTR-007, CMTR-069, CMTR-055, CMTR-038, CMTR-016

I Year wise future programme of exploration

Although the block is free from structural disturbances, but the seam structure of all the seams is complicated due to development of erratic dirt

bands. Such erratic development of dirt band leads to irregular effective thickness of the coal seam. Due to such development, there is requirement of putting few more boreholes to ascertain the exact nature of the seam in between existing boreholes. The present density of the borehole is adequate for geological modeling purpose but it is prudent that about 50 nos. of additional boreholes are necessary for increasing confidence level of interpretation, proper delineation of incrops and also for converting "Indicated" reserves of seam II B to "Proved" reserves.

4.3 RESERVES AND GRADE

4.3.1 Coal

Radhikapur (West) Coal Block covers an area of 10.48 Sq.km where 20 nos. of regionally correlatable coal horizons have been established to occur within the block. The seam I is reported to be thin and has not been confirmed by any of the boreholes drilled within the block. Many of the coal horizons, namely IIA, IIC, VA, VB, VIB, VIIA and VIII Bottom and Local 1, are either thin or developed in isolated small patches. These seams do not offer much mining potentiality and hence, are not considered for reserves estimation. As such, rest 12 nos. of coal seams have been dealt in detail. All the above 12 nos. of seams have been dealt considering opencast mineability in view, as the coal seams do not reflect good quality for underground exploitation.

The coal seams of Radhikapur (West) Coal Block are highly interbanded thick and thin coal horizons. The delineation of roof and floor of coal seams have become difficult due to occurrence of large number of dirt bands near roof and floor. Such problem also arises while delineating 1 metre and above dirt bands. In order to keep conservation of coal deposit in view, dirt bands either a single dirt band or a composite dirt band along with minor coal bands and some thin coal sections have also been excluded from the composite coal seam effective thickness during quality determination / calculation and reserves estimation.

4.3.2 Method of estimation of reserve

Seam folio plans showing the block boundaries, seam incrop, isochors and isograds on 1₁₀₀ samples with data of effective thickness, UHV, Grade and in-seam dirt band thickness were used as the base for the estimation of coal reserves and volume of coal having less than 1 metre and ungraded coal as well as in-seam dirt band. The intersections of all the parameters within a seam folio plan have generated numbers of polygons. The area of each polygon in Sq.km was measured by the digital planimeter. The area in Sq.km. thus obtained were multiplied by average thickness value of the two enclosing isochors in metres to obtain the volume of coal in million cubic metre, which in turn is multiplied by specific gravity of coal pertaining to the grade of the polygon. Thus, gross reserves of respective coal seam occurring within that polygon were obtained. The reserves of all the polygons were added to calculate Gross coal reserves. A deduction of 10%

was made to obtain the net reserve of the seam. The deduction is made to account for unforeseen geological features within the block.

Specific gravity for each grade had been calculated from the following formula by taking average ash% for each grade:

$$\text{Sp. Gr.} = 1.29 + 0.01 \times \text{Ash}$$

The following Table 4.9 shows average grade-wise specific gravity, thus arrived and considered for reserve estimation for different grades of coal.

TABLE 4.9
SEAM-WISE GRADE-WISE AVERAGE SPECIFIC GRAVITY,
RADHIKAPUR (WEST) COAL BLOCK, TALCHER COALFIELD

Seam	Specific gravity for 1 ₁₀₀ samples s per Grade			
	Grade D	Grade E	Grade F	Grade G
XI	-	-	1.68	1.75
X	-	-	-	1.75
IX	-	-	1.68	1.75
VIII Top	-	1.61	1.68	1.75
VII B	-	1.61	1.68	1.75
IV B	-	1.61	1.68	1.75
Local 2	-	-	-	1.75
III E	-	-	-	1.75
III D	1.55	1.61	1.68	1.75
III A Top	-	-	1.68	1.75
III A Bottom	-	1.61	1.68	1.75
II B	-	-	1.68	1.75

4.3.3 Categorisation of reserve

Radhikapur (West) Coal Block represents very simple geological structure and is devoid of any fault. There is, however, occurrence of very irregular and inconsistent dirt bands with the seams. Considering such complex, seam structure of individual coal seam due to irregular development of intra-seam dirt band, a 10% deduction has been made from gross reserves to arrive at Net "Proved" reserves. As such, the reserves presented in the report represents "Proved" net geological reserves considering block boundary is vertical for all the seams except lower most potential seam II B. The seam II B with less number of borehole intersections has been placed under "Indicated" category. No deduction of 10% has been made of "Indicated" category reserves.

4.3.4 Details of reserve estimation

The reserves were computed separately for full thickness as well as incrop zones as follows:

(I) Full thickness zone

The area enclosed by various intersections of isochors and isograds had been separately measured with the digital planimeter. Due consideration for barrier zone and beyond barrier zone had been maintained while determining such area. The volume of coal had been obtained by multiplying the area with the average thickness of the two binding isochors. The product obtained had yielded gross geological reserve on multiplication with the specific gravity relevant for the grade. A 10% deduction had been made to arrive at net geological reserve from the above mentioned gross geological reserve against unforeseen geological disturbance or localized deviation of the thickness, development of intra-seam dirt bands, quality, etc.

(II) Incrop zone

Areas enclosed by various intersections of isochors and iso-grades have been separately measured with the digital planimeter considering the barrier zone and beyond barrier zone separately. Rest of the procedures was the same as adopted in the estimation of reserves in the full thickness zone.

A net proved coal reserve of 288.440 million tonnes upto seam III A Bottom and Gross Indicated coal reserves of 23.596 million tonnes of seam II B have been estimated for the entire block from seams XI to IIB. The details of the reserves are given in Table 4.10, 4.11 & 4.12 respectively.

TABLE 4.10
SEAM-WISE AND CATEGORY-WISE GEOLOGICAL RESERVES,
RADHIKAPUR (WEST) COAL BLOCK, TALCHER COALFIELD

Seam	Net Proved Reserves (mt.)	Gross Indicated Reserves (mt.)	Total Reserves (mt.)
XI	4.128	0.000	4.128
X	1.291	0.000	1.291
IX	194.835	0.000	194.835
VIII Top	1.840	0.000	1.840
VII B	18.793	0.000	18.793
IV B	2.209	0.000	2.209
Local 2	3.687	0.000	3.687
III E	12.473	0.000	12.473
III D	3.949	0.000	3.949
III A Top	7.300	0.000	7.300
III A Bot	37.935	0.000	37.935
Total (Proved)	288.440	0.000	288.440
II B	0.000	23.596	23.596
Total (Proved + Indicated)	288.440	23.596	312.036

Seam Group-wise Total Net Proved Reserves and seam-wise Total Net Proved Reserves of the block are shown respectively.

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The seam-wise and grade-wise net proved geological reserves in Radhikapur (West) Coal Block is shown as under:-

TABLE 4.11
SEAM-WISE AND GRADE-WISE NET PROVED GEOLOGICAL RESERVES, RADHIKAPUR (WEST) COAL BLOCK, TALCHER COALFIELD

Seam	Grade-wise Net Proved Reserves in million tonnes				Net Proved reserves (mt.)	Seam-wise percentage of reserves	UHV K.Cal/Kg.	GCV K.Cal/Kg.
	D	E	F	G				
XI	0.000	0.000	0.023	4.105	4.128	1.431	1351-2235	3120-3670
X	0.000	0.000	0.000	1.291	1.291	0.448	1324-3049	3040-4174
IX	0.000	0.000	0.368	194.467	194.835	67.548	1034-3366	2807-4375
VIII Top	0.000	0.005	0.109	1.726	1.840	0.638	1517-3090	3000-4203
VII B	0.000	0.709	5.901	12.183	18.793	6.515	1351-3973	3092-4751
IV B	0.000	0.183	1.550	0.476	2.209	0.766	1365-2442	3125-4877
Local 2	0.000	0.000	0.000	3.687	3.687	1.278	1889-2248	3315-3760
III E	0.000	0.000	0.000	12.473	12.473	4.324	1338-2028	2995-4040
III D	0.005	0.294	1.686	1.964	3.949	1.369	2083-3739	3680-4345
III A Top	0.000	0.000	1.901	5.399	7.300	2.531	1945-3145	2050-4093
III A Bot	0.000	5.183	30.141	2.611	37.935	13.152	2248-3725	3630-4882
Total	0.005	6.374	41.679	240.382	288.440	100.00		
Grade-wise Percentage	0.002	2.210	14.450	83.338	100.00			

TABLE 4.12
PROVED COAL RESERVES UNDER SURFACE CONSTRAINTS, RADHIKAPUR (WEST) COAL BLOCK, TALCHER COALFIELD

Barrier / Beyond Barrier	Grade-wise Net Proved Reserves in (million tonnes)				Net Proved Reserves (mt.)
	D	E	F	G	
Total net proved reserves	0.005	6.374	41.679	240.382	288.440
Nala barrier	0.000	0.852	3.475	20.850	25.177
Boundary barrier	0.000	0.005	0.717	3.672	4.394
Water body	0.000	0.000	0.040	0.357	0.397
All Constraints	0.000	0.857	4.232	24.879	29.968
Constraints free net proved reserves	0.005	5.517	37.447	215.503	258.472

4.4 OVERBURDEN

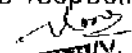
4.4.1 Nature

The overburden consists of soil, weathered mantle and argillaceous as well as arenaceous rocks. The parting between two seams consists of argillaceous and arenaceous rocks with thin coal / carbonaceous bands. Broadly, the overburden and parting upto seam II B had been divided into 6 categories as follows:

- (1) The soil and weathered mantle over the incrop of the seams.
- (2) The soil, weathered mantle and overburden (part parting) above the full seam.
- (3) The full parting between respective seam and next upper seam.
- (4) The volume of dirt bands of 1 metre and above in thickness occurring within coal seams had been added to the overburden / parting lying above.
- (5) Volume of the unworkable coal seams below 1 metre thickness had been accounted as part of the overburden / parting.
- (6) The volume of ungraded coal has been considered as overburden.

4.4.2 In-seam burden

The in-seam dirt bands of combustible and or non-combustible in nature of 1 metre and above in thickness have been identified and accordingly iso-thickness lines of in-seam bands has been drawn in the respective seam folio plans upto seam II B.


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CHAPTER 5

MINING

5.1 CHOICE OF METHOD OF MINING

The shallow coal deposit of Radhikapur (west) compels to primarily consider the mining through open cast mining. The stripping ratio without considering any blockage of coal in different constraints for mining will be as in Table 5.1.

TABLE 5.1
RESERVES, OVERBURDEN AND STRIPPING RATIO AS PER GR TABLE 5.7

Seam	Net Proved Reserves (MT)	Total Volume of Waste (MCM)	Seam-wise stripping Ratio (M.Cum/mt)	Successive Cumulative Reserves (MT)	Volume of Successive Cumulative waste (M.cum)	Successive Cumulative Stripping Ratio from surface (Mcum /MT)	Successive Cumulative Stripping Ratio below seam IX (Mcum /MT)
1	2	3	4		6	7	8
XI	4.128	168.704	40.9	4.128	168.704	40.9	Not Applicable
X	1.291	110.591	85.7	5.419	279.295	51.5	Not Applicable
IX	194.835	326.723	1.7	200.254	606.018	3.0	Not Applicable
VIII Top	1.840	75.251	40.9	202.094	681.269	3.4	40.90
VII B	18.793	178.985	9.5	220.887	860.254	3.9	12.32
IV B	2.209	478.292	216.5	223.096	1338.546	6.0	29.71
Local 2	3.687	145.130	39.4	226.783	1483.676	6.5	33.08
III E	12.473	185.734	14.9	239.256	1669.410	7.0	27.27
III D	3.949	241.522	61.2	243.205	1910.932	7.8	30.38
III A Top	7.300	83.272	11.4	250.505	1994.204	8.0	127.63
III A Bot	37.935	64.654	1.7	288.440	2058.858	7.1	119.47
All Seam	288.440	2058.858	7.1				

A perusal of the above Table shows that the minimum OB:Coal ratio of 3:0 (cum:t) is obtained for the OC mining of seam IX and the depth of this seam intersected ranges 41.69m and 199.74m. The ratio does not deteriorate upto the floor of Seam VIIB for which it comes to 3.9:1 (cum:t). The maximum depth of floor of this seam intersected is 209.90m. However, the ratio starts deteriorating as we consider deeper seams and the ratio becomes highest 8.0:1 at the floor of seam IIIA(top) and then drops down marginally to 7.1: 1 if considered to the floor of seam-IIIA(Bot), the maximum depth of intersected is 318.34m. The above table of GR does not show the name of lowermost seam of the IIB as the seam is intersected only by one bore hole and the reserves have been termed as indicated. It has been found out as a result of rough calculation that mining with any method, whether opencast or underground, will be highly uneconomic and hence this seam has not been considered for mining.

So, in the **FIRST ALTERNATIVE/ OPTION**, it is considered that open cast mining will be done from topmost seam XI up to III A (Bot.) and accordingly reserves are calculated as below.

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In the Geological report, the total net geological reserves are given as 288.44 MT comprising reserves from uppermost Seam-XI to lowermost seam III A(Bot). The net reserves after deducting the coal reserves blocked (29.968MT) due to surface constraints are 258.472 MT. The reserves are mainly of Grade G and some of Grade F. In addition to 288.44 MT proved reserves mentioned above, F grade 23.596 MT reserves of Indicated category are further lying in the further lower seam IIB with an overlying parting of about 50m and have not been considered for mining in the GR. Accordingly this seam has not been considered in the Mining Plan also.

The coal and OB computation above IIIA(B) seam are given in Table 5.2

TABLE 5.2
COAL AND OVERBURDEN ABOVE SEAM IIIA (BOT.)

Sl. No.	Description	Coal MT	OB Mcum	OB:Coal
1	Total reserves(from uppermost Seam XI to lowermost Seam IIB) Proved and Indicated	312.036		
2	(-) Indicated reserves of lowermost Seam IIB	23.596*		
3	Net Proved geological reserves vertically below the ML boundary line {upto seamIIIA(Bot)}	288.440		
4	Reserves blocked in barrier (60 m along S&E boundary of Singhada nala, 30m along the Naubanda seasonal nala and 7.5 m along other sides (as per GR)	29.968		
5	Reserves vertically within outer pit boundary excluding barrier	258.472		
6	Blocked in quarry batter	72.20		
7	Within quarry limits excluding batter	186.272		
8	Mining losses (5%)	9.314		
9	Extractable excluding mining losses	176.958	1326.80	7.50

* The seam II reserves are indicated at this stage as only --- Nos. of borehole as intersected the seam. This also reveals the thickness of the seam to be very thin. This seam will be explored, while working in seam IIIA Bot.. The mining will be further extended to this lower seam when the reserves are proved with a workable thickness range after exploration.

In this case, Opencast mining method has been adopted due to following reasons:

- The coal seams are incropping at a shallow depth and the dip of the coal is 8° in the eastern part to 3° in the western part.
- The OB : Coal ratio is reasonably favourable 7.1:1(M³ to Te) for opencast mining
- The mining by opencast method will be economical against underground method

- The opencast mining operations are comparatively safer and ensure higher recovery of coal resource.

In the **SECOND ALTERNATIVE/ OPTION**, it is considered that the OB : Coal ratio is much less from top seam XI up to seam IX. The grade of the coal remains unchanged as in Option first. The stripping ratio sharply increases from seam VIII (Top). This is 40.9:1 for this seam. The detailed coal and OB computation above seam IX are given in Table 5.3.

TABLE 5.3
COAL AND OVERBURDEN - SEAM IX AND ABOVE FOR OC MINE

Sl. No.	Description	Total Coal MT	Seam IX	Seam X	Seam XI	OB Mcum	OB:Coal
1.	Total reserves (from uppermost Seam XI to lowermost Seam IIB) Proved and Indicated	312.036					
2.	(-) Indicated reserves of lowermost Seam IIB	23.596					
3.	(-) Vertical reserves from seam VIII TOP to III A Bot.	88.186					
4.	Net Proved geological reserves vertically below the ML boundary line { Seam XI to seam IX }	200.254	194.835	1.291	4.128	627.88	
5.	Reserves blocked in barrier*	10.597	10.1606	0.0242	0.4124	35.05	
6.	Reserves vertically within outer pit boundary excluding barrier	189.657	184.674	1.2668	3.7156	592.83	
7.	Reserves blocked under Jharpada-Chhendipada road with 45m safety barrier on east and on west upto river	0.816	0.816	0	0	3.211	
8.	Reserves vertically within outer pit boundary excluding barrier and under road	188.841	183.858	1.2668	3.7156	589.62	
9.	Blocked in quarry batter	41.164	40.0245	0.2514	0.8882	74.863	
10.	Within quarry limits excluding batter and barriers	147.677	143.834	1.0154	2.8274	514.76	
11.	Mining losses (5%)	7.38385	7.1917	0.0508	0.1414		
12.	Extractable Reserves (I100) excluding mining losses	140.293	136.642	0.9646	2.686	514.76	3.669
13.	Inseam Dirt selectively removed by CSM	15.263	15.263	0	0	8.7217	
14.	Extractable Reserves (I20) excluding mining losses	125.03	121.379	0.9646	2.686	523.482	4.187

* Barrier against nala/ Jhore adopted as 30m

It is proposed to mine the remaining reserves in the block through underground mining method from seam VIII TOP to III A BOT. Hence the reserves for the underground mining are considered as in Table 5.4.

TABLE 5.4
RESERVES FOR UNDERGROUND MINING, MT

Particulars	Reserves in block (MT)
Net Proved geological reserves vertically below the ML boundary line {upto seam IIIA(Bot)}	288.440
Open cast net proved geological reserves vertically below the ML boundary line {seam XI to seam IX } for	200.254
Net Reserves	88.186
Extractable Reserves (30.03%)*	26.48

* Refer Table 5.13 for details

Considering the above two options, the second alternative for mining open cast as well as underground is superior due to following reasons:

- (i) Low cost of open cast coal production.
- (ii) Disposal of less OB against option first.
- (iii) The grade of coal remains same in both the options.
- (iv) The depth of ultimate pit (Conceptual stage) will be much less.
- (v) The seam IIIA(Bot.) is not outcropping and its floor is proposed to be adopted as the final quarry floor in first option. The minimum depth of this seam at the rise side is 162.60m. This situation of the block indicates that large volumes will have to be excavated to reach to the location when backfilling can be started and also that large areas will be required for surface dumps. The large quantity of OB produced in first option will not be accommodated in the leasehold area and land will be required for outside surface dump, which is not available in this area as there are coal bearing areas and forest areas around besides the villages.
- (vi) Only 10.342 MT of additional loss of coal due to UG mining which is 3.58% of the proved reserves.
- (vii) Very high gestation period, so it will require very long period for achieving 6.00 MTPA in Option -I.
- (viii) The existing rate of G grade coal in the area is Rs. 350 per tonne.
- (ix) Increase in depth of final pit to the extent of 250 m is likely to invite safety problems in Option -I.
- (x) Mining of G grade coal at an incremental ratio of 16.47 with massive rehandling of OB can hardly be economical; in addition to the related environmental issues. Further actual ratio considering mining losses and losses in batter etc would be over 20:1.

5.2 OPENCAST MINING UP TO SEAM IX

The mine will be worked by opencast method upto seam IX and seams below seam IX by underground, because stripping ratio below seam IX being over 16.

- i) Since the strike length is over 5 km, for a production level of 6 MTPA, it will require two access trenches to reduce the hauling distance.
- ii) The external dumping will be on the southern portion of the block with a height upto 100m.
- iii) It is proposed to adopt shovel dumper combination along with drilling and blasting for OB removal and shovel dumper/surface miner for coal extraction.
- iv) Back filling will start during the 3rd year of mine operation.
- v) Feeder breaker to be installed at the top of the two access trenches for sizing of coal
- vi) The extractable coal reserves and OB removal will be about 140.293 MT(l₁₀₀) and 514.76 MCUM respectively above seam IX.
- vii) With the use of CSM, it will be possible to mine the in-seam dirt bands of >20cm separately hence the coal reserves will become 125.03 MT(l₂₀) and the corresponding OB removal will become 523.48 mcum.
- viii) There may be further increase in coal extraction by adopting new technology like high wall mining/ auger mining for the coal blocked under batter, barrier, nala etc

5.2.1 Recoverable reserves, waste quantity and stripping ratio

The recoverable reserves of coal are about 140.293 MT(l₁₀₀) after considering coal blocked in barriers 11.413 MT, in batter (41.164 MT) and mining losses of 5% (7.384 MT) and the corresponding waste quantity will be 514.76 MCUM resulting into an OB coal ratio of 3.67:1.

However, with the use of CSM, coal (l₂₀) will become 125.03 MT(l₂₀) and the corresponding OB removal will become 523.48 mcum.

5.2.2 Selection of mining technology

There are following types of equipment systems available for opencast mining:

- a) Bucket wheel mining
- b) Dragline mining
- c) Shovel dumper combination
- d) Continuous surface miners (CSM)

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Each of them has been explained below:

(a) Bucket wheel excavation

The bucket wheel alternative has not been considered due to following reasons:

- The strata below the upper most weathered mantle is hard and strong requiring blasting hence bucket wheel excavators are not viable.
- Presence of large number of seams and interburden layers, mostly of small thickness, which will be uneconomic in this alternative.
- Requirement of precision selective mining which will not be possible by bucket wheels especially for thin seams and partings.

(b) Dragline

The dragline has not been recommended mainly due to the reason that the lowermost seam-IX is very thick (upto 41.84m) and the dragline will have to be placed on the top of the coal seam, the advantage of direct casting to backfill will not be there. In case the thickness of seam would have been low (say 8-10m), dragline could be advantageous for direct casting as the angle of the seam is within tolerable limits of operation (3° to 8°). The other point is that the application of CSM in coal will be difficult if dragline is sitting over the seam which has ultimately come out to be the better equipment system for application in this project.

(c) Shovel dumper

Keeping in mind that there are 3 seams and equal nos. of inter burden layers to be tackled, shovel dumper combination is capable of dealing many layers at a time (flexibility) of operations with the help of varying size of units. The quality problem can be handled with the help of hydraulic excavators which have three dimensional movement of bucket. They are capable of carrying out selective mining. Further more, to tackle 26.26 mm³ OB (max) and 6.00 mil te of coal at many locations in the mine, comparatively mixed size shovels upto 8m³ & 6m³ bucket capacity may be envisaged along with 100T & 50 T tonne rear dumpers. Flexibility in operation will be available due to such equipment system. This system will be much advantageous for OB removal in this block. This will be also applicable for upper two seams XI and X with shovel dumper combination.

The main objectives of mine development have been

- i. to design an economical production of required coal quality for the life of mine
- ii. to minimize transportation distance for coal and waste
- iii. to minimize adverse effects on environment and
- iv. non-sterilizing the remaining potential reserves for future mining

(d) Continuous surface miners (CSM)

Continuous Surface Miner (CSM) is capable of cutting the coal precisely and selectively. Due to number of splits of coal seams, CSM utilization will be useful; hence, two CSM machines with relevant supporting equipment are envisaged. The upper most seam is seam XI followed by seam LOC-1, X and IX seam having coal thickness of 1.08 – 41.84 m. It is proposed to utilise two nos. CSMs in seam IX as its reserves account for about 97.44% of the total reserves. In addition, it is also proposed to use shovel-dumper combination to support the continuous surface miners.

It is proposed to open the face of the open cast mine along the strike on the southern side advancing towards north. It is proposed to operate by dividing the face in two parts with main haul road at the centre.

The equipment selection and operating methods have been designed considering the volume and nature of overburden and disposition of coal seams.

Continuous Surface Miners (CSM) are now being very successfully worked in several limestone quarries and some coal mines specially for quality improvement in coal by the process of selective mining.

Main parameters for few typical surface miners recommended for use in mines are noted below in Table 5.5.

TABLE 5.5
MAIN PARAMETERS OF SURFACE MINERS

Parameters	Models		
	2200 (W)	2100S (W)	202M(B)
Cutting width (in m)	2.2	2.0	2.0
Cutting depth (m)	0.25	0.18	0.25
Speed (m/min)	21.0	21.0	25.0
Output m ³ /min	11.55	7.56	12.5
Coal production in tonne/Hr. (Sp.gr. 1.75)	1212	794	1312

W - Winger
B - Bitelli

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The above type of machine is a continuous cutting and loading machine, so long the material produced by the machines are continuously evacuated. This could have been possible by designing conveying system through shifting conveyor systems. The proposed mix of surface miner and shovel-dumper combination for working the block in different time frame make very complicated and difficult to use conveyors for evacuation of coal. Therefore, a more flexible approach for material evacuation is considered, and this is possible through application of off the highway dumpers of suitable size and numbers, along with the CSM. Experience indicates that effective hours of CSM on the average with dumpers combination can be taken as 14 hours of

CSM per day. Taking 300 working days per year, total number of effective working hour = $14 \times 300 = 4200$ hrs per year.

Annual capacity for 3 models of CSM with suitable evacuation system will be as given in Table 5.6.

TABLE 5.6
ANNUAL CAPACITY OF CCM

Particulars	2200 (W)	2100 (W)	202 M (B)
Annual production (MT)	1212 x 4200	794 x 4200	1312 x 4200
At 100% capacity (MT)	5.09	3.34	5.51
At 50% capacity(MT)	2.545	1.67	2.755

It is considered prudent to provide CSM on the basis of final field efficiency of only as 50%. Therefore, the annual capacity in tonne @ 1.75 te/m^3 will be about 2.545, 1.67 and 2.755 MTPA respectively for the three models. Since the application of CSM is proposed to be in thick seam, 2 nos. of 2200 (W) type may be considered for use in coal by which overall annual production of around 4.675MT(4 MT l₂₀ coal plus 0.675 MT in seam dirt bands) will be achieved by surface miners with about 9% cushion.

5.2.3 Coal production

It is proposed to use two no. of continuous surface miners and 0.90 to 1.5 m^3 shovel along with 15/20 T RDS for coal production.

5.2.4 Sequence of mining

Generally, the coal opencast mines propose to open up a box cut in the outcrop/incrop of lower most seams and plan to advance the mining operation from rise side to dip side. The main reason of such sequence lies behind the fact that the OB : Coal ratios are lower at the outcrop side and the back filling will be started at the early stage of mining operation. This will reduce the expenditure on transport of OB partially, till the full stage back filling starts. Hence, it is planned to work from rise side to dip side. It may be noted that the seam IX is outcropping in south side and its floor is proposed to be adopted as the final quarry floor. The minimum depth of this seam at the rise side is nil. This situation of the block indicates that only small volume will have to be excavated to reach to the location when backfilling can be started and a small area will be required for surface dumps.

5.2.5 Year wise development of the first five years

Adequate area will be kept reserved at the southern portion of the ML for providing all the facilities of opencast as well as underground mining operations including Inclines. This area is selected in non coal bearing part of the block. The development works during the first year include making

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access road to the site, obtaining 1st set of mining equipment, top-soil removal and driving box-cut and taking up other construction activities. The works to be completed during the second year are obtaining second set of mining equipment and progressive removal of over-burden. As described in earlier pages, the coal seams in this property are of relatively poor quality and intercalated with dirt bands.

A coal washery is proposed in the block for improving the quality of coal so that it can be effectively utilized in the power generation.

The transportation will be affected either by trucks or conveyors directly to coal washing plant.

Similarly, the road infrastructure upto the coal washery would need to be made before it becomes fit for large scale coal transportation. Keeping all the above in view, the build-up in coal production will be made. The mining will begin with an aim of producing 6.00 MTPA from 5th year onwards. The total coal production in the first five years will be 16.2 MT. The year wise development of the mine in the first five years is shown in Plate IX to XVIII.

Year 1

The initial mine entries will be made in the seam IX in the incrop in southern part of the ML area in a low lying terrain. Entry no. 1 will be 600m west of borehole No. CMRT-60 and Entry No. 2 will be 175m north east of the same borehole. These will be aligned from south to north. By the end of this year, OB generation is 3.08 Mcum(B) with a coal production of 0.030MT from seam IX. Two OB benches immediately below the surface (benches at 170 MRL and 160 MRL) in entry no. 1 and parting between seam IX & VIII Top will be worked out during the year. In pit related to entry no. 2 there will be 3 OB benches below surface (170, 160 and 150MRL). Plate IX shows the mine pit configuration at the end of the year.

There will be no backfilling in 1st year. All the OB will be disposed in surface dump. Topsoil will go to the topsoil dump.

Year 2

Above mentioned OB benches will be further extended while a new lower bench at 150MRL in pit of entry no. 1 and 140MRL in pit of entry no.2. will be opened and coal production takes place from seams IX as shown in Plate XI. During this stage, the OB removal is about 7.67 mcum(B) and Coal production being 1.80 MT. There will be no backfilling in 2nd year. All the OB generated will be disposed in the surface dump. Topsoil will go to the topsoil dump.

Year 3

The mine pit configuration remains the same as in the previous year. The previously worked out OB benches along with partings between seams

mentioned above will be extended resulting in waste generation of 14.29 Mcum (B). Coal is obtained by mining the upto floor of seam IX with coal production is 3.30 MT. 11.45 MCM(L) OB will be backfilled and 4.59 mcum (L) OB will be disposed on surface dump. There will be 5 benches in both the pits. The floor of pit of entry no. 1 will reach 140 MRL while it will be 120MRL in pit of entry no.2 (Plate XIII).

Year 4

The benches previously created are advanced and coal from seam IX will be mined. The western pit will have 130 lowest floor level while it will be 110 in eastern pit (entry no. 2). At the end of this year, the production of waste and coal is 26.26 mm³(B) and 4.80 MT respectively (Plate XV). Backfilling will be 15.71 mcum(L) and the rest {14.03 mcum (L)} will go to surface dump.

Year 5

In 5th year the pits of both the entries will merge into each other. There will be 5 and 7 benches in the western side and 7 benches in the eastern side of the merged pit.

The coal will be mined from seam IX. The waste generation is 25.94 Mcum(B) and coal production is 6.00 MT. The pit configuration at the end of this year is shown in (Plate XVII). Minimum floor will be at 110MRL. Backfilling will be 29.25 mcum(L) and there will not be any surface dumping in this year. The 15th Mine stage plan & ultimate pit plan are shown in Plate XIX & XXI respectively.

5.2.6 Calendar programme of excavation

Year wise production for the life of the mine is tabulated in Table 5.7.

TABLE 5.7
BANK CALENDAR PROGRAMME OF MINING BY OG METHOD

Year	Opencast					
	Prog. Coal (MT)	Cumi. Coal (MT)	Prog. OB Cum	Cumi. OB Cum	Prog. Ratio	Cumi. Ratio
1	0.30	0.30	3.08	3.08	10.26	10.26
2	1.80	2.10	7.67	10.75	4.26	5.12
3	3.30	5.40	14.29	25.04	4.33	4.64
4	4.80	10.20	26.26	51.30	5.47	5.03
5	6.00	16.20	25.94	77.24	4.32	4.77
6	6.00	22.20	24.84	102.08	4.14	4.60
7	6.00	28.20	24.18	126.26	4.03	4.48
8	6.00	34.20	23.52	149.78	3.92	4.38
9	6.00	40.20	23.52	173.30	3.92	4.31
10	6.00	46.20	23.52	196.82	3.92	4.26

Year	Opencast					
	Prog. Coal (MT)	Cumi. Coal (MT)	Prog. OB Cum	Cumi. OB Cum	Prog. Ratio	Cumi. Ratio
11	5.80	52.00	22.75	219.57	3.92	4.22
12	5.48	57.48	21.52	241.09	3.93	4.19
13	5.30	62.78	22.79	263.88	4.30	4.20
14	5.30	68.08	22.79	286.67	4.30	4.21
15	5.30	73.38	22.79	309.46	4.30	4.22
16	5.30	78.68	22.79	332.25	4.30	4.22
17	5.30	83.98	22.79	355.04	4.30	4.23
18	5.30	89.28	22.79	377.83	4.30	4.23
19	5.30	94.58	22.79	400.62	4.30	4.24
20	5.30	99.88	22.79	423.41	4.30	4.24
21	5.30	105.18	22.79	446.20	4.30	4.24
22	5.30	110.48	22.79	468.99	4.30	4.25
23	5.30	115.78	22.79	491.78	4.30	4.25
24	5.30	121.08	22.79	514.57	4.30	4.25
25	3.95	125.03	8.91	523.48	2.26	4.19
Total	125.030		523.48		4.19	

5.2.7 Proposed rate of production when the mine is fully developed

Coal production	-	6.00 MT
Overburden excavation	-	25.14 Mcum. (average)
Average OB : Coal	-	4.19 : 1

5.2.8 Mineable reserves and anticipated life of the mine

The recoverable (extractable) reserves are already given in Table 5.7 in as 125.03 MT by opencast mining.

The life of the opencast mine will be about 25 years at maximum annual production rate of 6.0 MTPA as per the calendar programme of production worked out to attain the production level of 6.00 MT by 5th year.

5.2.9 Proposed method of working

Opencast mining method is selected for mining the uppermost seams upto the floor of seam-ix as stated earlier in view of workable thickness of coal seams and favourable overburden to coal ratio (4.19:1). The proposed mining operations in the Radhikapur (west) coal block will commence from the southern portion of the lease area viz. rise side of the deposit.

It is proposed to adopt mechanised opencast method on three shift basis with the deployment of CSM, drill machines, loaders, shovels, dumpers, R.Ds etc.

The final mining stage plan at (25th year) is shown in Plate XXII. The cross-sections showing the final stage are shown in Plate XXIII.

5.2.10 Opencast working

i) Overburden removal : Trucks and shovels

The overburden comprises soil cover underlain by weathered mantle which is in turn underlain by comparatively stronger OB strata.

The 8 m to 10 m high benches will be developed to excavate the OB. To start with, the topsoil material (0.60m thick) will be excavated by 0.9/1.2 cum hydraulic shovel and transported to a designated area by dumpers. Two types of topsoil storages will be made-one permanent type near the external OB dump and another temporary stack on the backfilled area for immediate use within the same year before the onset of monsoon. This topsoil will be eventually re-used for reclamation. It is estimated that a total of 4.56 Mcum(B) of top soil will be generated during the entire period of mining operations i.e. 25 years.

The 8 m to 10 m bench in waste material specifically soil and weathered mantle will not require any drilling/blasting where as the underlying stronger strata of OB will be drilled by rotary blast hole drill using a bit size of 200-250mm. The blast hole will be loaded with explosive and blasted. Hydraulic excavators equipped with 8m³ & 6 m³ bucket capacity will be used for OB. The dumpers will haul the material either to the surface waste dump or to previously mined pit section for backfilling. At the dump site, dozer will be used for the purpose of grading the dumps. Transport will be affected by 100 T & 50T rear dumpers.

ii) Coal mining

The continuous miner will be deployed in seam IX and Conventional methods of mining employing shovel-dumper combination will be mainly used to excavate coal in other two seams XI & X. For these two seams 110/115 mm dia drills will be used for blast hole drilling and the blasted coal will be loaded in 15/20 T dumpers (coal body) by 1.5 cum hydraulic backhoe and 0.9 cum hydraulic backhoe initially.

The coal benches will also be maintained at their prevalent thickness. All haulage roads and dumps will be maintained at a gradient of not less than 1 in 16. (Refer Plate IX to XIX).

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5.2.11 Extent of mechanisation

Mining and transport of coal and OB will be fully mechanised. The mine will operate 300 days an year and 3 shifts per day.

The production capacity of 8m³ Electric Hydraulic shovel with 100 T RD in OB will be:

i) 8 m ³ Electric Hydraulic backhoe +100 T RD	2.20 mil cum
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The production capacity of 6m³ Electric Hydraulic shovel with 50 T RD in OB will be:

i) 6 m ³ Electric Hydraulic backhoe +50 T RD	1.60 mil cum
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The production capacity of 1.5m³ Hydraulic backhoe with 15T RD in coal will be:

ii) 1.5 m ³ Electric Hydraulic backhoe +15 T RD	0.65 mil Te
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The production capacity of 0.9 m³ Hydraulic backhoe with 15T RD in coal will be:

ii) 1.5 m ³ Electric Hydraulic backhoe +15 T RD	0.35 mil Te
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Mining and transport of coal and OB will be fully mechanised. The details of equipment are given in Table 5.8.

TABLE 5.8
LIST OF PRODUCTION AND AUXILIARY EQUIPMENT

Sl. No.	Particulars	Unit	Quantity
I.	Heavy Earth Moving Machinery		
A.	Coal		
a)	Hydraulic shovel 1.5m ³ (Diesel)	Nos.	2
b)	Hydraulic Shovel 0.9 m ³ (Diesel Operated) with one backhoe	Nos.	1
c)	15/20 T.R.D. trucks (Diesel Operated)	Nos.	12
d)	R.B.H drills 110/150 mm (Diesel Operated)	Nos.	3
e)	Dozer 275-320 HP (two with ripper attachment)	Nos.	2
f)	Continuous surface miners(2200W)	Nos.	2
B.	Overburden		
a)	Hydraulic shovel front end 8 m ³ (Diesel Operated)	Nos.	10
b)	Hydraulic Shovel 6 m ³	Nos.	2
c)	100 T.R.D.	Nos.	40
d)	50 T.R.D. trucks (Diesel Operated)	Nos.	8
e)	R.B.H drills 200/250 mm (Diesel Operated)	Nos.	10
f)	Dozer 410 HP (Diesel Operated)	Nos.	5
g)	Dozer 275-320 HP (Diesel Operated)	Nos.	5
II.	Auxiliary & Service Equipment		
a)	3.5 m ³ front end loader (Coal) (Diesel Operated)	Nos.	3
b)	6 m ³ front end loader (Coal) (Diesel Operated)	Nos.	3
c)	Graders 145 HP (Diesel Operated)	Nos.	2

Sl. No.	Particulars	Unit	Quantity
d)	Diesel Bouser	Nos.	2
e)	Construction backhoe -0.9 CUM (Diesel Operated)	Nos.	1
f)	Water sprinkler (26 KL) (Diesel Operated)	Nos.	6
g)	TOW truck on 70T truck chassis (Diesel Operated)	Nos.	1
h)	100 T tractors (Diesel Operated)	Nos.	1
i)	Rough terrain crane - 40T mobile (Diesel Operated)	Nos.	1
j)	Lattice crane 70 T	Nos.	1
k)	Service trucks		
	Fuel trucks (Diesel Operated)	Nos.	4
	Wash trucks (Diesel Operated)	Nos.	2
	Mobile maintenance trucks (Diesel Operated)	Nos.	4
	Lube trucks (Diesel Operated)	Nos.	2
	Fire trucks (Diesel Operated)	Nos.	1
	Explosive van (Diesel Operated)	Nos.	2
	Site mix trucks	Nos.	2
l)	Portable air compressor	Nos.	1
m)	Tyre handler	Nos.	2
	Reclamation		
	2.5 cum front end loader	Nos.	1
	10 T Truck	Nos.	4
	0.9-1.2 cum hydraulic excavator	Nos.	1

All material handling will be carried out on contract basis & other jobs will be done departmentally.

5.2.12 Drilling

Crawler-mounted pneumatically operated down the hole drilling rigs with hole diameter of 200-250 mm and those rigs are capable to meet the future requirement of 8 m/hr will be deployed for OB & R.B.H drills will be used for drilling 110/115 mm dia. holes in coal.

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5.2.13 Loading

The excavation shovels deployed for coal will be used for loading the coal at the face.

5.2.14 Haulage/Transport

The OB will be transported by 100 T & 50 T R.D. trucks to surface dumps and later on, as soon as decoaled area is available suitable for backfilling, to the site of backfilling. The coal will be transported by 50 T R.D. trucks to the coal receiving pit/crusher and the proposed washery, at the pit head and

the washed coal will be transported to the plant by the trucks. A coal stack facility has also been provided for accommodating one week's production. FE loading machines with 6 m³ coal bucket will load the coal into trucks for haulage to plant or railway station. This system will offer mobility or flexibility.

The production from each seam will be mined in the ratio's of thickness to ensure near consistency of quality over the life of the mine.

5.3 UNDERGROUND WORKING

The remaining coal other than opencast upto the lower most seam IIIA (Bot.) will be extracted by underground working. The lay and disposition of Seams is suitable for underground mining due to higher stripping ratio below seam IX. Hence various parameters for mining the block have been dealt in accordance with the requirements for underground mining also.

5.3.1 Reserves, mode of entry and selection of mining method

i. Reserves For Under Ground Mining

This mining plan is prepared for a thickness range of more than 1.8 meters as typical mining practice for thin seams of less than 1.8m is not popular in India due to heavy cost parameters involved for current available technologies and grade of available coal. So the following base line reserves are considered at Radhikapur(west) Coal block for underground mining in lower seams of coal block.

The Radhikapur(west) Coal block is divided for underground mining as well as opencast mining. The calculated vertical UG reserves can be seen in Table 5.9.

The vertical reserves for underground mining are blocked under certain constraints. This includes blockage of coal in small patches of about 3.45MT in all the seams due to uneconomical access by long drive in stone. The thickness wise and grade wise vertical reserves considered for mining are summarised as under:

TABLE 5.9
THICKNESS WISE VERTICAL RESERVES AT RADHIKAPUR (WEST)
COAL BLOCK IN MT

Seam	Net Proved Reserves as per GR	Not Workable Reserves of <1.8M Thickness	Workable Reserves of >1.8m Thickness						
			1.8-2m	2-3m	3-4m	4-5m	5-6m	6-7m	Total
VIII Top	1.84	1.76	0.03	0.05	0.00	0.00	0.00	0.00	0.08
VII B	18.793	11.57	2.10	3.11	0.65	1.36	0.00	0.00	7.23
IV B	2.209	0.91	0.27	0.42	0.60	0.00	0.00	0.00	1.30
Local 2	3.687	3.55	0.07	0.06	0.00	0.00	0.00	0.00	0.13

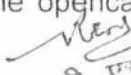
Seam	Net Proved Reserves as per GR	Not Workable Reserves of <1.8M Thickness	Workable Reserves of >1.8 m Thickness						Total
			1.8-2m	2-3m	3-4m	4-5m	5-6m	6-7m	
IIIE	12.473	3.42	0.64	1.43	2.00	1.94	2.91	0.13	9.06
IIID	3.949	3.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IIIA Top	7.3	7.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IIIA Bot.	37.935	4.87	0.95	5.67	8.16	11.19	4.80	2.29	33.06
Total	88.186	37.34	4.07	10.74	11.41	14.49	7.72	2.42	50.85

TABLE 5.10
GRADE WISE VERTICAL RESERVES IN MORE THAN 1.8M THICKNESS
AT RADHIKAPUR (WEST) COAL BLOCK IN MT

Seam	Grade Wise Quantity in MT			Total
	E	F	G	
VIII TOP	0.00	0.00	0.08	0.08
VIIB	0.99	1.76	4.48	7.23
IVB	1.22	0.00	0.08	1.30
LOCAL2	0.00	0.00	0.13	0.13
IIIE	0.00	0.00	9.06	9.06
IIID	0.00	0.00	0.00	0.00
IIIA TOP	0.00	0.00	0.00	0.00
IIIA BOT.	0.00	31.83	1.23	33.06
Total	2.21	33.59	15.05	50.85

The above reserves excludes the reserves under different constraints like Nala barrier, 7.5m barrier from block boundary etc but include reserves (3.45 MT) in unworkable patches. In addition to these the following constraints also restricts the mining in Radhikapur (west) coal block:

1. Only seams VII BOT., IIIE and IIIA BOT. are mineable as the other seams have the scattered small patches of reserves with more than 1.8m in thickness. The cost of waste rock drivages for the entry to these seams does not permit the mining in these patches.
2. The parting between the floor of conceptual pit up to seam IX and underground working in seam VIIB is only 10m to 20m. This parting will be disturbed in either case of mining first in this area. So only possible recovery from seam VIIB is through development up to maximum thickness up to 3.00m before the opencast mining in this area.
3. No depillaring will be done in underground until the opencast working over the depillaring area is completed as it may affect the overlying strata.


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4. The dewatering operations will continue in open cast mining (conceptual pit) till the end of underground mining operations if the underground workings extend to within 60m vertically below the water body in the OC mine.
5. The entry to seam IIIE and VIIB is through rising drifts in north eastern part of the block. So ventilation in this area requires specific arrangements. A peripheral ventilation shaft will be sunk in North east part of the block adjoining to the block boundary barrier pillar. It will be protected through protection pillars throughout the life of the mine. The timing of reaching in seam VIIB through ventilation shaft will be so arranged that the rising drifts from lower seams IIIA (B) via seam IIIE reaches in seam VIIB at the same time.

TABLE 5.11
MINEABLE RESERVES AT RADHIKAPUR (WEST) COAL BLOCK

Seam	Net Available Reserve for UG	Blocked Reserves in <1.8M Thickness in & Unviable Patch	Blocked Reserves in Unworkable Patches	Net Mineable Reserves
	1	2	3	(4=1-2-3)
VIII TOP	1.84	1.76	0.08	0.00
VIIB	18.793	11.57	1.60	5.63
IVB	2.209	0.91	1.30	0.00
LOCAL2	3.687	3.55	0.13	0.00
IIIE	12.473	3.42	0.34	8.71
IIID	3.949	3.95	0.00	0.00
IIIA TOP	7.3	7.30	0.00	0.00
IIIA BOT.	37.935	4.87	0.00	33.06
TOTAL	88.186	37.34	3.45	

It has been assumed that the workable thickness by underground mining will be restricted to 1.8m (due to poor grade of coal and also to avoid dinting). Iso line of 1.8m have, therefore, been drawn on seams to calculate the reserves in less than 1.8m thickness and to exclude the same (refer Plate XXIVA to XXIVC for workable area of Seam VIIB, IIIE and IIIA Bot).

The above mineable reserves will be won through two distinct activities i.e., Development and depillaring. The total extractable reserves will not be more than 60% of mineable reserves. So these are further calculated for these activities also. These are given as under:

TABLE 5.12
EXTRACTABLE RESERVES AT RADHIKAPUR (WEST) COAL BLOCK

Seam	Net Available Reserve for UG	Total Blocked Reserves	Net Mineable Reserves	Expected Extractable Reserves @60% of Mineable Reserves in the Seam
VIII TOP	1.84	1.84	0.00	0.00
VIIB	18.793	13.16	5.63	3.38
IVB	2.209	2.21	0.00	0.00
LOCAL2	3.687	3.68	0.00	0.00
IIIE	12.473	3.76	8.71	5.23
IIID	3.949	3.95	0.00	0.00
IIIA TOP	7.3	7.30	0.00	0.00
IIIA BOT.	37.935	4.87	33.06	19.84
TOTAL	88.186	40.79	47.40	28.44

As mentioned earlier, the parting between the floor of conceptual pit up to seam IX through opencast mining and underground working in seam VIIB is only 10m to 20m. This parting will be disturbed in either case of mining first in this area. So the only possible recovery from seam VIIB is through development up to maximum thickness of up to 3.00m before the opencast mining is done in this area.

TABLE 5.13
EXTRACTABLE RESERVES IN DEVELOPMENT AND DEPILLARING AT RADHIKAPUR (WEST) COAL BLOCK (MT)

Seam	Net Available Reserve for UG	Total Blocked Reserves	Net Balance Reserves for (Free From Blockage)	Expected Mineable Reserves @60% of Balance Reserves Seam wise	Expected Extractable Coal Through Development	Expected Extractable Coal Through Dippilaring	Total extractable reserves
VIII TOP	1.84	1.84	0	0	0.00	0.00	0.00
VIIB#	18.793	13.16	5.63	3.38	1.41	0.00	1.41
IVB	2.209	2.21	0	0	0.00	0.00	0.00
LOCAL2	3.687	3.68	0	0	0.00	0.00	0.00
IIIE	12.473	3.76	8.71	5.23	1.74	3.49	5.23
IIID	3.949	3.95	0	0	0.00	0.00	0.00
IIIA TOP	7.3	7.3	0	0	0.00	0.00	0.00
IIIA BOT.	37.935	4.87	33.06	19.84	6.61	13.23	19.84
Total	88.186	40.79	47.4	28.44	9.76	16.72	26.48

Extraction only through development. Depillaring not proposed due to less parting upto quarry bottom.

In the above table expected extractable reserves through development from seam VIIB are considered @25.0% of extractable reserves for development in pillar size 35mX35m. As the depillaring is not proposed in this seam due to less parting, there will be no coal received from depillaring. For other two seams IIIE and IIIA(B), extraction through development will be @20.0% for pillar sizes 45mX45m. And rest of the coal will be won through depillaring.

The final coal produced quantity from underground mining of Radhikapur (west) Coal Block will be 26.48 MT. These reserves will be won from a pair of inclines named as Incline No. 1 & 2 in southern side of the block. The rated targeted production from underground mine is planned @ 0.70 MTPA.

(ii) Mode of mine entry

Following considerations have been given while locating the main entry to the proposed mine.

1. The entry to be central, allowing access to both extremities and the majority of the reserves almost at equal distance on either side of the main entry.
2. The main entry should serve for the whole mine, if possible and support evacuation of the total extractable coal reserve on a long term economically.
3. The existing surface features should make it feasible to acquire land over adequate area for locating the basic infrastructure at the main mine entry.
4. The location of the Mine entry should facilitate maximum percentage extraction of the coal reserve and ensure minimum sterilization of coal to be left in barriers for protection of existing surface structures.
5. The location of the Mine entry should take advantage of existing infrastructure facilities like highways, power lines, drainage, roads, availability of water, and industrial development in the neighbourhood etc. to make operational costs optimum.
6. The coal transportation should be economical and take advantage of the existing infrastructure.
7. The block includes multiple seams. The selection of main entry needs to take into consideration accessibility to various coal seams for mining to ensure highest overall percentage of extraction.
8. The adequacy of ventilation from single intake and return for all seams.

In view of the above facts that the access to the coal reserve is considered through inclines only. The strike length of the block is about 5 km. Though there are 8 seams (VIII TOP, VIIB, IVB, Local 2, IIIE, IIID, IIIA TOP and IIIA BOT.) but the mineable areas (>1.8m) are not symmetrical in all the seams on both sides and they are irregular. The seam IIIA BOT is occupied the workable area in almost half of northern part of the block whereas the seam IIIE and VIIB is workable in north eastern part only. Since the seam IIIA BOT is the most potential seam, the entry is made in the almost centre of

the block from surface to this seam. The seam IIIE and VIIB will be connected to this seam through drifts at a rising gradient of 1 in 4.5.

Pair of Inclines will be opened up in the south central part at 45m apart named 1 & 2 Inclines. The stone drifts will be driven in 1 in 4.5 to touch coal. Length of loose earth will be totally excavated and properly designed concrete / brick wall sides and concrete roofing of size 4.5m X 3m at inclination of 1 in 4.5 will be done till drifting work in hard rock could be taken up and continued in the same size and the gradient till coal is touched. The lengths of Incline 1 & 2 will be 846m each. In addition to these, one ventilation incline with same specification will be also driven at 45m apart from these inclines and 100m away from block boundary.

(iii) Selection of underground mining technology

There are two primary methods of underground mining viz. Longwall and Bord & Pillar or Room & Pillar. Both the methods of mining are being practiced in India. The selection of the most suitable method of mining in Radhikapur(west) Block is to be considered under the parameters prevailing at the block. These are summarized as below:

1. The depth range of occurrence of the workable coal Seams below seam IX for a thickness range of more than 1.8m in Radhikapur(west) Block is from 163m (seam-VIIB) to 325m(seam-IIIA Bot).
2. The geology of the block exhibits a simple structure with no faults, however presence of miner slips are not ruled out.
3. Only seam VIIB, IIIE and IIIA B are workable seams by underground mining system.
4. The working thickness considered for the coal seams vary from 1.8m to 7.00m
5. The gradient of the coal Seams vary from 8° in the eastern part to 3° in the western part.

Longwall Method

- A globally recognized mining method with very high potential production rates up to 1 million tones per month (in China – with Western equipment).
- Some Seams can only be extracted by longwall method and most suitable for depths exceeding 450 m.
- High capital cost.
- High risk.

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- Equipment is designed site specific and for a set of seam parameters and as such cannot be adopted easily for a different site.
- Very dependant upon excellent geological condition and mine infrastructure.
- Sophisticated system requiring strong management techniques and discipline.
- Requires very strict operator discipline.
- Not very successful in Indian applications in the past due mainly to unsuitable geological conditions.

Longwall technology is not essential for the mining parameters prevailing at Radhikapur(west) Block considering depth range of the coal Seams is only 173m to 325m. Other geo-mining conditions and particularly highly varying thickness range of the coal seams are not favourable for application of longwall technology. As such longwall technology is not proposed for Radhikapur(west) coal block.

Bord & Pillar / Room & Pillar Technology

- Globally recognized method of mining and practiced in India over 200 year
- Mechanized Bord & Pillar method is highly productive mining method up to 120,000 tonnes per month in South Africa
- Very flexible system and can be designed and adopted in varying thickness range of the coal Seams or working below surface features.
- Easier to manage than longwall
- Much lower capital cost than longwall
- Low cost production / competitive with longwall
- Pillar extraction possible
- Very suited to Radhikapur(west) geological conditions


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Accordingly Bord & Pilar (B&P) or Room & Pillar (R&P) Methods are only proposed for Radhikapur(west) Coal block.

The seam IIIA (Bot.) is the highest potential seam of the Radhikapur(west) coal block with a strike length of 4 to 5KM in a width of 1.5 to 2 KM. The block is free from faults and mineable thickness ranges from 1.8m to 7.00m.

The dip of the coal seams is 8° (1 in 7.11) in the eastern part to 3° (1 in 19.08) in the western part.

Because of the prevailing mining parameters mainly arising out of varying seam gradients geology, need for economic exploitation of the multiple seams with maximum percentage of extraction possible, optimum production and productivity two proven B&P technology methods are considered suitable for application in Radhikapur(west).

1. Mechanized R&P method with application of continuous miner without blasting.
2. Semi mechanized B&P method with application of blasting with explosives and LHD.
 - Very successful and economic to date in Indian applications
 - Universal acceptance of the technology
 - Higher percentage of extraction both in first extraction and final extraction is achievable
 - More productive than any lonwall in India
 - Pillar extraction achieved successfully
 - Production levels being maintained till the life of the machine by involving manufactures in maintenance of the equipment
 - Huge potential to improve performance
 - Does not require blasting and as such better roof control
 - Since no blasting is required, this method is preferable in working underneath populated surface features like villages, highways etc.
 - Dispensation from DGMS have been available in India for developing coal seams with gallery widths up to 6.5m and heights up to 4.5m where mining conditions permit, thus allowing much higher percentage of extraction in first extraction which is particularly advantageous in developing coal seams below surface features like villages provided adequate long term factor of safety in maintained.

The disadvantages are

- Productivity decreases rapidly with increases in gradient above 1 in 5.5 and the limiting gradient is 1 in 4.
- The continuous miner equipment approved for use in India by DGMS has a working height range of 2m to 4.5m. For a different working

height range, fresh approval will be required which may require some time.

- This method requires an adequately trained and competent term to operate and maintain the equipment and high level of management skill for effective utilization and optimum productivity.

It is proposed to employ mechanized R&P technology for extraction of all seams in Radhikapur(west) coal block on contract mining basis to ensure highest economy and productivity throughout the life of the equipment. Though the maximum dip of the coal seams is 1 in 7.11, the panels will be developed along apparent dip direction to get the optimum gradient in almost all over the seams. The production equipment package will comprise of one continuous miner, two shuttle cars, one twin boom roof bolter equipment one LHD, one feeder breaker and associated electrical accessories. The equipment to be selected would have the specification to cover a seam height range in single lift varying from 1.80m to 3.5m (12CM12B) and 2.5m to 5m (12CM27D). The development will be carried out in a height range of seam thickness to maximum up to 3.00m. The DGMS has already approved the application of Continuous Miner in a thickness range of 2m to 4.50m for use in India. During depillaring it should be possible to extract up to a height of at least 6.5m with these equipment. The development may be carried with gallery height of up to 4.5 m and widths up to 6.5 m which may be permitted by DGMS under special dispensation allowed for mechanized extraction by CM in India. We are proposing the gallery size of 3.00m height and 4.8m width. The centre to centre pillar dimensions shall be as per CMR 99. The five heading dip drives will be also developed with continuous miner. The method of development and depillaring with Continuous Miner technology is discussed in detail later. The general specification of the equipment is given in para 5.6.

One set of continuous miner equipment package can achieve an annual production capacity from 0.30MTPA to 0.40 MTPA.

In this coal block, the winning of coal is proposed to be carried out with continuous miner technology. For the seam height above 5.5m winning is not feasible by this equipment and hence will be left intact.

Support

In the mechanized R&P technology area, all the supports will be carried out with full column resin grouted roof bolts installed by mechanized roof bolter which is supplied as a part of the continuous miner package. Depillaring is also carried with resin roof bolts.

Scientific studies will need to be carried out to assess the support requirement and design by measurement for the pattern of roof bolting and their specifications. During both development and depillaring monitoring of

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effectiveness of supports will have to be carried out by actual measurements.

5.3.2 Proposed mining method

Mechanized Continuous Miner Technology–Development & Depillaring

Application of Room and Pillar Mining in India

Indian coal mines have a long history of successfully applying Room & Pillar mining methods. Until recently labour intensive "hand got" methods were universally applied. Mechanization to improve productivity by the application of "Side Dump Loaders" (SDL), Load Haul Dump (LHD) and now continuous miner (CM) has been successful and is being widely practiced in the CIL mines.

A mechanized room and pillar mining culture therefore already exists. The Indian coal mining industry has also introduced with limited success fully mechanised longwall mining.

The mechanization program is now aimed to increase the tonnage produced from each district with minimum capital expenditure with the obvious resultant saving in new mine development cost, utilization of developed coal standing in pillars and a further improvement in productivity.

The district layout to introduce one fully mechanized room and pillar mining district may use a combination of 5 heading pillar development and pillar extraction using continuous miners and ancillary equipment.

Typical Face Equipment

Typically the face will be equipped with the following:

- One of suitable "Continuous Miner" equipped with radio/umbilical core remote control, dust scrubber and methane monitor approved by the Director General of Mine Safety (DGMS) for use in Indian Coal Mines. The continuous miner cuts and loads the coal in a single operation.
- Two approved "Shuttle Cars", one left and one right hand including service jacks and side boards. The shuttle cars transport the cut coal from the continuous miner loading conveyor to the feeder breaker.
- One "Twin Roof bolter" track mounted mobile roofbolting machine with two roof drilling rigs, equipped with a "Temporary-Roof-Support" (TRS) system and set up for wet drilling operations.
- One electric cable reel "Load-Haul-Dump" (LHD) machine to be dedicated to the face operation is a multi-purpose vehicle and is essential for the efficient of the district by maintaining the panel floor to

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the high standard required to sustain high performance. Other uses include but are not restricted to cleaning up spillages in the district from the shuttle cars, to assist with transport for materials to site (from the end of the haulage), to spread stone dust, to lift items and assist with the repair of equipment during break downs and to carry spare parts from the haulage to the equipment. This vehicle is also used to carry out electrical move ups of the load centre/transformer complex.

- One "Feeder/Breaker" mounted on tracks to size and feed the tipped coal from the shuttle car on to the conveyor at a consistent controlled rate. The feeder/breaker has a hopper sufficient to hold a complete shuttle car load. The shuttle car is capable of tipping at two speeds. With a feeder/breaker in the system the shuttle car can tip at high speed into the hopper, the feeder/breaker (or with just a breaker plate) then sizes the coal (possibly to 150mm) and feeds the conveyor at a controlled even rate thus preventing belt damage, maximizing conveyor capacity and allowing the shuttle car to travel back to the continuous miner for loading in the shortest time possible.
- Complete set of special maintenance tools with secure storage box.
- Hand tools, shovels, picks, brushes, pinch bars for scaling roof and an assortment of pulling, jacks and lifting tools.

Typical Development Mining Method

Strike Development

It is proposed that the "strike" or "near strike" development and bulk tonnage producing areas be mined by continuous miners and ancillary equipment where the face equipment is, installed, maintained and operated by the Contractor as described above. The standard layout consists of a five road development, with the main conveyor and feeder breaker positioned in the Central roadway {Plate XXVIA (FIG 1)}

Place Changing

Place changing is where the continuous miner cuts for a specific distance beyond the last row of support (up to a maximum 15m called a "Place") using radio remote control of the continuous miner. The workforce at all times operates under supported roof. A lesser distance may be advanced depending on DGMS approvals. The time to cut a place is largely dependant upon the efficiency of shuttle car operation ("wheeling"). Once a "Place" is cut the continuous miner is trammed to an adjacent heading to commence the cutting cycle over again. A roof bolting machine then supports the area mined by the continuous miner as a separate operation then the roadway is cleaned by LHD and ventilation extended in preparation for the continuous miner returning. The machines therefore operate independently and hence with greater flexibility for both cutting and roofbolting operations.

The work of the LHD cannot be understated. The quality of floor is one of the keys to success in place changing. A clean and well maintained floor provides a safer working environment, enables shuttle cars to operate at fast speeds, lessens the potential for cable damage and allows for unhindered continuous miner and bolter relocations.

Mining Geometry

The continuous miner typically have a cutting head 3.3m to 3.5m wide. The machine is usually "sumped in" between 0.5m and 0.75m at roof level, the rear stab jack on the machine lowered and the head sheared down to floor level. This cycle is repeated 3 to 4 times, the roof and floor trimmed and the operation repeated.

"Bord Width"- Indian Coal Mines Regulations restrict "bord", "room" or "roadway" width to a maximum of 4.8m. The continuous miner and all ancillary equipment proposed by JOY is able to operate at this dimension however productivity and safety around moving equipment is greatly enhanced with wider roads.

Since the coal is cut and not blasted, the pillar sides are far stronger. It is estimated that blasting effectively increases the bord width by at least 0.5m on each side of the drive due to the shattering effect of the explosives on the pillar sides. Blasting would therefore effectively create a bord width of 5.8m in a nominal 4.8m wide bord driven using drill and blast methods. It is proposed to work generally with a 6.0m bord width and to optimize the system based on the technical study by a scientific consultant and envisages that DGMS will be approached for an exemption to regulations to permit a bord width up to 6.5m wide. The effect of increasing bord width would be to.

- Increase production and productivity of the mining system
- Improve safety of men and machines since there would be greater clearances for equipment to operate and for people to travel in the district.

Mining Height

Indian Coal Mines Regulations restrict the mining height during development to 3m. This is understandable for traditional systems of drill, blast and support where access to the roof for support and manual drilling holes etc. in thick seams is onerous and extremely difficult. With the equipment and systems proposed coal winning and support and achieved mechanically and can be undertaken safely and efficiently within the operating range of the equipment. The mining height should therefore be restricted by the operating range of the equipment which in most cases exceeds 3m. It is good practice to mine and support as one phase. Removal of support, particularly cement or resin grouted roofbolts is not possible without blasting. This then further weakens the roof and exposes the work force to unnecessary exposure to unsupported roof.

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The impact on strata control of working at increased height will be assessed by the scientific consultant and the contractor envisages that the DGMS will be approached for exemption to permit the mining height during the development phases be restricted by the operating range of the equipment or seam height whichever ever the greater.

Pillar Dimensions

Indian Coal Mines Regulations define pillar dimensions in terms of depth of workings and bord width. In the case where the bord width is 4.8m the distance between the centres of any two adjacent pillars shall not be less than:

Depth	Centres
Not exceeding 60m	19.5m
Exceeding 60m but not exceeding 90m	21.0m
Exceeding 90m but not exceeding 150m	24.5m
Exceeding 150m but not exceeding 240m	34.5m
Exceeding 240m but not exceeding 360m	45.0m
Exceeding 360m	48.0m

It is likely that the continuous miner will be operating at depths around 173 to 325m. The pillar sizes, under current Indian regulations should therefore be 34.5m to 45.0m (centre to centre) with 4.8m bord width to comply with the Indian Coal Mines Regulations. Scientific studies and practices to date in India indicate that the legislated design criteria are very conservative. These pillar dimensions are considered excessive for the desired Factor of Safety and the contractor envisages that application will be made to DGMS to reduce the pillar dimensions in order to increase the productivity of the purposed system. Optimization of the bord width, mining height and pillar sizing may be carried out by calculating and using safety factors from established formulae.

Typical method of support

A typical support system consists of 4 X 1.8m full column resin grouted roofbolts, the roofbolts being installed and tensioned by the roofbolter. In is anticipated that with bord widths exceeding 4.8m an additional bolt would be required.

Pillar extraction generates additional roof stresses and the additional support applied before bed separation can take place, during the development phases, would be beneficial in the long term.

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It is necessary that Coal Company retain the responsibility for the management the legal aspects of the mine. It is therefore the responsibility of Coal Company to ensure that any support system suggested by the contractor is adequate and approved by the DGMS.

Typical Pillar Extraction Methods

Pillar removal plans are an important part of the continuous miner operations and must be full considered prior to the mining of the advancing panel. There are many different methods of pillar removal and these must be assessed to determine the most appropriate to suit the conditions at the mine. This requires full assessment of the mining height, depth, roof strata, floor strata, immediate roof and floor properties, rib stability, pillar size and roadway width. All continuous Miners supplied to India have radio remote control operation ensuring that the operators are always standing in a place of safety under fully supported ground, some 15 to 30 meters behind the working face. The Mine Managers safety and mining rules should specify where the operators must position themselves.

The size of pillar and the roadway width depends on the depth and geological conditions, as well as the proposed method of de-pillaring. The safety factors, method of operation and layout of de-pillaring have a marked effect on the choice of roadway width and pillar size on development.

Knowledge of the composition of the overburden is important in deciding whether to carry out retreat mining. This affects pillar dimensions, roof control plans and selection of the technique. The overburden should be strong enough, given the pillar sizes and temporary support, to allow the development work to be carried out safely, yet weak enough to fall at the proper time during retreat. If this is not the case, then variations to the pillaring plan, such as increasing or decreasing pillar dimensions or utilizing a different sequence of cuts must be employed.

The composition of the floor under the coal is another important consideration. The floor is often weaker than the roof and if mixed with water can create mud and poor mining conditions. Plastic flow of the floor can cause instability in the pillars. A full geological survey and interpretation of the conditions is necessary to establish the pillar sizing, roadway width and retreat mining sequence of extraction.

The seam gradient is another factor that requires careful consideration, with slight grades affecting haulage effort and time for operations, which in turn affects the productivity. Also the gradient may have an effect on the shape of the pillars and layout and direction of the panel with main working along the line of strike and cross cuts angled to reduce the angle of apparent dip.

There are many different methods of pillar removal and these must be assessed to determine the most appropriate to suit the conditions at the mine. Typical layouts for Depillaring are shown in figures 2, 3 and 4 in Plate XXVI A.

Operating Methods for De-pillaring

The standard operating method in India is to fully develop the panel, with typically 5 entries on advance, to the panel boundary. At the boundary, the panel may be connected to other 'bleeder' ventilation roadways depending on the mine layout. Height of development and extraction is usually the full seam section or 4.6m (the maximum extraction height of the only approved continuous miner operating in India) (Refer Plate XXVI B).

During retreat from the panel, the pillars are split (either a single split as in Fig 2 or two splits as in Fig 3 (Plate XXVIA), depending on panel size and caving conditions) and extracted on their side or at angles to take the ribs in an arranged and safe extraction method. Extra roofbolting is used at the edges of the pillars to provide an effective 'breaker line' and ensure that after the extraction sequence is complete the roof collapses in a controlled manner up to the roof bolt breaker line.

In poor ground conditions different methods of pillar extraction or partial pillar extraction, such as the Nevid method, as in Fig 4 (Plate XXVA), may be more appropriate. This method has been extensively used in South Africa and allows a series of cuts into the pillar sides in a sequential manner ensuring minimum tramming distances for the continuous miner and improved safety for the operator. Depending upon the depth and width of the cuts, the central core of the pillar is also kept intact, resulting in a higher factor of safety and better control of caving in areas of weak roof.

During retreat mining/pillar removal the aim is to keep active working places (where the continuous miner is operating) away from the caved areas. Also the length of time that openings are maintained must be kept to a minimum and workplaces should be concentrated in a limited area.

The infrastructure, conveyors, material transport system, power, water, pumping and ventilation are in place from the development phase.

The same equipment is required for pillar extraction as for development.

Pillar extraction techniques may follow the traditional 45° "stooping" line, or the preferred straight line method employed with continuous miners.

Two pillars are mined simultaneously using either system.

The disadvantage of the traditional "45° System" with FULLY mechanized equipment is the creation of excessive tramming distances which effectively restricts production.

The protection afforded by the 45° line was originally developed for a hand loading scenario due to the long time period the pillar had to stand whilst being extracted and the number of working places required by the cyclic, drill, blast and hand load method.

The straight line method reduces both tramming distances and cable lengths to a minimum whilst optimizing tramming routes.

Percentage extraction

The "IN PANEL" extraction is estimated with both the 45° and straight line methods as shown above to typically be 80% by area, this may increase by "robbing snooks" (pillar remnants) whilst retreating from the pillar.

Conveyor

A 1000mm "fire resistant" conveyor at around 3m/s with a duty equivalent to average 500 tonnes per hour (tph) should be installed in the centre roadway to ensure equal tramming distances and cable lengths on each side of the loading point. Peaks of 750 tph are expected.

The conveyor should be equipped with a look take-up at least of sufficient capacity to hold belt stretch for one week and preferably to hold one roll (usually 300m) of conveyor belting for extension and retreat of the conveyor.

At the inbye end of the conveyor, a sledge mounted and guarded return pulley frame, graduated loading section (at least 3m in length) equipped with impact rollers, and anchor chains should be provided.

The "head" end of the conveyor should be equipped with a suitable loading section on to the trunk conveyor, dust suppression equipment, belt alignment, belt slack and belt slip detectors. The "gate" belt should be electrically interlocked with the "trunk" conveyor to automatically stop the gate belt should the trunk belt stop.

Communication and continuous signaling and "stop pulls" should be provided along the length of the conveyor. The conveyor should also be provided with an effective bottom belt scraper.

One side of the conveyor should be designated as the "man, walkway" into the district. To prevent "Tripping and Falling" accidents, this walkway should be kept clear of any supplies, materials, be clean, level and well illuminated.

District materials should not as far as possible be transported along the conveyor belt route.

Material Transport

Materials such as timber, roof bolts, grouts/resins, spare parts, cables, lubricants, ventilation stopping materials etc. are to be transported by the mine to within one split of the gate belt "tail end".

It is proposed that a method is used with which the mine is familiar such as an endless rope haulage system using 15 kg track with a 0.6m gauge. The

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track and return wheel should lag no more than 2 pillars behind the conveyor tail end.

Pumping

Water made in the district shall be pumped out via at least a 100 mm pump range running along side of the conveyor. This district range shall be connected to intermediated sumps in the district and ultimately in the mine main sump.

The pump range, intermediate sumps and pumps shall be provided, installed and maintained by the mine. The pump range shall at all times be advanced or retreated to the gate belt tail end and provided with a 100 mm valve at each end. The CM district will require two mobile face pumps, cables, switchgear, flexible hoses and manifold to connect to the 100 mm valve provided by the mine.

Should more "permanent" or intermediate pump installations be required within the district as a result of "hitting" water, "permanent / intermediate pumps" shall always be kept supplied, installed, maintained and operated by the mine (including all electrical and pipe connections) to appropriate standards.

Clean water

In the case of CM districts clean water at neutral pH and minimum suspended solids is required to be provided at the rate of 250 l/min at 2000 kpa for cooling motors, drilling and dust suppression of the CM system. In all cases drinking water need to be provide in the district inbye.

The clean water shall be supplied by means of a 100 mm pipe range installed in the conveyor road. A 100 mm valve shall be provided at each end of the district clean water range. Fire hydrants shall be installed along the clean water range at intervals not exceeding 200m. At each hydrant in box containing fire hoses (sufficient for 200 m), nozzles etc. shall be provided. The clean water range to the gate belt "tail end", valves, fire hydrants hoses etc. shall be supplied, installed and maintained by the mine.

Power supply

Power is to be supplied to the districts at a tension of 3.3 KV. The main feed cable to the district transformers (HT) shall be supplied and installed along the No 4 roadway. This would be required whichever technology is employed. It is required to have an installed capacity of 1500 KVA to supply the face equipment in the mechanized R&P district from the conveyor tail end inbye.

The face equipment will operate at 1100V. The CM package will include all electrical equipment, transformer (3.3 to 1.1 KV), switchgear, cables sockets etc. for the face equipment. It is necessary to provide separate HT

cable and section isolator to the face transformer and between the district transformer and the face switchgear.

Communications

A suitable communication system shall be provided between the district gate belt tail end, mid-point of the conveyor run, gate belt head end and the office on the surface of the mine (or control centre if available) by the mine.

Safety management

Safe is paramount to all operations. A project management plan will be developed specific to the continuous miner operations. The plan will include standards and procedures for the safe and efficient undertaking of all activities and tasks within the project scope. Standards will, as an absolute minimum, comply with the Indian Coal Mines Regulations 1957.

Development of panels

The pattern of panel formation and likely number of faces as available during initial stage is shown in Plate XXVII to XXXVI. The Conveyor and haulage are kept in inclines which also serves the purpose of intake for the panels. The same extends in the seam with four headings dip drives. The idea is to keep two panels operating. The panels shall be laid out on apparent gradient, thus reducing the gradient of the headings and to be self draining.

5.3.3 Production from underground mines

The production from one continuous miner will be 0.30 (12CM12B) to 0.4 MTPA (12CM27D). There will be two continuous miners operational at any time with following capacity.

Production from one set of JOY 12CM12B standard	=	0.30MTPA
Production from one set of JOY 12CM27D standard	=	0.40MTPA
Total	=	0.70MTPA

The main dip drives will be also driven with continuous miners. All the workable seams will be developed and depillared with continuous miners along with two shuttle cars in each set of continuous miner.

Accordingly, this mining plan has proposed 0.70 MTPA production from underground mining which will be easily achieved.

5.3.4 List of equipments

The following are the main equipments required for fully mechanised bord and pillar method deployed with Continuous Miner in Table 5.14 at Radhikapur (west) East Coal block.

TABLE 5.14
EQUIPMENT CONFIGURATION FOR FULLY MECHANISED PANEL

Sl. No.	Name of equipment	No.	Broad Specification	Remark
1.	Continuous Miner	2	Remote controlled	Brief technical specification are enclosed
2.	Shuttle Cars	4	2.5cum capacity	Brief technical specification are enclosed
3.	Twin Mast Roof Bolter	2	Rotary wet flush drilling	Brief technical specification are enclosed
4.	LHD with Electric cable reel	2		This is essential for efficient panel operation and shifting of materials.
5.	Feeder/Breaker	2	Crushing coal 150mm	Brief technical specification are enclosed
6.	Load centre and transformer	2	3.3kV/1130 V 1500kVA TX	Brief technical specification are enclosed
7.	Special Maintenance tools along with Hand tools, shovels, picks, brushes, pinch bars & jacks etc.	Complete Set with secure storage box for each miner	-	Required for maintenance

5.3.5 Year wise development during initial years

The open cast workings are first started and underground activities are started in 8th year. Accordingly the combined calendar programme is envisaged for Radhikapur(west) Coal Block. The year wise major activities at Radhikapur(west) Coal Block will be as under (Refer Plate XXVII to XXXIC for 1st 5 years of underground mining):

1ST to 2nd Year of underground mining or 9th to 10th year of mining operation:

The pair of Inclines No. 1 & 2 along with ventilation Incline will be started @ 35m per month. Both the inclines and ventilation Incline will touch the floor of seam IIIA (Bot) in 24 months.

3rd Year of underground mining or 11th year of mining operation:

Drivage in coal seam IIIA (Bot) in four heading by Continuous Miner in a section 4.8 X 3m will be undertaken for a duration of about 8 months. The production starts from this seam in 11th year by development of four heading dip drives. Though it is planned to get 0.30 MTPA from this pair of Inclines but we may get only 0.20 MT in 3rd year of underground mining (11th year of overall mine operation). During the last 4 months of this year, drivage of cross measure drift will be started from seam IIIA(Bot) towards seam IIIE at 4.5:1 gradient. Sinking operation of ventilation shaft will also start from 10th month of this year

4th Year of underground mining or 12th year of mining operation:

During the 4th year of underground operation, drivage of cross measure drift will be advanced from seam IIIA(Bot) towards seam IIIE at 4.5:1 gradient and further continued and completed upto the upper seam VIIB. A production of 0.52 MT will be achieved by 2 CMs from seam IIIA (B) and IIIE. The sinking operation of ventilation shaft will be completed at the end of this year and it will touch seam VIIB.

5th Year of underground mining or 13th year of mining operation:

Drivage in less than 1.8m thickness coal to connect the other workable patch (west side) in seam VIIB in a section 4.8m X 2m will be started during this year which will be completed upto half of its length (total length 1163.). Coal production of 0.70 MT will be achieved by 2 CMs from seam IIIA (Bot.), IIIE and VII B.

The Conceptual stage plan at the end of 9th year can be seen in Plate XXXIIA for Seam VIIB. Further stage plans for this seam are not shown as the life of this seam is 9th year.

Conceptual stage plan at the end of 14th year can be seen in Plate XXXIIB for Seam IIIE. Further stage plans for this seam are not shown as the life of this seam is 14th year.

15th, 25th, 35th year stage plans can be seen in Plate XXXIII to XXXV for Seam IIIA and Conceptual stage of this seam (41st year) is given in Plate XXXVI.

5.4 CALENDAR PROGRAMME OF UNDERGROUND PRODUCTION

The coal production from underground mining envisaged as per the following calendar programme is given in Table 5.15.

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CALENDER PROGRAMME FOR COAL PRODUCTION FROM UNDERGROUND MINES

YEAR OF OVERALL MINE OPERATION	YEAR OF UG MINE OPERATION	SEAM IIIA BOT.			SEAM IIIE			SEAM VII B			TOTAL	
		DEV	DEP	TOTAL	DEV	DEP	TOTAL	DEV	DEP	TOTAL	DEV	TOTAL
1.		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3.		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7.		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8.		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9.	1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10.	2	PAIR OF INCLINES STARTS FROM THIS YEAR										
11.	3	PAIR OF INCLINES COMPLETE IN THIS YEAR										
12.	4	0.200	0.000	0.200	0.000	0.000	0.000	0.000	0.000	0.000	0.200	0.200
13.	5	0.400	0.000	0.400	0.120	0.000	0.120	0.000	0.000	0.000	0.520	0.520
		0.333	0.000	0.333	0.300	0.000	0.300	0.067	0.000	0.067	0.700	0.700
	SUB TOTAL OF 1ST 5 YEARS	0.933	0.000	0.933	0.420	0.000	0.420	0.067	0.000	0.067	1.420	1.420
14.	6	0.000	0.000	0.000	0.300	0.000	0.300	0.400	0.000	0.400	0.700	0.700
15.	7	0.000	0.000	0.000	0.300	0.000	0.300	0.400	0.000	0.400	0.700	0.700
16.	8	0.000	0.000	0.000	0.300	0.000	0.300	0.400	0.000	0.400	0.700	0.700
17.	9	0.000	0.000	0.000	0.300	0.257	0.557	0.143	0.000	0.143	0.443	0.257
18.	10	0.000	0.000	0.000	0.120	0.580	0.700	0.000	0.000	0.000	0.120	0.580
19.	11	0.000	0.000	0.000	0.000	0.700	0.700	0.000	0.000	0.000	0.700	0.700
20.	12	0.000	0.000	0.000	0.000	0.700	0.700	0.000	0.000	0.000	0.700	0.700
21.	13	0.000	0.000	0.000	0.000	0.700	0.700	0.000	0.000	0.000	0.700	0.700
22.	14	0.147	0.000	0.147	0.000	0.553	0.553	0.000	0.000	0.000	0.147	0.553
23.	15	0.700	0.000	0.700	0.000	0.000	0.000	0.000	0.000	0.000	0.700	0.700
	SUB TOTAL OF 6 TO 15 YEARS	0.847	0.000	0.847	1.320	3.490	4.810	1.343	0.000	1.343	3.510	3.490
24.	16	0.700	0.000	0.700	0.000	0.000	0.000	0.000	0.000	0.000	0.700	0.700
25.	17	0.700	0.000	0.700	0.000	0.000	0.000	0.000	0.000	0.000	0.700	0.700
26.	18	0.700	0.000	0.700	0.000	0.000	0.000	0.000	0.000	0.000	0.700	0.700
27.	19	0.700	0.000	0.700	0.000	0.000	0.000	0.000	0.000	0.000	0.700	0.700
28.	20	0.700	0.000	0.700	0.000	0.000	0.000	0.000	0.000	0.000	0.700	0.700
29.	21	0.700	0.000	0.700	0.000	0.000	0.000	0.000	0.000	0.000	0.700	0.700

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YEAR OF OVERALL MINE OPERATION	YEAR OF UG MINE OPERATION	SEAM IIIA BOT.			SEAM IIIIE			SEAM VII B			TOTAL		
		DEV	DEP	TOTAL	DEV	DEP	TOTAL	DEV	DEP	TOTAL	DEV	DEP	TOTAL
30.	22	0.630	0.070	0.700	0.000	0.000	0.000	0.000	0.000	0.000	0.630	0.070	0.700
31.	23	0.000	0.700	0.700	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.700	0.700
32.	24	0.000	0.700	0.700	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.700	0.700
33.	25	0.000	0.700	0.700	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.700	0.700
	SUB TOTAL OF 16 TO 25 YEARS	4.830	2.170	7.000	0.000	0.000	0.000	0.000	0.000	0.000	4.830	2.170	7.000
34.	26	0.000	0.700	0.700	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.700	0.700
35.	27	0.000	0.700	0.700	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.700	0.700
36.	28	0.000	0.700	0.700	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.700	0.700
37.	29	0.000	0.700	0.700	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.700	0.700
38.	30	0.000	0.700	0.700	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.700	0.700
39.	31	0.000	0.700	0.700	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.700	0.700
40.	32	0.000	0.700	0.700	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.700	0.700
41.	33	-0.000	0.700	0.700	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.700	0.700
42.	34	0.000	0.700	0.700	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.700	0.700
43.	35	0.000	0.700	0.700	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.700	0.700
	SUB TOTAL OF 26 TO 35 YEARS	0.000	7.000	7.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	7.000	7.000
44.	36	0.000	0.700	0.700	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.700	0.700
45.	37	0.000	0.700	0.700	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.700	0.700
46.	38	0.000	0.700	0.700	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.700	0.700
47.	39	0.000	0.700	0.700	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.700	0.700
48.	40	0.000	0.700	0.700	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.700	0.700
49.	41	0.000	0.560	0.560	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.560	0.560
	SUB TOTAL OF 36 TO CONCEPTUAL YEAR (41TH) (E)	0.000	4.060	4.060	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.060	4.060
	TOTAL PRODUCTION FROM THE SEAM (A+B+C+D+E+F)	6.610	13.230	19.840	1.740	3.490	5.230	1.410	0.000	1.410	9.760	16.720	26.480

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5.5 COMBINED CALENDAR PROGRAMME OF PRODUCTION

The Radhikapur (west) coal mining block is proposed for both underground as well as open cast mining. The cumulative coal production will be as per the following combined calendar programme:

TABLE 5.16
COMBINED CALENDAR PROGRAMME OF COAL PRODUCTION

Year	Opencast	OB Cum	Ratio	Underground	Total OC & UG
	Coal (MT)			Coal (MT)	Coal (MT)
1	0.30	3.08	10.26		0.3
2	1.80	7.67	4.26		1.8
3	3.30	14.29	4.33		3.3
4	4.80	26.26	5.47		4.8
5	6.00	25.94	4.32		6
6	6.00	24.84	4.14		6
7	6.00	24.18	4.03		6
8	6.00	23.52	3.92		6
9	6.00	23.52	3.92	Start of Inclines	6
10	6.00	23.52	3.92	Driving incline	6
11	5.80	22.75	3.92	0.20	6
12	5.48	21.52	3.93	0.52	6
13	5.30	22.79	4.30	0.70	6
14	5.30	22.79	4.30	0.70	6
15	5.30	22.79	4.30	0.70	6
16	5.30	22.79	4.30	0.70	6
17	5.30	22.79	4.30	0.70	6
18	5.30	22.79	4.30	0.70	6
19	5.30	22.79	4.30	0.70	6
20	5.30	22.79	4.30	0.70	6
21	5.30	22.79	4.30	0.70	6
22	5.30	22.79	4.30	0.70	6
23	5.30	22.79	4.30	0.70	6
24	5.30	22.79	4.30	0.70	6
25	3.95	8.91	2.26	0.70	4.65
26	0	0	0	0.70	0.7
27	0	0	0	0.70	0.7
28	0	0	0	0.70	0.7
29	0	0	0	0.70	0.7
30	0	0	0	0.70	0.7
31	0	0	0	0.70	0.7
32	0	0	0	0.70	0.7

Year	Opencast	OB Cum	Ratio	Underground	Total OC & UG
	Coal (MT)			Coal (MT)	Coal (MT)
33	0	0	0	0.70	0.7
34	0	0	0	0.70	0.7
35	0	0	0	0.70	0.7
36	0	0	0	0.70	0.7
37	0	0	0	0.70	0.7
38	0	0	0	0.70	0.7
39	0	0	0	0.70	0.7
40	0	0	0	0.70	0.7
41	0	0	0	0.70	0.7
42	0	0	0	0.70	0.7
43	0	0	0	0.70	0.7
44	0	0	0	0.70	0.7
45	0	0	0	0.70	0.7
46	0	0	0	0.70	0.7
47	0	0	0	0.70	0.7
48	0	0	0	0.70	0.7
49	0	0	0	0.56	0.56
Total	125.03	523.48	4.19	26.48	151.51

5.6 SPECIFICATIONS OF SOME EQUIPMENT

The brief technical specifications of main equipments are as under:

5.6.1 Continuous miner

TABLE 5.17
BRIEF TECHNICAL SPECIFICATIONS OF CONTINUOUS MINER

Sl. No.	Operating Parameters	12CM12B	12CM27D
1	Loading Rate	15-29 tonne/min	17-32 tonne/min
2	Cutter Head Diameter (Optional)	1120 mm	1310 mm(1367mm)
3	Conveyor		
	i. Width	965 mm	965 mm
	ii. Chassis Depth	305 mm	305 mm
	iii. Chain Pitch	82 mm	82 mm
	iv. Speed	123 or 145 m/min	123 or 145 m/min
4	Crawler Chain		
	i. Width	470 mm	560 mm
	ii. Pitch	178 mm	184 mm
5	Cutter Drums JOY Bit Blocks, Spacing,	57 mm	115 mm

Sl. No.	Operating Parameters	12CM12B	12CM27D
	Fixed Head Width, Interlocked End Rings		
6	Cutting Width	3302 mm	3505 mm
7	Ground Pressure	221 kPa	234 kPa
8	Weight	59 tonnes	74.7 tonnes
9	Maximum Cutting Height	3683 mm	5000 mm
10	Minimum Cutting Height	1270 mm	2410 mm
11	Basic Chassis Height	1005 mm	1625 mm
12	Ground Clearance	305 mm	305 mm
13	Sump Range	0-7.6 m/min	0-7.6 m/min
14	Tram Speed		
	i. Slow	4.6 m/min	4.6 m/min
	ii. Intermediate	9.1 m/min	9.1 m/min
	iii. High	19.8 m/min	18.3 m/min
15	Centrifugal Loading Arm Speed	45 or 54 rpm	45 or 54 rpm
16	Cutter Speed		
	i. (950 Volt, 60 Hz)	60 rpm	50.5 rpm
	ii. (950/1050 Volt, 50 Hz)	50 rpm	46 rpm
17	Bit Tip Speed		
	i. (950 Volt, 60 Hz)	3.51 m/sec	3.45 m/sec
	ii. (950/1050 Volt, 50 Hz)	2.92 m/sec	3.15 m/sec
18	Motors (Water Cooled) 950 Volt, 60 Hz		
	i. Cutter - 2	175 kW	245 kW
	ii. Pump - 1	40 kW	40 kW
	iii. Gathering Head - 2	50 kW	50 kW
	iv. Traction (DC) - 2	35 kW	35 kW
	v. Traction (OPTIDRIVE) - 2	60 kW	60 kW
	vi. Total Power (DC)	560 kW	700 kW
	vii. Total Power (OPTIDRIVE)	610 hp	750 kVA
19	Motors (Water Cooled) 950/1050 Volt, 50 Hz		
	i. Cutter - 2	170 kW	260 kW
	ii. Pump - 1	40 kW	40 kW
	iii. Gathering Head - 1	45 kW	45 kW
	iv. Traction (DC) - 2	37 kW	37 kW
	v. Traction (OPTIDRIVE) - 2	60 kW	60 kW
	vi. Total Power (DC)	499 kW	724 kW
	vii. Total Power (OPTIDRIVE)	545 kW	770 kW

5.6.2 Shuttle cars

TABLE 5.18
BRIEF TECHNICAL SPECIFICATIONS OF SHUTTLE CARS

2.2	Operating parameters	Values
2.2.1	Payload (coal) (kg) cubic capacity (cu.m)	10.1 / 10.19
2.2.2	Unladen weight (kg)	22000 kg
2.2.3	Power (KW)	219
2.2.4	Vehicle speed (kmph)	8.5 max
2.2.5	Grade ability	20% max
2.2.6	Turning radius (mm)	inside 2590/Outside 64300
2.2.7	Fuel consumption (L/shift) (if operated)	N/A
2.2.8	Operating voltage	1050 Volt AC 50 Hz
2.2.9	Total service life (million tones)	1.5 depending conditions
2.2.10	Ground clearance (mm)	290
2.2.11	Ground pressure (kPa)	984 Laden to 14 T
2.2.12	Cable reel capacity (electrically (m)	200
2.3	Dimensions	
2.3.1	Overall length (mm)	8990
2.3.2	Width (mm)	2580
2.3.3	Height (mm)	1310
2.4	Wheel	
2.4.1	Size	14.00 X 20
2.4.2	Ply rating	24
2.4.3	Filling	Pneumatic or Foam Filled

5.6.3 Twin mast roof bolter

TABLE 5.19
BRIEF TECHNICAL SPECIFICATIONS OF TWIN MAST ROOF BOLTER

3.2	Operating parameters	Values
3.2.2	Operating mining height (m)	2.6 m – 5.0 m
3.2.3	Drilling length (m)	Single pass stroke 2.845m, retracted length 1.885mm extended length 3.170m
3.2.4	Drill hole size (mm)	Nominal 24mm-38mm. Up to 56mm dia, if larger required please confirm suitability of drill as options are available
3.2.5	Tram speed (m/min)	0-20 m/min max speed
3.2.6	Weight (t)/ Ground Pressure (MPa)	Approximately 140 Kpa, depending on final machine specification
3.2.7	Tire/Track chain	Crawler Chain Manufacture-JOY

3.2.8	Max. Platform elevation from ground (m)	2.80m
3.2.9	Drilling nature	Rotary Wet Flush Drilling
3.2.10	Power (kW)	112 KW
3.2.11	Operating voltage (v)	1050v ac+/- 10%
3.2.12	Bolting rate (bolts/hr.)	12 min to install 4 X 2.1m roofbolts and 4 X 1.2m rib bolts = 40 bolts/hr
3.2.13	Max. material hardness that can be drilled (MPa)	40-60 Mpa
3.3	Dimensions	
3.3.1	Overall length(mm)	8008 mm
3.3.2	Width (mm)	3160 mm retracted, 5680 mm platforms extended
3.3.3	Height (chassis) mm	2180 mm
3.3.4	Wheel base (mm)	Length 3250 mm
3.3.5	Ground clearance (mm)	269 mm
3.4	Drilling system	
3.4.1	Torque (Nm)	320 Nm at 175 Bar. (Adjustable to suit application)
3.4.2	Rotation (rpm)	Typical 450-550 RPM, 71 l/min. (adjustable to suit application)
3.4.3	Feed thrust	2000 kg at 190 Bar (adjustable to suit application)
3.4.4	Feed length (m)	Single pass stroke 2.845m, retracted length 1.885m, extended length 3.170m
3.4.5	Feed rate (m/min)	0.25 m/min (Adjustable to suit application)
3.4.6	Mast height range (m)	Single pass stroke 2.845 m, retracted length 1.885 m, extended length 3.170 m
3.4.7	Mast tilt (deg.)	10° past vertical to 10° past horizontal, total 110°

5.6.4 Feeder breaker

TABLE 5.20
BRIEF TECHNICAL SPECIFICATIONS OF FEEDER BREAKER

Sl. No.	Particulars	Values
4.1.1	Make	Continental Crushing & Conveying – Stamler
4.1.2	Machine model	BF – 14B-58-64C
4.2	Operating parameters	
4.2.1	Capacity (TPH)	0-500 mtpH
4.2.2	Input size (mmxmmxmm)	400 mm x 600 mm x 700 mm
4.2.3	Output size (mmxmmxmm)	200 mm – one dim only

Sl. No.	Particulars	Values
4.2.4	Weight (t)	33 tonnes
4.2.5	Ground pressure (MPa)	0.14
4.2.6	Tram speed (m/min)	12
4.2.7	Crusher Power (kW)	110
4.2.8	Dust suppression	Water – Spray
4.2.9	Hopper size (m ³)	11
4.3	Dimensions	
4.3.1	Overall length (mm)	9493
4.3.2	Width over bucket type hopper	2972
4.3.3	Overall width (frame) (mm)	3243
4.3.4	Tram height (mm)	1397
4.3.5	Max. discharge height (mm)	1426
4.4	Conveyor	
4.4.1	Conveyor width (mm)	1270
4.4.2	Conveyor chain (mm)	89 (nominal)
4.4.3	Conveyor fights (mmxmm)	44 x 101

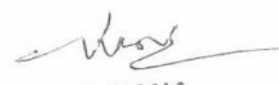
5.6.5 Brief technical specifications of load centre and transformer

HV Circuit Breaker

- Circuit Breaker
- Off load Isolator (ON/OFF/EARTH)
- Static overload and short circuit transformation protection
- Voltage and current display.

Power Transformer Specification

- Rating 1500 kVA at 40°C ambient.
- Off load ratio 3300/1130V
- Tappings $\pm 5\%$, $\pm 10\%$
- Impedance 3-4% (Typical)


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Load centre Specification

- Transformer secondary 1100V earth fault protection
- 1100V, 1200Amp circuit breaker with short circuit tripping function
- 1100V Test switch

- 5 kVA 120V lighting transformer with 4 switched outlets
- 3.5 kVA 110V 3 phase drill transformer with 2 outlets
- 2 off 400A vacuum contactors feeding 350 Amp 1100V restrained Victor sockets
- 8 off 160A vacuum contactors feeding 200 Amp 1100V restrained Victor sockets
- Individual pilot circuit control on all outgoing motor drives sockets
- Individual short circuit protection on all 1100V motor drives
- Individual overload protection on all 1100V motor drives
- Earth fault protection on all 1100V motor drives
- Loss of vacuum protection on all 1100V motor drives
- Indication of voltage, current and power for all 1100V socket outlets

5.7 BRIEF DESCRIPTION ON UNDER GROUND ELECTRICAL LAY OUT

Power is to be supplied to the districts at a tension of 3.3 KV. The main feed cable to the district transformers (HT) shall be supplied and installed along the central roadway. This would be required whichever technology is employed.

It is required to have an installed capacity of 1500 KVA to supply the face equipment in the mechanized B&P district from the conveyor tail end in bye.

The face equipment will operate at 1100V. The CM package will include all electrical equipment, transformer (3.3 to 1.1 KV), switchgear, cables sockets etc. for the face equipment.

It is necessary to provide separate HT cable and section isolator to the face transformer and between the district transformer and the face switchgear.

5.8 UNDERGROUND COMMUNICATION AND TELEPHONE

A suitable communication system shall be provided between the district gate belt tail end, mid-point of the conveyor run, gate belt head end and the office on the surface of the mine (or control centre if available) by the mine.

5.9 TARGET OUTPUT & LIFE OF THE MINE

The target is kept 0.70 MTPA. The life of the underground mine will be 41 years. The underground mine starts from 9th year of opencast mining. All underground operation ends after 49 years of mining in Radhikapur (west) coal block. Hence the overall life of mine is 49 years for opencast as well as underground operations. Additionally, there will be construction activities for 1 year prior to start of production.

CHAPTER 6

BLASTING

This mine will be operated both by OC as well as by UG method. The method of blasting and requirement of the explosives has, therefore been separately described below.

6.1 OPENCAST MINING

After shot holes are drilled into the horizontal bench cut by the shovel, the OB benches are blasted using ANFO with booster explosives and detonators or TLD and DTH combination. Coal is also extracted after blasting off the coal faces. In this mine, main waste is overburden in the form of top soil, alluvium and weathered mantle. Only 0.60m average thickness of top soil has been considered for separate removal and stacking for use in mine reclamation later.

The minimum and the maximum depth of weathered mantle recorded from CMPDIL boreholes ranges from 0.00m (CMTR 024) to 37.83m (CMTR 016). It has been assumed that about 10% of the OB material may not require blasting.

6.1.1 Broad blasting parameters

The drill is deployed on the horizontal bench cut by the shovel. From this level, blast holes are drilled down to the floor of the seam or bench, the length of hole ranging between 8m and 10 m. Easy access to the drill is provided via the waste bench.

In the blasting operations shaking blast practices are proposed using low powder factor. This method will generate a set of cracks in the blasted strata with material movement reduced to minimum.

Medium dia. holes of 200-250mm will be drilled in order to excavate on an average of 22.02 million BCM (Bank Cubic Meter of OB) per year. A powder factor of 0.30 to 0.35 kg per BCM has been adopted for overburden. The powder factor for coal has been adopted as 7 te/Kg with 110/115 mm dia drills. The highest production of coal is 6 MTPA from OC mine out of which 4.00 MTPA coal and 0.675 MTPA in-seam bands will be produced by CSMs and the balance coal amounting to 1.08MTPA will be produced by blasting. The highest quantity of OB is 26.26 MCUM including 0.675 MT in-seam dirt bands in 4th year.

Short delay detonators shall be used. The control blasting techniques will be adopted at the time of blasting to reduce noise, ground vibrations and fly rocks.

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6.1.2 Type of explosives to be used

The open cast mine production is envisaged 6.00 MTPA. ANFO explosive is proposed to be used for heavy blasting and the daily requirement will be as follows for 6.0MTPA coal production with stripping ratio 1 te coal: 3.67 cum OB:

For OB $25.87^{**} \text{MCUM} \times 10^6 \times 0.32 \times 0.9^* \div 300$	=	24.84 te/day
For coal $1.08 \text{ MT} \times 10^6 \div 7.0 \div 300$	=	0.53 te/day
Total	=	25.37 te/day

* Assumed that 10% of Overburden does not require the blasting.

** Highest quantity of OB in any one year. $\{26.26 - (0.675/1.75)\}$

6.1.3 Preparation of ANFO and Storage of AN to be used

A separate license in Form 37 is required for preparation for ANFO at site for immediate use in mine. This is required to be stored at site. The ammonium nitrate becomes an explosive after mixing with fuel oil (6 to 7%). A sufficient quantity of booster explosives is required to be stored in main magazine along with TLD and DTH.

6.2 UNDERGROUND MINING

The mine is also envisaged to be worked with underground system. The mine is targeted for an annual coal production of 0.7 MTPA from underground mine. In underground, development and depillaring will be done with the help of Continuous Miners only requiring no blasting. So explosives will be required for drifting and drivage of access inclines in stone or drivage in seams with less than 1.8m thickness. The average annual requirement will be about 12.77 T and that also during the initial 6 years of UG mining only. It may be noted that only permitted explosives will be used in underground coal mines.

6.2.1 Broad blasting parameters

Mine is planned to be worked by bord & pillar underground mining method. The width of the development galleries will be 4.8 m and height of such gallery will be maximum 3m. It will be not less than 1.8m where the seam thickness is less than 1.8m. All these galleries are driven with the help of continous miner. Hence no blasting is required for winning coal except drifting in stone.

The details of drifts is given in Table below:

Particulars of drifts	Crossection, (width x Height) sqm	No. of drives	Length of each drive	Total length (m)	Total volume (cum)	Waste rock (cum)	Coal (cum)
Main inclines from 176m RL at surface to (-)12m RL at IIIA (Bot) floor	4.5m X 3m	3	846	2538	34263	34263	0.00

Particulars of drifts	Crossection, (width x Height) sqm	No. of drives	Length of each drive	Total length (m)	Total volume (cum)	Waste rock (cum)	Coal (cum)
Cross measure drifts from IIIA(Bot) to VIIB seam	4.8 X 2	4	495	1980	19008	19008	0.00
Drift for access to workable patch in seam VIIB (partially in coal and partially in stone)	4.8 X 2	4	1163	4652	44659	13398	31261
Ventilation shaft from 163m surface RL to (-) 40m RL in seam VIIB	19.625 (dia 5m)	1	203	203	3984	3984	0.00
Total				9373	101914	70653	31261

The drilling pattern has to be evolved for best results on the basis of hardness and other parameters. However, wedge cut is generally practiced and in section of 4.8X2.0 by putting around 18 holes, a pull of 1.5 m could be obtained getting muck around 32 tonnes in one round of blast, charging the holes between 0.5 to 0.6 kg each with permitted explosive like Soligex etc. Blasting efficiency could be achieved to over 3 tonnes/ kg.

6.2.2 Type and quantity of explosives to be used in underground mine

Permitted P 5 type explosives will be used in underground mining even for stone drifting. The blasting in coal is not required wherever continuous miner is used.

The explosive for underground mining will be required for initial 6 years as most of the drifting work is over within this period. The total expected drifting will be as given in above table.

Hence the total 70653 BCUM of waste rock quantity will be generated due to stone drifting for underground mining. Considering the specific gravity of insitu rock at 2.5, the tonnage comes to 176633 tonnes rock.

As 31261 cum (53144T) of coal will also be won during the driveage to the isolated pach in seam VIIB, the consumption of explosive for drifting will be $(176633+53144)T/3.0/ 1000 = 76.6$ tonnes.

6.3 STORAGE OF EXPLOSIVES TO BE USED

Manufacturers and suppliers of permitted explosives are few and a large numbers of holes are to be blasted frequently in OC, which required considerable quantity of booster explosives and considering that there could be delays in supplies for several reasons, a 10 tonnes magazine capacity for 2 to 3 weeks of storage of permitted explosive, detonators primers and fuse etc has been provided.

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CHAPTER 7

VENTILATION

7.1 VENTILATION INCLINE DETAILS

One pair of inclines is envisaged for mining in the block. One of these will be used for conveyor transport of coal and the other for transport of materials up to the face with track haulage. Both these Inclines will also serve as intakes of fresh air. In addition to these a third Incline is also proposed along with them exclusively for return air current from the mine. The location of all these Inclines are marked on surface master Plan (Refer Plate IV). These will be driven from the south side of the block and will be aligned in north at 4.5:1 gradient. These will be driven up to seam IIIA (Bot) and the total length up to seam-IIIA Bot will be 846m driven from surface RL 176m to FRL (-)12m. The exhaust fan will be installed at this third Incline through a properly constructed evacuee. In addition to this ventilation Incline, provision is also made for ventilation shaft located in North West part of the block adjoining to the block boundary. This ventilation shaft will be driven up to seam VII B. The sinking of the shaft is so scheduled that the drivage from incline and this shaft reaches at the same time in seam VIIB at a point marked as shaft in the development plan of seam VIIB. The following table is used for assessment of this time:

TABLE 7.1
ASSESSMENT OF TIME SCHEDULE FOR SINKING OF VENTILATION
SHAFT AND INCLINES AND CROSS MEASURE DRIFTS

Sl. No.	Particulars	Length of Drivage (m)	Progress per month (m)	Time required for Drivage in months
1	Drivage of Incline from surface SRL 176M to Seam IIIA (Bot.) at floor FRL (-)12m at Gradient 1 in 4.5.	846	35	24.17
2	Drivage in coal seam IIIA (BOT) in four heading by Continuous Miner in a section 4.8 X 3m	2000	250	8.00
3	Drivage of cross measure drift from Seam IIIA (BOT.) FRL(-)140M to Seam IIIE at floor FRL (-)95m with rising Gradient 1 in 4.5.	202.5	30	6.75
4	Drivage of cross measure drift from Seam IIIE FRL (-)95M to Seam VIIB at floor FRL (-)30m with rising Gradient 1 in 4.5.	292.5	30	9.75
	Total time to reach Seam VIIB via incline and cross measure drift			48.67

Sl. No.	Particulars	Length of Drivage (m)	Progress per month (m)	Time required for Drivage in months
5	Drivage in less than 1.8m thickness coal to connect the other workable patch (west side) in seam VIIB in a section 4.8m X 2m	1163	50	23.26
6	Shaft sinking from a point 270m west of Bore Hole CMRT 16 surface RL 163m to seam VIIB at FRL (-) 40m	203	12	16.92

From the above table it may be noted that the drivage from the incline reaches in 48.67 months in seam VIIB. It further reaches at the marked point in another one month. The shaft sinking consumed 16.92 months from surface to floor of seam VIIB. So, shaft sinking should start after 33 months of starting the drivage of inclines.

7.2 REQUIREMENT OF QUANTITY OF AIR

- a) Requirement of air, based on production basis (i.e, daily production of coal) is given by :

$$= 2.5 \text{ m}^3 / \text{minute} \times 2334 \text{ te of coal/ day}$$

$$= 5835 \text{ m}^3 / \text{minute.}$$

- b) Requirement of air, based on manpower basis i.e. manpower working in general shift are:

$$= 6 \text{ m}^3 / \text{minute} \times 250 \text{ persons in largest shift}$$

$$= 1500 \text{ m}^3 / \text{minute}$$

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- c) Requirement of air, based on Gas basis (i.e, daily gas emission by production of per tonne of coal for degree II Mine max. up to 10 m³ per tonne of coal raised) is given as under :

Max. allowable concentration of methane in return air = 0.75%

i) Requirement of air for the Mine

$$\begin{aligned} \text{Avg. daily coal production (@ 0.70 MTPA)} &= 2334 \text{ te/day} \\ \text{Daily gas emission} &= 2334 \times 10 \\ &= 23340 \text{ m}^3/\text{day} \end{aligned}$$

$$\begin{aligned} \text{Air required to bring this 100\% concentration to 0.75\%} &= 23340 \times 100/0.75 \\ &= 3.112 \text{ mil. cum / day} \\ &= 2162 \text{ cum/min} \end{aligned}$$

ii) Requirement of air for the District in the Mine

There are two fully mechanized districts in the mine deployed with Continuous miner with capacity of 0.40MTPA and 0.30MTPA.

Max. allowable concentration of methane in return air	= 0.75%
Avg. daily coal production (@0.40 MTPA)	= 1334 te/day
Daily gas emission	= 1334 x 10 = 13340 m ³ /day
Air required to bring this 100% concentration to 0.75	= 13340 x 100/0.75 = 1778667 cum/day = 1235 cum/min

The production from the other CM district @ 0.30MTPA is 75% of above district (@0.40MTPA)

So, air required for the CM district for production @ 0.30MTPA = 1235 x 0.75 = 927 cum/min

= 927 cum/min

Thus the total requirement for two districts (1235 + 927) = 2162 cum/min

- d) Requirement of air, based on speed limit basis i.e. max. 4.0 m/sec vide DGMS circular No. 8674-94 dated 29.5.74 for CM district near working face and min. 0.50m/sec. :

The min. quantity of air required in highest capacity CM district for a daily production of 1334 tonne is 1235 cum per min for 4.8m wide and 3.0m height.

Thus, the velocity of air current = $1235 / (4.8 \times 3) = 1235 / 14.4 = 85.76 \text{ m/min.}$
= 1.43m/sec.

This is 35.75% of max. permissible limit i.e. 4 m/sec.

Thus Max allowable quantity of air in the district = $1235 / 0.3575 = 3455$
and in other district max allowable quantity of air = $927 / 0.3575 = 2593$

Total = 6048 cum/min.

Hence, considering all the options from a) to d), the option "a" is selected. After considering 30% leakage during circulation and requirement of panels individually, total air requirement works out to 7586 m³/min. To meet this requirement, it is proposed to install 2 nos. mechanical Ventilators of total capacity of 7586 m³/min. One fan (exhaust) will be installed at ventilation incline on surface through evacuee at the time the drivage of inclines starts. Its capacity will be 3250 cum/min (based on 0.3MTPA assumed production to be served by this fan). Second fan (exhaust) will be installed during the 5th year at the ventilation shaft at surface through properly constructed

evacuee. Its capacity will be 4336 cum/min (based on 0.4MTPA assumed production to be served by this fan). Both the exhaust fans will have the provision of variable pitch of blades to improve the quantity of air required in future.

7.3 SIZE AND CAPACITY OF MAIN FANS

The two main mechanical ventilators of following specification will be installed at incline and ventilation shaft through evacuee.

TABLE 7.2
SPECIFICATIONS OF MAIN VENTILATORS

Type	Axial flow fan at Incline (serving for 0.3 MTPA coal production)	Axial flow fan at Shaft (serving for 0.4 MTPA coal production)
KW	120	150
RPM	975	750
Air flow	35-85 cum/Sec	110
W.g.	110-40 mm	110-75 mm

Evacuee of suitable design will be constructed for improving the efficiency of the mechanical ventilators.

7.4 DESCRIPTION OF VENTILATION ROUTE

The main mechanical Ventilator will be installed at surface for exhaust ventilation system for all the seams. Both the inclines will be kept as air intakes. The four heading dip drives will serve the purpose of ventilation for each of the seams. The pair of middle dip drives connected to panels will be kept as air intakes and outer side dip drives will work as return from the panels. The air route will be maintained by erecting proper air crossings in the panels.

During the 1st phase (initial 4 years), the total ventilation will be done by fan installed at the incline. In the 2nd phase (after initial 4 years), the ventilation will be undertaken by two return routes as the 2nd fan will also be additionally installed at the ventilation shaft. During the 2nd phase, only western part of Seam-III A (Bot) will be ventilated by the incline fan while the ventilation of the rest of the mine will be done by the return air route to ventilation shaft.

Auxiliary fans with suitable ducts will be used for blind headings of more than 30 meters length for a sufficient supply of air.

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Following objectives are to be attained by adequate ventilation:-

- The inflammable gas does not exceed 0.75% in return air of any district and 1.25% in any place in the mine.

- b) The velocity of air at immediate out by connection from the face should not be less than 30m/minute.

For other places it should be as follows :

TABLE 7.3
VELOCITY OF AIR CURRENT REQUIRED AT VARIOUS PLACES IN
UG MINE WORKINGS

Degree of Gassiness	Places where velocity of air is to be measured	Velocity of Air
1 st , 2 nd , 3 rd degree	Immediate out by ventilation connection from the face.	30 m/min.
1 st & 2 nd degree	i) 4.5m from any face in intake side of brattice or partition ii) 7.5m outbye of the discharge end of air pipe	30 m/min
3 rd degree	i) 4.5 m from any face on intake side of brattice or partition ii) 7.5m outbye of the discharge end of an air pipe	45 m/min 25 m/min.

- c) In case of solid blasting, a minimum of 284 m³/min of air should be circulated to every face.
- d) If wet bulb temp at any working place exceeds 30.5°C, the air current should be less than 60m/min and more.
- e) Provision and transport of the ventilation stopping materials (including access doors), building of the walls, air crossings etc. shall be the responsibility of the mine. Nowadays a range of pre-fabricated pressure rated ventilation structures may also be used which can offer significant savings in installation time and cost and also in materials transport.
- f) Ventilation monitoring, measurements, updating of plans etc. and all legal responsibilities as required by the Indian Coal Mines Regulations shall be the responsibility of the mine. Exemption from existing quantity requirements as specified in the Indian Coal Mines Regulations would be required.

The Radhikapur (West) Block coal seams are considered as degree 2nd gassiness for all purposes of calculation of ventilation.

7.4.1 Ventilation in mine panels

Mechanized Bord and Pillar mining generally results in a high quantity/low pressure ventilation system due to the large cross section and the number of driven roadways.

Two auxiliary fans with a minimum duty of 10 cu meters per second discharging into the return airways are to be installed with reinforced flexible ventilation ducting between the face and fans or should be used and hung from the roof bolts on straining wires.

- Two operating auxiliary exhaust fans with a capacity each to deliver 10m³/sec. at the working face.
- Standby auxiliary fans to maintain efficient ventilation management during panel advance and relocations.
- Cables and switchgear
- Sufficient staining wire reinforced flexible ventilation tubing etc. as necessary (at least 200 m) and 'T' pieces etc. to ventilate all blind ends.

Precautions against coal dust explosions such as the application of stone dust, stone dust/water barriers in conveyor roads, regular sampling and analysis of dust shall be according to the requirements of the Indian Coal Mines Regulations. These precautions shall be the responsibility of the mine.

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CHAPTER 8

MINE DRAINAGE AND PUMPING

The surface topography is generally flat around most of the area which is being used for cultivation purposes by the villagers around south central part. The surface topography is mildly undulating and slopes towards water body. The ground level rises towards south-central area with highest elevation above mean sea level and is at about 195m. The surface elevation gradually decreases towards north-eastern corner of the above and is as low as about 130 metres near boreholes no. CMTR 085 located in proximity to Singhada jhor.

Brahmani river, flowing approximately north to south direction along the eastern boundary of the Talcher coalfield, provides the main drainage of the region. This river is fed by seasonal nalas, viz., Tikra Jhor, Singhada Jhor, Bangaru Jhor, Nandira Jhor and a few other nalas. From the eastern boundary of Radhikapur (West) Coal Block, the Brahmani river lies eastwards at a distance of about 35 km.

Singhada Jhor flows eastwards in the eastern and northern extremities of the block and forms the eastern and northern boundary of the block as well. The Singhada Jhor merges in its down stream into Brahmani river at the north eastern part of the coalfield. Nuabanda nala, which forms the eastern boundary of the block, flows into Singhada Jhor at the north-eastern corner of the block and controls the drainage pattern of the block. Nuabanda nala originates from a water body at the south-central part of the block.

Small ponds and dug wells are common in this block. Morrum and mud roads are very common in and around villages within the block, viz. Nuapada, Kushila and Barpada.

8.1 OC MINE DRAINAGE AND PUMPING

During 1st year of mining, about 30 m to 40m excavation depth will be achieved in western and eastern pit respectively. Hence, the ground water table will be intersected even during the 1st year of mining. The water will accumulate through precipitation as well as mine seepage in the mine sump.

During the course of mining, the water will be pumped out from mine sump to settling reservoir on surface. A sump of suitable size will be provided in the pit. This water will be pumped out into the surface reservoir. After settling, the overflow water will be drained out (if it is in excess of requirement) after ascertaining its quality for disposal into surface water streams. In case it does not confirm to norms, it will be disposed off after appropriate treatment.

The maximum 24 hourly rainfall during the last 50 years at the nearest IMD station at Angul was recorded as 154 mm over 24 hours on 9.9.77. The mining activity as per mining plan will be carried out. The largest void created will have an area of 307.01ha in 15th year of mining which will accumulate rainwater. The largest rainwater collection during 24 hours will be 260037.5 cum in 15th year. Let us calculate the water volume of the 5th year end. The void area will be 149.3 ha. The water collected due to rain fall will be 229922 cum. Adding additional 10% water volume gain from the lease area into the void, the volume will become 22992.2 cum. Assuming the water loss through evaporation as equal to 50% of this the volume will remain back as 126457.1 cum/day (at the end of 5th year). In case mine seepage water is assumed as 20% of this, the water volume to be handled will become 126457.1 cum. This rainwater may have to be evacuated with in three days time to facilitate mining operation for which suitable pumping arrangement will be required, the required capacity of which would be 62.45 cum/minute. The stage wise pumping requirement is given in Table 8.1.

TABLE 8.1
WATER ACCUMULATION

Stage	Void (ha)	Rainwater (Peak 24 hours, cum)	Adding Additional 10% from lease Area cum	Total rainwater accumulated in a day (cum)	Left water after 50% evaporation (cum)	Mine seepage (cum)	*Total for pumping per day (cum)	**Pump capacity cum/m
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)= (6)/3+(7)	(9)=(8)/18 /60
1 st	17.22	26518.8	2651.88	29170.68	14585.34	2917.07	7778.85	7.20
2 nd	47.88	73735.2	7373.52	81108.72	40554.36	8110.87	21628.99	20.03
3 rd	87.99	135505	13550.46	149055.06	74527.53	14905.5	39748.02	36.80
4 th	128.16	197366	19736.64	217103.04	108551.5	21710.3	57894.14	53.61
5 th	149.3	229922	22992.2	252914.2	126457.1	25291.4	67443.79	62.45
15 th	307.01	472795	47279.5	520074.94	260037.5	52007.5	138686.7	128.41
28 th	154.11	237329	23732.94	261062.34	130531.2	26106.2	69616.62	64.46

* The daily water for pumping will be one third of water left after evaporation plus the seepage water.

** The pumping capacity will be calculated by dividing the water for pumping per day by 18 hours and 60 minutes per hour

As far as the surface water is concerned, Singhada Jore is flowing along the northern boundary of the block. Adequate measures to protect the mine workings from surface water flow during the rains will be taken by way of providing garland drains around the mine excavation, surface dumps and also providing suitable drainage gradients for mine benches. Sumps of adequate capacity will be provided on the quarry floor. The coal excavation and transport machinery are organized to be sited over the lowermost coal bench top and will not be affected by water accumulation from rains or strata seepage.

8.2 UG MINE DRAINAGE AND PUMPING

The probable source of water to be taken care as mine drainage in any mine could be either accumulation of rain/surface water in working area or

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contribution of groundwater as mine seepage. The proposed mine will be worked out through underground as well as open cast mining techniques. Hence accumulation of rain / surface water is primarily considered for open cast mines. Only the groundwater seepage will form the source of water for underground mine drainage. The make of water in the underground mine will be from following sources.

- a) Normal seepage / leakage from overlying sandstone of Barakar formation.
- b) Inflow of water from Barakar sandstone roof and Karharbari formation during underground mining.

The water will be automatically drained to the sump in underground working at the lower most part of the mine. Adequate provision for draining out the seepage water from the sump will be provided and the working face will be kept dry. The face pumps will pump the water to the intermediate stage sumps from where the pumps will be finally pumping the water to the surface reservoir. The quantity of water make will be available from the hydrogeological study based on which the capacity and number of pumps will be decided.

The pumped out water shall be utilised to meet the industrial need of mine working and only surplus water, if any, will be discharged into natural drainage after testing.

The maximum and minimum depth of the underground workings in seam IIIA (Bot.) will be 325m and 167m respectively. It will be advisable to have three stage pumping for which appropriate location of intermediate stage pumping will be identified.

8.3 REQUIREMENT OF WATER

Total requirement of water for mining and allied activities are estimated as 1581 m³/day which includes 1024 cum per day industrial water. The requirement of water for drinking purpose @ 557 Cum/day will be met from borewell initially and later from the treated mine water. The water requirement for other purposes will be met from mine sump and surface water reservoir.

The water requirement projected above can be easily met from the mine water (after treatment as required) after the mine is adequately developed. However, during the initial stage of few years, the water requirement will have to be met from the ground water through bore wells.

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CHAPTER 9

MANPOWER, SAFETY AND SUPERVISION

9.1 EMPLOYMENT POTENTIAL

Large number of local personnel including land losers would be mostly recruited in unskilled, semi skilled office assistant categories etc. These personnel need training and orientation before project starts. Besides, some I.T.I qualified young people from the region can be recruited for operation and maintenance job of plant and machineries after proper training. The employment of local people in primary and secondary sectors of project shall upgrade the prosperity of the region. But, many skilled and highly skilled personnel have to be brought from outside as there is no industrial culture in the locality. A phase wise employment potential for the proposed mine is given in Table 9.1.

TABLE 9.1
EMPLOYMENT POTENTIAL

Sl. No.	Designation	Manpower Required
A	Coal Production	
1	Dumper operator	36
2	Shovel operator	9
3	Drill operator	9
4	Drill	9
5	Wheel dozer operator	6
	Sub Total	69
B	Overburden Removal	
1	Dumper operator	144
2	Shovel operator	36
3	Dozer operator	36
4	Drill operator	33
5	Drill helper	33
	Sub Total	282
C	Common	
1	Back hoe operator	2
2	Front end loader operator	6
3	Front end loader helper	6
4	Grader operator	4
5	Grader helper	4
6	Water sprinkler operator	12
7	Water sprinkler helper	12
	Sub Total	46

Sl. No.	Designation	Manpower Required
D	Workshop	
1	Crane operator	3
2	Mobile maintenance van/other truck - operator	8
3	Explosive van operator	2
4	Tyre handler	6
5	Pump air compressor operator	3
6	Tata tipper drivers	11
	Sub Total	33
E	Excavation	
1	Sr. Engg. excavator	2
2	Engineer excavator	10
3	Foreman excavator	20
4	Mechanical fitter	36
5	Electrician	20
6	Welder	6
7	Turner	4
8	Mechinist	4
9	Blacksmith	6
10	Helper/greaser	25
11	Mazdoor	25
	Sub Total	158
F	C.H.P. Washery & General & Continuous surface mines	
1	Senior engineer	2
2	Engineer	12
3	Electric supervisor	3
4	Foreman (elect)	8
5	Foreman (mech)	8
6	Time keeper	6
7	Machine fitter	12
8	Electric fitter	12
9	Turner	4
10	Welder	4
11	Electrician	6
12	Auto	6
13	S/s attendant	6
14	S/s mazdoor	6
15	Pump khalasi	24
16	Pump fitter	9
17	Pump electrician	4
18	Chute/feeder breaker	21
19	Conveyor operator	-

Sl. No.	Designation	Manpower Required
20	Conveyor maintenance	8
21	Mazdoor	12
22	Continuous surface mines	42
	Sub Total	215
G	Communication	
1	Foreman	1
2	Tele communicator mechanic	3
3	Battery charging personal	3
	Sub Total	7
H	Quality Control, Mining Safety, Environment, Dispatch	
1	Agent	1
2	Manager	1
3	Safety officer	1
4	Assistant colliery manager	10
5	Under manager	10
6	Blasting overman	4
7	OB & coal overman	12
8	Mining sardar/shot firer	24
9	Blasting mazdoor (OB & coal)	32
10	Surveyor	2
11	Draftman/ferro printer operator	3
12	Chainman	8
13	Mazdoor	10
14	Quality control & dispatch	4
15	Pitmunshi/tripman	15
16	Chemist	1
17	Assistant to chemist	3
18	Lab mazdoor cum sampler	9
	Sub Total	150
I	Store & Purchase	
1	Store and purchase officer	2
2	Senior store keeper	4
3	Store keeper/issue clerk	8
4	Magazine clerk	2
5	Mazdoor	4
	Sub Total	20
J	Water Supply	
1	Pump operator	9
2	Filter plant attendant	3
3	Pump khalashi	3
4	Pipe fitter	2
5	Helper	4
	Sub Total	21

Sl. No.	Designation	Manpower Required
K	Environment Protection	
1	Assistant manager (horticulture)	1
2	Forester	1
3	Forest guard	2
4	Mazdoor	6
	Sub Total	10
L	Personal/welfare	
1	Welfare officer	2
2	Manager personal	2
3	Personal & wages clerk	8
	Sub Total	12
M	Finance/Accounts	
1	Accounts officer	2
2	Accountant	4
3	Account clerk	6
4	Cashier	2
	Sub Total	14
N	General Staff (L.D.C)	
1	Excavation record clerk	4
2	Electric & mechanical department clerk	4
3	Safety officers clerk	1
4	P.A. to agent	1
5	Clerk to P.A.	3
	Sub Total	13
O	Misc. – Hospital, Security, etc.	30
	Total (A to O)	1080
	Add 10% absenteeism	108
	Grand Total	1188

TABLE 9.2
SUMMARY OF MANPOWER

Sl. No.	Particulars	Employees
I.	FOR OC MINING	
1.	Overburden removal	282
2.	Coal Production	69
3.	Common	40
4.	Workshop	33
5.	Excavation	158
6.	C.H.P. Washery & General & Continuous surface mines	215
7.	Communication	7
8.	Quality control, safety, despatch	150

Sl. No.	Particulars	Employees
9.	Store & purchase	20
10.	Water supply	21
11.	Environment	10
12.	Personal/Welfare	12
13.	Accounts	14
14.	Medical	30
15.	General	13
	TOTAL	1080
	add 10% for absenteeism	108
	Total for OC and General	1188
II	for UG mining @ OMS=5 For 0.70MTPA	467
	add 10% for absenteeism	47
	Total for UG Mine	514
	Grand Total	1702

Note : Security services will be Outsourced (Say 20)

9.2 SAFETY ASPECTS AND DISASTER MANAGEMENT

All types of industries face certain types of hazards which can disrupt normal activities abruptly and lead to disaster like fires, inundation, failure of machinery, explosion to name a few. Similarly coal mines also have impending dangers or risk which need be investigated addressed, disaster management plan formulated with an aim of taking precautionary steps to avert disaster and also to take such action after the disaster which limits the damage to the minimum.

9.2.1 Implementation of general rules and regulations

The Mines Act 1952 and all the regulations and schedules of CMR 1957 relating to underground mining shall be adhered to and implemented in order to maintain day to day safety. All statutory rules, regulations, applicable laws etc. and statutory requirement related to Government licenses, workmen compensation, insurance etc. including Minimum Wages Act for workers shall be adhered to. Rules, if any, imposed by Local / State Central authorities shall be complied with. Personal protective equipment like helmets, safety shoes etc. shall be provided.

9.2.2 Employment of persons

- No persons shall be deployed unless he is vocationally trained.
- Record in Form-B, Form C & Form-D shall be maintained.
- Records of Vocational Training Certificates and driving licenses of operators shall be kept at the mine and shall be made readily available for inspection.

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- ### 9.2.3 Deployment of equipments and machineries

- #### 9.2.4 Disaster due to failure of waste dump

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1. Gullies (chutes) will be cut for flow of water from the waste dump slowly to channelise it to garland drain. This precaution is necessary to

prevent erosion of waste dump here and there due to erratic flow of rainwater.

2. On the slope of the dump, small pits of 0.3 x 0.3 x 0.3 m will be cut and seedlings will be planted and also over the 1.5 m width of top from edge of the bench similar plantation shall be done so that the top of the waste dump slope will get stabilized.
3. A stone toe wall will be made all around the waste dump to prevent waste dump material being carried out of the dump area and mixing with the general drainage system of the area.
4. A garland drain will be constructed all around the waste dump area for smooth flow of water.
5. The overall slope of dump sides will be kept below 28°.

9.2.5 Disaster due to surface fire/coal stack fires

Special concern is required for storage and transport of low ash and high moisture coal of Radhikapur (west) block. Sufficient numbers of fire extinguishers will be installed at selected locations on surface like Electrical Sub-stations, work-shop, Garage, Diesel Depot, Stores etc. Besides, sufficient number of water hydrants with sufficient hose pipes will be made available in the surface for fire protection. In order to prevent fire hazards in coal stock piles, following types of precaution shall be taken.

- (i) Prevent the happening or presence of any external source of fire in the vicinity of coal stockpiles i.e.

- naked fire
- electric fire
- fuel oil fire

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In case of electric equipment operating in the vicinity of fuel oil being used or stored in the vicinity of the coal stock piles, appropriate types of fire extinguishers will be provided on or near such equipment in order to extinguish the fire at the very start.

- (ii) Restrict the stacking height of the coal to below 6m. Higher height may only be attempted for shorter interval of stacking. The time and height shall be established with respect to spontaneous combustion which will help in restricting to safe parameters.
- (iii) Appropriate arrangement will be made by inserting pipes in the stack to monitor the internal temperature of coal. In case, temperature is found to shoot above safe limits, the coal from the part of stack shall be immediately dug out and disposed safely.
- (iv) Intrinsically safe equipment will be used underground to prevent spark from electricity being used.

9.2.6 Possible dangers due to storage of explosives in the magazine

The total production of coal will be 6.00 MTPA. The 0.70 MTPA coal will be produced by Continuous miner from Underground and 5.3MTPA from open cast mine. It has been calculated that the daily requirement will be about 23.5T (23.124+0.376 miscellaneous). For keeping a buffer stock of 2-3 weeks, 10T capacity magazine has been envisaged including primers, detonators etc.

The explosive magazine will be designed in line with the prescription of Chief Inspector of Explosives that any chance of fire inside the magazine is ruled out. The following precautions will be taken additionally:

- Clearance of dried vegetation within 15 m of Magazine House.
- Installation of lightening arresters on the Magazine to prevent damages in the event of an explosion.
- Provision of fire extinguishers, water and sand filled buckets.
- Arrangement of mounds around the magazine to mitigate damage in the event of an explosion.

Appropriate safety zone margin around the Magazine will be kept as per the guidelines given in Schedule VIII of The Explosives Rules, 1983.

9.2.7 Prevention of electric shock

During mining operations, all the statutory provisions of Indian Electricity Rules 1956, and Indian standards for installation and maintenance of electric equipment etc. shall be observed.

- a. For protection of electric shocks to persons, Earth Leakage Relay shall be provided which will automatically disconnect electrical circuits in case of fault.
- b. Closed mobile substations and switchgears shall be mechanically interlocked which shall eliminate the possibility of opening of the door when oil switch and air circuit breakers are in operation.
- c. All metallic parts of electrical equipment shall be properly earthed.

9.3 SAFETY MANAGEMENT

Safety is paramount to all operations. A safety management plan will be developed specific to the underground mining operations and the open cast as well. The plan will include standards and procedures for the safe and efficient undertaking of all activities and tasks within the project scope. Standards will, as an absolute minimum, complying with the Indian Coal Mines Regulations 1957.

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i. Fencing

All the areas where access to unauthorized persons or animals is prohibited will be protected by barbed wire. Abandoned UG workings and depillared or unsafe goaves shall also be fenced or closed with the help of stopping. Waste disposal areas at surface shall be fenced to prevent inadvertent entry.

ii. Frisking

All persons, entering the mine, will be frisked before entering to prevent them from taking any prohibited article especially the fire generating articles like matches.


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CHAPTER 10

COAL HANDLING, WASHING AND MODE OF DISPATCH

10.1 COAL HANDLING PLANT

A Dual Stream Coal Handling Plant with design capacity of 3.5 million tonnes per annum per stream will be established. The operating capacity of each stream will be 3.15 million tonnes / annum, which is 90% of the design capacity. A higher operating capacity of the CHP at 6.30 will ensure that it is able to absorb the fluctuations in coal production.

ROM (Run-of-Mine) coal loaded into the trucks from the mine will be received in the hoppers below which a Grizzly Screen followed by feeder breaker having capacity of each crushing 3.5 million tonnes of coal annually will be installed. The Grizzly Screen will arrest input of more than 1000 mm size coal to the Primary Crusher.

The Primary Crusher will crush the -1000 mm coal to -200 mm size for passing it through the Secondary Crusher.

This -200 mm coal will be first screened on a vibratory screen or a roller screen. The + 50 mm coal will be fed to a Secondary Crusher which will reduce the size to -50 mm. This along with the -50 mm coal obtained from the underflow of the screen will be fed to a Bunker of 1000 ton capacity. Coal from this bunker will be fed to the Washery.

The salient features of the CHP shall be as under:

- a. A pair of 1200 mm wide Belt Conveyor System designed to run at 800 TPH to meet the 3.5 MTPA design output.
- b. Crushing of coal via Primary Crusher to -200 mm then through Secondary Crushers to produce a final crushed coal product of -50 mm.
- c. A Belt Weigher and an on line Coal Ash Analyser will be located post Secondary Crusher to get the tonnage and on line indication of ash and moisture prior to feed to washery.
- d. A suspended magnet will be provided to remove tramp iron prior to Primary and Secondary Crushers.
- e. The second stream coal received from the Coal Washery shall be further crushed into a tertiary crusher to -20 mm and shall be dispatched by suitable net work of transport to the Power Plant.
- f. The above conveyor system shall be fitted with an electronic Belt weigher and an on-line-ash indicator at a suitable location.

10.1.1 Ground stock

Ground stock yard to accommodate one week coal production of the mine will be located near the coal handling plant and coal from this ground stock will be loaded into trucks with the help of pay loaders. This is for emergencies.

Normally the raw coal received from the mine shall be directly fed into the feeder breakers and the crushed coal will be dispatched to the coal washery directly from the bunker.

10.1.2 Weighment

Two numbers of electronic weigh bridges, each of 100 tonne capacity, shall be installed at the dispatch end. Tare and Gross Weight of the trucks shall be recorded for dispatch of coal to the washery.

10.2 COAL WASHERY**10.2.1 Introduction**

The coal mined from Radhikapur (West) Coal Block, will be used for the manufacture of Sponge Iron, Power Plant and cement production. The process needs coal with different ash content. The quality of coal in Radhikapur (West) Coal Block warrants installation of Coal Washery.

A Pit-Head Coal Washery is, therefore, planned to be installed to produce clean coal with $27\% \pm 1\%$ ash having raw coal through output capacity of 6 Million Tonnes per Annum for washing the coal from Radhikapur (West) mine. The rejects (2nd stream) generated from two stream coal washing will be utilized for generation of power in the Thermal Power Plant.

10.2.2 Process selection

The coal in Radhikapur (West) Coal Block is mostly of grade **PG** with about 45.3% ash content on average in seam IX accounting for 97.08% of extractable reserves by OC method (the extractable reserves by OC method are 125.03 MT belonging to Seams XI, X and IX out of which 121.379 MT belong to Seam IX) and 80.11% of overall extractable by OC & UG method (121.379 MT out of 151.51 MT). In addition it also contains some un-graded coal. This high ash coal needs washing for bringing down the ash content. A number of Coal Beneficiation Methods are available to upgrade the coal to desired ash level. The choice of coal washing process mainly depends on following factors;

- Washability Characteristics of Feed Coal.
- Required Size Range for the End-Use Product.
- Desired Ash Percent in Clean Coal.
- Techno-economic Viability.

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Considering the quality of coal to be mined from Radhikapur (West) Block the following technological options are available:

- i) Jigs
- ii) Heavy Media Bath or
- iii) Heavy Media Cyclones

10.2.3 Coal washing scheme

Coal from following seams will constitute production from Radhikapur (West) Coal Block:

- 1. Seam III A (Bot.)
- 2. Seam III E
- 3. Seam VII B
- 4. Seam IX
- 5. Seam XI

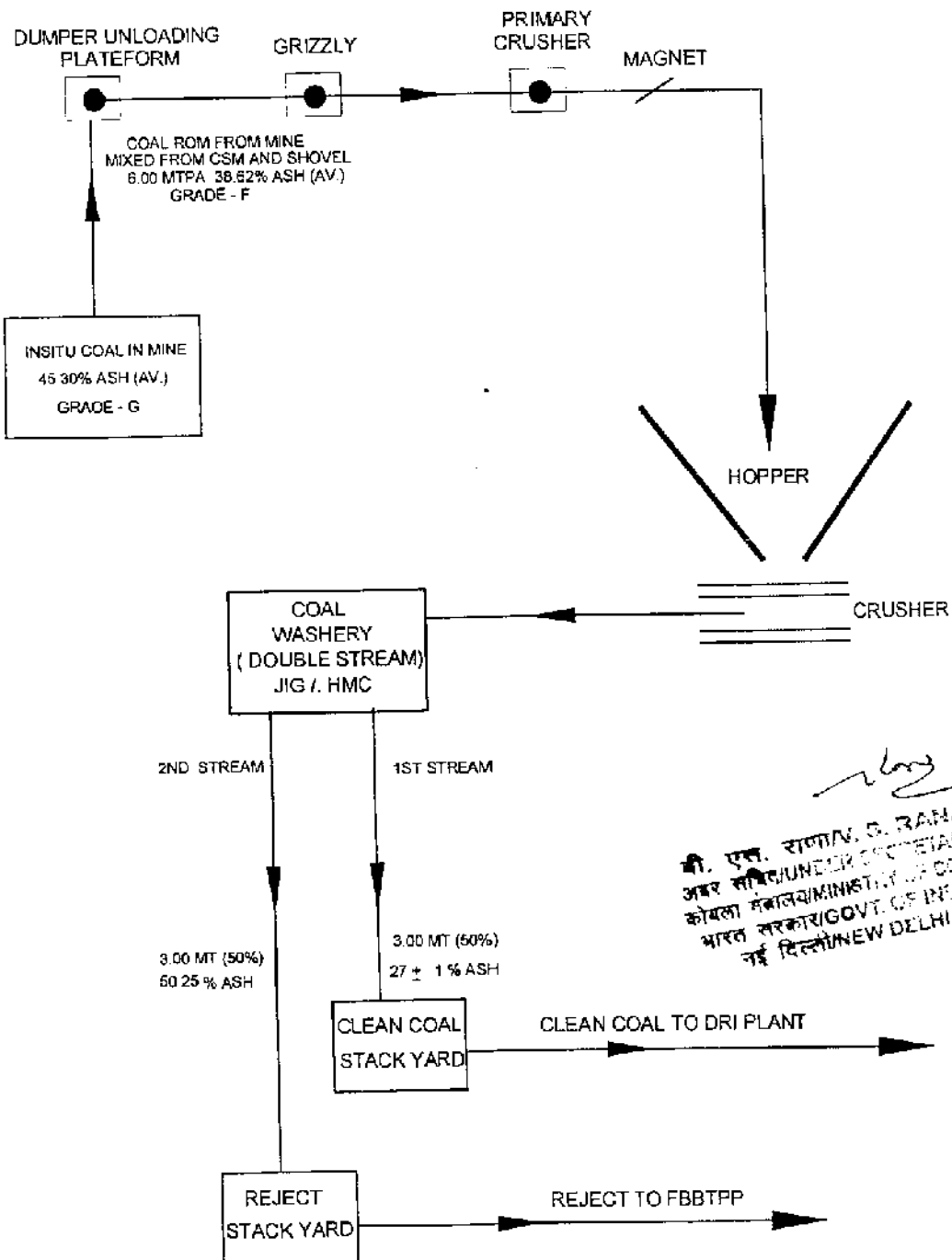
Seam IX is a highly banded seam with large number of dirt bands. The seam IX is the most potential seam available in Radhikapur (West) Coal Block. It incrops within the block and attains a full seam thickness of maximum 41.84m. The maximum depth of occurrence of seam is 157.90m. The seam is highly interbanded and contains as much as 19.82m in-seam dirt bands in different sections. The in-seam dirt bands constitute upto 69% of the seam.

Seam VII B occurs below inconsistent seam VIII Bottom in Radhikapur (West) Coal Block. It incrops within the block and attains maximum thickness of 4.06m. The grade on I₁₀₀ sample varies from E-G. Seam III E is developed in the north - eastern part of the block. It does not incrop within the block and thickness upto 8.90m. The proximate analysis on 60% RH and 40°C of the seam on I₁₀₀ sample shows moisture%, ash% and volatile matter% as 5.2 - 6.0, 43.9 - 49.1 and 22.1 - 25.2 respectively. The grade of the coal seam is G. Seam III A Bottom is the lowermost potential seam proved to be exploited within the Radhikapur (West) Coal Block. The proximate analysis on 60% RH and 40°C of the seam on I₁₀₀ sample shows moisture %, ash % and volatile matter % as 5.4 - 9.1, 30.6 - 42.8 and 22.4 - 28.6 respectively. The grade of the seam varies from E-G. Seam XI is the topmost seam and attains a thickness up to 5.92m. The combustible as well as non-combustible dirt bands within seam constituting maximum upto 50%. The proximate analysis on 60% RH and 40°C of the seam on I₁₀₀ sample shows moisture%, ash% and volatile matter% as 5.6-6.6, 44.9-49.1 and 23.4 respectively.

Considering this, a two product washing scheme has been selected. The scheme for washing of coal shall be as under:

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SCHEMATIC FLOW SHEET OF COAL BENEFICIATION, RADHIKAPUR WEST



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10.2.4 Process description

6.00 Million Tonnes of coal in the size range of 0-50 mm will be received from the Coal Handling Plant. An 1200 TPH conveyor will bring this coal from the raw coal Bunker to the Washery.

The Coal will be screened on a double deck vibratory screen with top deck having aperture of 25mm and bottom deck 10mm. The +10 mm coal will be fed to a desliming screen prior to feeding it to the washing equipment. After washing, the coal will get separated into two streams i.e. clean coal and Rejects. The clean coal yield will be 50% as shown in flowsheet above.

The products will be dewatered in dewatering screens and then fed to respective conveyors which will take the clean coal to the 1000 ton capacity Over Head bunker with truck loading arrangement. The rejects would be fed to 500 ton double hopper over head bunker with truck loading arrangement. From the Bunker the rejects will pass through a crusher house having a crusher with on load adjustment facility for sizing the middling to the required size (-30/-20mm). In order to ensure consistent supply of rejects to the Power Plant, a 1200 TPH stacker cum reclaimer shall be installed with take off from and return to the crusher house.

The rejects would be transported to the power plant through a system of conveyors and the rejects would be stored in an over head hopper for further disposal.

10.2.5 Process control philosophy

Operation of the entire Washery Plant will be done by a centralized PLC based computerized control system designed to enable one operator to start-up, monitor, control and shut down all main equipment items and process functions from the feed input to the washery through to product transfer conveyors.

The PLC will have provision for hot standby. An UPS with hot standby back up will be provided to take care of power tripping and fluctuations.

Sequence Control system for all conveyors with automatic interlocking in stopping sequence will be provided in the PLC software circuit in such a manner that both material and liquid flows will always fall safe to avoid spill of material and media on to the ground floor. Local start & stop buttons with emergency stop button will be located adjacent to each drive and will be able to operate at all times.

An emergency stop button will be located in the control room desk as well as in the operating computer so that the whole plant can be stopped with the help of this button at the time of emergency.

The density of the magnetite media, if Heavy Media Cyclone is used, will be accurately controlled within the range of 1.4 to 2.0 to maintain required

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quality of the washed product. The density measurement will be done by a nucleonic density gauge. Indication and recording of the density levels will be given in the control room computer. The On line ash indication from the on-Line-Ash Indicators installed in the raw coal and middling circuits shall be brought to the Central Control Room and shall be used for quality control. Similarly the indications from the Electronic Belt Weighers installed in the Raw Coal feed circuit, Clean Coal and Middling circuits shall also be available in the Central Control Room for feed and process control.

The fines (-0.5mm) collected from the desliming screen and the dewatering screens will be lead to a sump in the ground floor of washery building. From here these will be pumped to a central Thickener for settling. The clarified water will over flow to the clear water sump. Make up water (440 cum/day) shall be added to this sump.

The settled coal fines (slurry) shall be pumped to a slurry pond for drying and the over flow water shall be recovered and brought back to the Thickener. The dried slurry will be reclaimed from time to time and shall be added to the stock in the Stacker reclaimer Yard.

10.3

MODE OF DISPATCH

The coal will be dispatched through road trucks/coal tippers. The provision of weighment will be made in the washery. The loaded trucks/tippers are weighed before dispatch from washery to railway siding with help of a weigh bridge.

For destinations, the coal will be loaded into 20T trucks from the bunkers at coal washery and transported by road to the nearest railway siding at Jarapada, which is 10KM from the block. Front end loaders will be used for loading of Wagons.

There is a proposal for IDCO rail corridor on south of the block. Once the corridor becomes operational, the Radhikapur siding will be only 1km from the block.

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CHAPTER 11

INFRASTRUCTURE FACILITIES PROPOSED AND THEIR LOCATION

11.1 SITE SERVICES

Complete facilities near to the site are very important for such a high capacity mines and quantum of overburden. It is imperative to develop core infrastructure like power, road, telecommunication, housing, service buildings viz. office, store, first aid centre, canteen, etc. for a large number of employees for the project. The mine project is at a remote place from the district headquarter. The site services required at proposed mine will be housed within the premises of proposed mine complex shown in Plate IV.

11.1.1 Workshop

Garage-cum-workshop-cum-engineering store is meant for regular repairs and maintenance of earth moving equipment and dumpers etc. for quarry operation. The garage and workshop complex comprises repairs bays for dumpers and pay-loaders, washing bays, storage rooms, inspection pits, engine repair room, auto-electrician room, open yard for parking Heavy Earth Moving Equipment (HEMM) and repairing of excavators and shovels.

11.1.2 Road

Jarapada - Chhendipada road passes through the western side of the block which can be used to access the block.

In addition, the Talcher – Sambalpur railway line is around 10 km away from the southern boundary of the block. Nearest rail head is Jarapada.

11.1.3 Water supply

Industrial water required for washing, sprinkling on mine road for dust suppression and for watering the mine site plantations, will be supplied from pumping installation at mine sump and surface reservoir.

The drinking water will be supplied from bore well and stored in overhead tank near the facilities area and distributed through pipe lines to different facilities area for drinking and domestic purposes.

Total requirement of water for mining and allied activities are estimated as 1581 m³/day which includes 1024 cum per day industrial water. The requirement of water for drinking purpose @ 557 CUM/day will be met from borewell initially and later from the treated mine water. The water requirement for other purposes will be met from mine sump and surface water reservoir.

The break up of the required water for different activities is as follows:

TABLE 11.1
BREAK UP OF THE REQUIRED WATER FOR OC AND UG OPERATIONS

Underground Spraying after blasting (not common), conveyor transfer points etc)	=	10.00
Underground water requirement for continuous miner @ 250 lpm/machine for 2 units assuming 50% effective operational time	=	360
Fire water makeup		10.00
Plantation @ 15 cum/ hac for 30 hac.=450- recirculated water from colony STP 276=174 CMD	=	174.00
Vehicles washing @ 2.0 m ³ /vehicle/day for 30 vehicles considering 50% recirculation	=	30.00
Coal washery		440
Drinking at working place @ 45 lpd/head for 1702x45LPD	=	77.00
For colony {total manpower in mine 1702 of which colony provision has been made for 50% i.e. 851x 135 lpd x4 members=460	=	460
For peripheral villages (potable)	=	20.00
Total KL Per Day	=	1581

11.1.4 Power supply

The required 15 MW (overall for OC and UG) power supply at 33 KV will be drawn from nearest sub station to the local sub-station from where the power will be supplied to the mine and other functional buildings. An emergency arrangement for power supply has been made by providing a set of 2x1000 KVA and 2x500 KVA DG sets which will take care of ventilation and pumping.

11.1.5 Residential facilities

As the nearest town (Angul) is at about 24 km away from the mine site and the nearest village is only about 0.5 km away from the M.L. boundary. The semiskilled, unskilled and labour grade manpower will easily be available in the surrounding area and the outsider employees will be accommodated at the colony of Radhikapur mine block.

11.1.6 Stores

A store will be provided alongside the workshop to take care of providing necessary consumable, maintenance and repair store house.

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11.1.7 Diesel storage

Most of the HEMM will operate on diesel. Hence, an underground 50 kl diesel pump will be established at the steel plant site. A diesel bouzer will also be provided for the crawler mounted machines operating in the mine.

11.1.8 Canteen and site office

A temporary canteen, first aid center, rest shelter and site office will be available at site while the main facilities will be within the ML area.

11.1.9 Vocation training centre

A Vocational Training Centre will be provided for training of operators and other workmen adjoining to the main mines office located inside the steel complex.

11.1.10 Explosive magazine

A 10 T capacity magazine will be provided in the ML area of the block to take care of the requirement of the block.


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CHAPTER 12

LAND REQUIREMENT

12.1 PRESENT LAND USE AND OCCUPANCY

Summary of the village wise ownership of land and land use wise details are given in Table 12.1 and 12.2 respectively.

TABLE 12.1
VILLAGE WISE OWNERSHIP OF LAND IN MINING LEASE AREA

Sl. No.	Name of the Village	Private Lands (In Acres)	Government Lands (in Acres)					Grand Total (in Acres)
			Community	Leasable	Gochar	Village Forest	Total Govt.	
1	Barapada	584.263	75.249	32.342	43.832	55.919	207.342	791.605
2	Kusakila	609.170	37.570	39.240	47.510	34.420	158.740	767.910
3	Naupada	330.100	17.000	45.100	39.120	21.370	122.590	452.690
4	Kusakila Jungle Bar	225.582	3.550	98.150	36.180	69.960	207.840	433.422
5	Jhintipal	25.267	2.940	21.169	15.537	4.362	44.008	69.275
6	Putagadia	38.680	0.480	0.000	0.000	22.210	22.690	61.370
7	Balipata	9.211	0.173	0.000	0.040	1.289	1.502	10.713
8	Kosala	2.621	0.000	0.000	0.000	0.000	0.000	2.621
	Total	1824.894	136.962	236.001	182.219	209.530	764.712	2589.606
Say 1048 Ha								

TABLE 12.2
EXISTING LAND USE DETAILS OF MINING LEASE AREA (HA)

Type of land use	Pvt. land	Govt. land	Forest land	Total
Habitation	42.4081	22.2119	0	64.62
Agriculture land	502.1153	0.7035	0	502.819
Non agriculture land	185.1066	72.6948	0	257.801
Water body(Pond, Nala Well etc.)	8.602	26.6134	0	35.2154
Temple/Worship place	0.0445	0.709	0	0.7535
Gochar	0.0324	73.7424	0	73.7748
Road	0.2185	22.3339	0	22.5524
Community land		1.0825	0	1.0825
Samansana		4.5854	0	4.5854
Forest				
i Bada jungle			8.3325	8.3325
ii Chhota Jungle			9.3037	9.3037
iii Garmya Jungle			65.4557	65.4557
iv Jungle			1.703	1.703
Total	738.5274	224.6768	84.7949	1048

12.2 PROPOSED LAND USE

There will be opencast as well as underground mining activity within the applied mining lease area. So the profile of the land use will change after mining due to both these activities.

The proposed land use is given below:

**TABLE 12.3
PROPOSED LAND USE**

Particular		Area in Ha
OC Mine Pit Area		750.92
Washery		10.00
OB Dump		100.00
Top Soil Stack		5.00
Raw Coal Stack		7.00
Facility Area	OC	6.55
	UG	3.45
CHP		1.00
Washed Coal Stack		6.00
Green Belt		16.75
Settling Pond		5.50
Washery Reject Stack		2.00
Road		12.00
Bund		15.7
Magazine		0.20
Undisturbed at surface (under UG mining)		105.93
Total Block Area		1048.00

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CHAPTER 13

STACKING OF MINERAL REJECTS
AND DISPOSAL OF WASTE

13.1 NATURE OF TOP SOIL AND OVERBURDEN / WASTE

In this mine, main waste is overburden in the form of top soil, alluvium and weathered mantle. The maximum depth of soil, alluvium and weathered mantle is upto 37.83m. Only 0.6m average thickness of top soil has been considered for separate removal and stacking for use in mine reclamation later.

13.2 YEAR/STAGE WISE WASTE GENERATION

The waste generation year/stage wise is given in Table 13.1.

TABLE 13.1
WASTE GENERATION (TOPSOIL & OVERBURDEN) IN MCUM (BANK)

Year	Excavated area (Ha)- Progressive	Topsoil generated- Progressive	Pure OB generated- Progressive	Total waste generated	
				Progressive	Cumulative
1 st year	17.22	0.10	2.98	3.08	3.08
2 nd year	30.66	0.18	7.49	7.67	10.75
3 rd year	57.59	0.35	13.94	14.29	25.04
4 th year	67.08	0.40	25.86	26.26	51.30
5 th year	83.65	0.50	25.44	25.94	77.24
15 th year	344.00	2.06	230.16	232.22	309.46
Final Year (25 year)	150.72	0.90	213.12	214.02	523.48
Total	750.92	4.51	518.98	523.48	

13.3 WASTE DISPOSAL SITES

There is one waste disposal site over southern side of the block over non workable coal thickness area. There will be two top soil stacking sites- one permanent and the other temporary as explained in the following paragraphs.

i. The surface dump located inside the block boundary

The Surface dump of OB generated during the initial years will be made on South-West side of the Block. The location of the surface dump is over non coal bearing area. The height of the dump will be 100m and its capacity is 58.94 MCUM (L). The area of the dump will be 100.00 ha. (Plate XX).

ii. Backfill dump

Backfilling will start from 3rd year of the project operation with a quantity of 11.45 MCUM (L). 56.41 MCUM (L) material will be backfilled till 5th year.

With the advance of mining operations, the internal backfill quantities will progressively increase and full-scale backfilling will be achieved from 16th year onwards.

The ash generated from the TPP will be disposed off in to the quarry void along with the OB waste.

iii. Crown dump

Crown dumps of height 60m and 70m will be made over the backfilled area on east and west sides of haul road through entry no.1.

iv. Top soil dump

Top soil disposal sites will be 2 at the initial stage-one near the entry no.1 (permanent over 5 ha area) while the other temporary (15 ha) will be over part of the area of proposed surface dump. Both the top stack areas will be utilised upto 5th year as more storage area will be required due to less utilization in reclamation. The temporary stack will be totally utilised by the 10th year and the area freed by it will be utilised for constructing the surface waste dump.

13.4 THE VOID

The remaining void area (154.11 ha) of the excavated pit will ultimately become a water reservoir, having a maximum depth of about 160m. This void area will also be suitably sloped, bounded and fenced. Plate XXII shows the final stage at the end of mine operations with external dump and final void. The generation and disposal of total waste quantities for the life of the mine are shown in Table 13.2.

TABLE 13.2
WASTE DISPOSAL (PURE OB) IN MCUM (BANK) PROGRESSIVE

Year	Total surface dump	Total backfill	Total bund	Topsoil used	Total OB and TS disposal
1 st year	2.64	0.00	0.33	0.00	2.98
2 nd year	7.49	0.00	0.00	0.03	7.52
3 rd year	3.99	9.96	0.00	0.00	13.95
4 th year	12.20	13.66	0.00	0.08	25.94
5 th year	0.00	25.44	0.00	0.00	25.44
15 th year	24.94	205.22	0.00	2.99	233.14
Final year (25 Year)	0.00	213.12	0.00	1.39	214.51
Total	51.25	467.39	0.33	4.50	523.48

The ash generated from the TPP will be disposed off in to the quarry void along with the OB waste.

CHAPTER 14

ENVIRONMENT MANAGEMENT

14.1 INTRODUCTION

Baseline environmental status in and around proposed project depicts the existing environmental conditions of air, noise, water, soil, biological and socio-economic environment. With proposed project as the center, a radial distance of 10 km is considered as 'study area' for baseline data collection and environmental monitoring. Baseline data was collected for various/environmental attributes so as to compute the impacts that are likely to arise due to proposed developmental activity.

The baseline data generation was carried out to use the baseline monitoring data for future impact studies. This study is carried out during the project planning stage itself, so that the proponent can implement the project in a technically, financially and environmentally viable way.

The success of any impact assessment study depends mainly on two factors. One is estimation of impact from proposed project on the environment and the second one is assessment of the environmental condition. Both are key factors to arrive at the post project scenario. The estimated impact due to the proposal can be superimposed over the existing conditions to arrive at the post project scenario. The scope of the baseline studies includes detailed characterization of following environmental components, which are most likely to be influenced by the setting up an industry:

- ❖ Meteorological conditions
- ❖ Ambient air quality
- ❖ Noise levels
- ❖ Water quality (Surface + Ground water)
- ❖ Soil quality and
- ❖ Socio-economic studies.

a) Study period

The baseline data generation was carried out during the summer season 2010 (March 2010 to May 2010).

b) Study Area

The study area for the Baseline monitoring studies has been taken as 10Km radius from the boundary of the Radhikapur (West) Coal block, keeping in


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view the guide-lines of Ministry of Environment and Forest (MOEF), Govt. of India.

c) Location and Accessibility

The Radhikapur (West) Coal Block spans over an area of 10.48 Sq.km between Latitude 20° 57' 28" & 20° 59' 42" North and Longitude 84° 51' 00" & 84° 54' 47" East. The block is covered under Survey of India Toposheet no. 73 D/13 on R.F. 1:50000, and special toposheet nos. M-1, M-2, L-1 and L-2 on R.F. 1:10,000 and falls within Angul district of Orissa state. The maximum extents of the block are about 5 km strike direction and about 3.5 km in dip direction. Present report covers an area of 10.48 sq. km.

The block forms it's eastern limit with Utkal-F coal block while the western and Northern boundary is with Singhada Jhor nala. The district headquarter Angul is about 32 km from the M.L. area. The nearest railhead is Jarapada and the nearest airport is Bhubneshwer, which is about 175 km from the M.L. area.

Lease area	-	1048 Ha
Nature of land	-	Mainly Private agriculture
Mineral to be mined	-	Coal
Anticipated life of mine	-	49 years (combined OC and UG)
Method of mining	-	Opencast as well as Underground
Surface transport	-	By coal tippers & Railways

14.2 BASELINE STATUS OF ENVIRONMENT

The different elements of environment namely land, water, ecology, air, climate and socio-economic status of the area was studied for the summer season from 01.03.2010 to 31.05.2010. The schedules adopted for sampling/monitoring the area are indicated in Table 14.1 and the location of sampling/monitoring stations is enclosed (Plate II) along with 10 km buffer zone (study area).

TABLE 14.1
MONITORING SCHEDULE AND PARAMETERS

Sl. No.	Description of parameters	Schedule and duration of monitoring
1	Air quality in the vicinity of the mine – SPM, SO ₂ , NO _x and RPM	Twice a week for three months
2	Water quality (all parameters as per drinking water standards IS:10500)	9 samples once in a season
3	Ambient noise levels	10 stations once in a season
4	Study of Flora and Fauna	Within the study area
5	Soil quality	At lease one sample from core zone and one from study area

Secondary data sources were utilized for collection of information about hydro-geological conditions, socio-economics, seismicity and important places and industries in surrounding areas.

14.2.1 Existing land use pattern

a) Core zone

The total area of 1048 Ha, covering part of the 8 villages is mostly in the form of private agriculture land and village Forest land. Summary of the land details are given in Table 14.2 and the details khasra wise are given in Annexure 3-1.

TABLE 14.2
AREA DETAILS FOR MINING LEASE APPLIED IN TEHSIL NAUPARA,
BARAPADA & KUSKILA OF DISTRICT ANGUL

Sl. No.	Name of the Village	Private Lands (In Acres)	Government Lands (in Acres)					Grand Total (in Acres)
			Communal	Leasable	Gochar	Village Forest	Total Govt.	
1	Barapada	584.263	75.249	32.342	43.832	55.919	207.342	791.605
2	Kusakila	609.170	37.570	39.240	47.510	34.420	158.740	767.910
3	Naupada	330.100	17.000	45.100	39.120	21.370	122.590	452.690
4	Kusakila Jungle Bar	225.582	3.550	98.150	36.180	69.960	207.840	433.422
5	Jhintipal	25.267	2.940	21.169	15.537	4.362	44.008	69.275
6	Putagadia	38.680	0.480	0.000	0.000	22.210	22.690	61.370
7	Balipata	9.211	0.173	0.000	0.040	1.289	1.502	10.713
8	Kosala	2.621	0.000	0.000	0.000	0.000	0.000	2.621
	Total	1824.894	136.962	236.001	182.219	209.530	764.712	2589.606 (1048 Ha)

b) Buffer zone

The land use pattern in the buffer zone as per Census 2001 is given in Table 14.3.

TABLE 14.3
LAND USE PATTERN OF BUFFER ZONE (AS PER CENSUS 2001)

Land use	Area (Ha)	Percent
Irrigated agricultural land	1291.23	2.77
Unirrigated agricultural land	16517.13	35.49
Culturable waste land	5454.91	11.72
Area not available for cultivation	3604.62	7.74
Forest land	19676.01	42.27
Total	46543.9	100.00

14.2.2 Water regime

a) Surface water regime

The surface topography is generally flat around most of the area which is being used for cultivation purposes by the villagers around south central part. The surface topography is mildly undulating and slopes towards water body. The ground level rises towards south-central area with highest elevation above mean sea level and is at about 195m. The surface elevation gradually decreases towards north-eastern corner of the above and is as low as about 153 metres near boreholes no. CMTR 085 located in proximity to Singhada jhor.

Brahmani river, flowing approximately north to south direction along the eastern boundary of the Talcher coalfield, provides the main drainage of the region. This river is fed by seasonal nalas, viz., Tikra Jhor, Singhada Jhor, Bangaru Jhor, Nandira Jhor and a few other nalas. From the eastern boundary of Radhikapur (West) Coal Block, the Brahmani river lies eastwards at a distance of about 35 km.

Singhada Jhor flows eastwards in the western and northern extremities of the block and forms the western and northern boundary of the block as well. The Singhada Jhor merges in its down stream into Brahmani river at the north eastern part of the coalfield. Nuabanda nala, which forms the eastern boundary of the block, flows into Singhada Jhor at the north-eastern corner of the block and controls the drainage pattern of the block. Nuabanda nala originates from a large water body at the south-central part of the block. The water collected within the water body.

Small ponds and dug wells are common in this block. Morrum and mud roads are very common in and around villages within the block, viz. Nuapada, Kushila and Barpada.

b) Ground water

The principal source of ground water in the study area is rainfall infiltration. The other source of ground water recharge is seepage from small tanks and ponds. Detailed hydro-geological investigations have been carried out by CMPDI in eastern part of Talchir Coalfield covering about 600 sq. km. area to fulfill the requirement of data information for Talchir Master Plan in 1986-88. Results of the investigations have been incorporated in the report titled "Hydrology of Talchir Coalfield (East), Dhenkanal District, Orissa, India, CMPDI Ranchi, Jan. 1988".

The block under investigation forms a part of the report.

During survey period, the water level was observed at many Govt./Private dug wells in the study area and it is varying between 1.2 m and 11.2 m from the surface.

14.2.3 Ecology

The leasehold area can be demarcated under two major groups of vegetation structure i.e. village Forest land and non forest land. The non forest land under private ownership is both agriculture and non agriculture land. The forest in core zone is Revenue Forest to the extent of 84.8 Ha which amounts to only 8.1 % of the core area. In the lease area "Mahua" and "Am" are the main dominating species. The vegetation along water bodies (i.e. Nala, river etc) is thicker than in the other parts of the area. There are no Protected or Reserve Forests in the area.

a) Flora

According to the Working Plan, the forest has been classified as Northern Dry Mixed Deciduous Forests and as per Champian & Seth's classification it is classified as 5B/C2. The forest floor is characterised by dry slopes, rugged ground with poor and shallow soil. The soil is exposed and dominated by conglomerates. The soil possesses poor water-retaining capacity. Gullies and reels are noticed at intervals particularly on the bank of the nalas. Tree canopy is seriously broken by human activities, so that, scattered trees in small groups are now typical. This broken canopy characterizes transition to still drier types having trees with low spreading crown, large shrubs and small trees.

It appears that, in the past this area was a good Sal forest. Due to excessive pressure of human activities on this forest for collection of forest produce for their bonafide use, fire and grazing now this area is highly degraded.

b) Fauna

Due to biotic pressure, forest fire and overgrazing, the number of fauna seen in the study area is limited. There are no migratory or endangered species within the study area. From the field survey, by evidence of droppings and by collecting data from local inhabitants it is evident that, the following fauna are commonly noticed in this locality as well as in the nearby Durgapur R.F.

Mammals

Sloth Bear	<i>Melursus ursinus</i>	Barking Deer	<i>Muntiacus muntjak</i>
Mouse Deer	<i>Tragulus meminna</i>	Ratel	<i>Mellivora capensis</i>
Jackal	<i>Canis aureus</i>	Langur	<i>Presbytis entellus</i>
Rhesus monkey	<i>Macaca radiate</i>	Mongoose	<i>Herpestes edwardi</i>

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Birds

Common Myna	<i>Acridotheres tristis</i>	Black drongo	<i>Dicrurus adsimillus</i>
Wood pecker	<i>Picoides maharashtra</i>	Dove	<i>Streptopelia chinensis</i>
Red-necked parakeet	<i>Dinopium benghalensis</i>	Barn Owl	<i>Bubo bubo</i>
Koel	<i>Eudynamis scolopacea</i>	Quail	<i>Perdix asiatica</i>
Partridge	<i>Francolinus pondicerianus</i>		

Reptiles

Yellow monitor lizard	<i>Varanus bengalensis</i>
Bino-cled cobra	<i>Naja naja naja</i>

This is neither a corridor nor impact area nor migratory path for elephants. However, stray elephant does visit at a distance of 10 Km from this area near Chhendipada.

14.2.4 Quality of air, ambient noise and water**i. Air quality**

Air pollution is defined as "the presence in the outdoor atmosphere of one or more contaminants or combinations thereof in such quantities and of such duration as are or may tend to be injurious to human, plant or animal life, or property". Thus collection of data of air environment occupies a predominant role in the estimation of pollution load of the area.

The criteria followed for selecting the AAQM stations is as recommended by IS: 5182 and CPCB. They are:

- The sampling station has free exposure so that it does not collect air from stagnant pockets.
- It is not obstructed by large structures including hills.
- Sampling point is not directly influenced by any local source of emission.
- It is located at a minimum height of 1.5 m from the ground level.

The parameters selected for analyzing ambient air quality status were Sulphur dioxide (SO₂), Nitrogen Oxides (NO_x), Suspended Particulate Matter (SPM), Respirable Particulate Matter (RPM) and Carbon Monoxide (CO). The Indian Standards limiting the maximum concentration of

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contaminants for ambient air quality, set for different categories of areas are given in Table 14.4 for the sake of comparison.

TABLE 14.4
AMBIENT AIR QUALITY STANDARDS

Area	Category	24 hours average concentrations, $\mu\text{g}/\text{m}^3$		
		SPM	SO ₂	NO _x
A	Industrial and mixed zone	500	120	120
B	Residential and rural	200	80	80
C	Sensitive zone	100	30	30

Source: Air (Prevention & Control of Pollution) Act, 1981

Monitoring and analytical procedure

Ambient air quality was monitored for the presence of contaminants existing in the air. In order to evaluate and quantify the air pollution problem, measurements were carried out for various air pollutants mentioned above. This data was used not only to evaluate the air quality in the study region but also as the basis to develop programs aiming at preventing the spread of pollutants leading to a risk for human health and general environment. The methodology for sampling and analysis are as recommended by IS: 5182 and given in Table 14.5.

TABLE 14.5
METHODOLOGY FOR SAMPLING AND ANALYSIS FOR AAQ MONITORING

Parameter	Instrument Used	Methodology	Reference
SPM	High Volume Sampler	Gravimetry	CPCB Notification of 11-04-1994
RPM	Respirable Dust Sampler	Gravimetry	CPCB Notification of 11-04-1994
SO ₂	HVAS with Impinger tube, spectrophotometer	Improved West & Gaeke Method	CPCB Notification of 11-04-1994
NO _x	HVAS with Impinger tube, spectrophotometer	Jacob & Hochheiser Modified Method	CPCB Notification of 11-04-1994
CO	Gas Chromatograph	Chromatography	CPCB Notification of 11-04-1994

Ambient air quality monitoring was undertaken at 8 different stations within the study area during winter season (March to May 2010). The location details are given in Table 14.6 and analysis results with respect to SO₂, NO_x and SPM are summarised in Table 14.7, while the air quality monitoring locations are shown in Key Plan. Respirable particulate matter measurements have been made at core zone during monitoring period.

TABLE 14.6
AMBIENT AIR QUALITY MONITORING LOCATIONS

Name	Location	Distance	Direction
CA1	Core zone	Adjoining	-
BA1	Kisinda	3.1	W
BA2	Palsabani	1.2	WNW
BA3	Nuapada	0.2	W
BA4	NE of Jhintipal	0.6	E
BA5	Putgaria	1.5	S
BA6	Gopiballabhpur	3.3	E
BA7	Dubanali	0.4	NW

The monitoring results are given in Table 14.7.

TABLE 14.7
AMBIENT AIR QUALITY DURING SUMMER SEASON

Location	Minimum	Maximum	Mean	75 Percentile	98 Percentile	Standard
SPM						
Kisinda	76	130	108.96	119.75	129.50	200
Palsabani	88	136	110.23	118	133	200
Nuapada	76	135	109.23	123.50	134	200
NE of Jhintipal	68	132	105.08	120.75	130.75	200
Putgaria	68	142	104.15	121.25	137	200
Gopiballabhpur	73	156	116.69	129.50	146	200
Dubanali	66	138	98.38	108.25	135	200
Kuskila village (Core Zone)	85	131	108.12	117.25	128	200
RSPM						
Kisinda	40	69	55.77	62	67.50	100
Palsabani	46	66	56.96	61.75	65.50	100
Nuapada	38	72	54.85	60.00	70.50	100
NE of Jhintipal	35	69	55.31	62.75	69	100
Putgaria	40	69	55.04	60.75	68	100
Gopiballabhpur	36	72	60.35	66	71	100
Dubanali	32	73	54	60.75	72.50	100
Kuskila village (Core Zone)	46	66	57.42	61	65.50	100
NO_x						
Kisinda	9.20	13.70	11.14	12.20	13.55	80
Palsabani	9.50	13.7	11.18	12.03	13.65	80
Nuapada	9.80	13.80	12.07	12.50	13.65	80
NE of Jhintipal	9.50	13.80	11.47	12.08	13.40	80
Putgaria	9.00	12.00	10.22	10.73	11.80	80
Gopiballabhpur	10.00	13.80	12.18	12.88	13.65	80
Dubanali	9.00	12.00	9.63	10	11.60	80
Kuskila village (Core Zone)	9.00	12.40	10.17	10.78	12.25	80
SO₂						
Kisinda	BDL	BDL	BDL	BDL	BDL	80
Palsabani	BDL	BDL	BDL	BDL	BDL	80

Location	Minimum	Maximum	Mean	75 Percentile	98 Percentile	Standard
Nuapada	BDL	BDL	BDL	BDL	BDL	80
NE of Jhintipal	BDL	BDL	BDL	BDL	BDL	80
Putgaria	BDL	BDL	BDL	BDL	BDL	80
Gopiballabhpur	BDL	BDL	BDL	BDL	BDL	80
Dubanali	BDL	BDL	BDL	BDL	BDL	80
Kuskila village (Core Zone)	BDL	BDL	BDL	BDL	BDL	80
CO						
Kisinda	BDL	BDL	BDL	BDL	BDL	4 mg/m ³
Palsabani	BDL	BDL	BDL	BDL	BDL	4 mg/m ³
Nuapada	BDL	BDL	BDL	BDL	BDL	4 mg/m ³
NE of Jhintipal	BDL	BDL	BDL	BDL	BDL	4 mg/m ³
Putgaria	BDL	BDL	BDL	BDL	BDL	4 mg/m ³
Gopiballabhpur	BDL	BDL	BDL	BDL	BDL	4 mg/m ³
Dubanali	BDL	BDL	BDL	BDL	BDL	4 mg/m ³
Kuskila village (Core Zone)	BDL	BDL	BDL	BDL	BDL	4 mg/m ³

ii. Noise levels

The noise levels monitoring stations are given in Table 14.8

TABLE 14.8
NOISE LEVELS MONITORING STATIONS

Sl. No.	Station	Distance, Direction
N1	Chakundapal	0.6 km, N
N2	Hadisah	0.2 km, W
N3	Durgapur	4.3 km, W
N4	Tangrashi	8.2 km, E
N5	Bakala	4.0 km, W
N6	Kisinda	3.1 km, W
N7	Naupada	0.2 km, W
N8	Gopiballabhpur	3.3 km, E
N9	Dubanali	0.4 km, NW
N10	Palsabani	1.2 km, WNW

The noise levels monitored have been given in Table 14.9

TABLE 14.9
NOISE LEVEL RANGE

Sl. No.	Station	Level Range, dB(A) Day time	Level Range, dB(A) Day time
N1	Chakundapal	42-59	30-48
N2	Hadisah	40-65	32-61
N3	Durgapur	39-62	31-58
N4	Tangrashi	42-58	32-56
N5	Bakala	39-62	31-58

Sl. No.	Station	Level Range, dB(A) Day time	Level Range, dB(A) Day time
N6	Kisinda	36-58	29-49
N7	Naupada	43-63	32-60
N8	Gopiballabhpur	36-55	28-48
N9	Dubanali	35-58	27-48
N10	Palsabani	38-59	26-55

iii. Water quality

Selected physico-chemical parameters along with bacteriological indicators of pollution have been used for describing the baseline status of water environment. Generation of baseline data for water quality covers sources of ground and surface water. The major water source in the area is ground water. The frequency of monitoring was once in a season covering all seasons. Assessment of water quality in the study area includes Ground water quality (IS 10500) and Surface water quality (IS 2296).

(a) Surface water quality

During the study period five locations were identified for assessing the water quality. The surface water sampling locations are given in Table 14.10. The results of surface water quality are given in Table 14.11. The water samples were collected and analyzed as per IS: 3025 and the results of analysis are compared with respective quality standards, IS: 10500, 1991 for drinking water and IS: 2296, 1982 or IS: 2996, 1974 for surface water given in Table 14.10.

TABLE 14.10
SURFACE WATER-SAMPLING LOCATIONS

Sl. No.	Locations	Station Code	Distance From Site (km)	Direction From Site
1.	Nuabanda Nala near Barapada	SW1	Adjacent to lease boundary	N
2.	Singhada Jhor near Gopinathpur	SW2	0.5	NE
3.	Singhada Jhor near Dubanali	SW3	1.9	NW
4.	Pond water near Korara	SW4	1.8	SW
5.	Stream near Dhobamalia	SW5	1.0	W

TABLE 14.11
SURFACE WATER QUALITY OF THE STUDY AREA

Sl. No.	Parameters	Standards as per IS - 2296 Class - C	Sampling Locations				
			SW1	SW2	SW3	SW4	SW5
1	Colour(Hazen)	300	C/L	C/L	C/L	C/L	C/L
2	Odour	U/O	U/O	U/O	U/O	U/O	U/O
3	Taste	Tasteless	Tasteless				

Sl. No.	Parameters	Standards as per IS - 2296 Class -C	Sampling Locations				
			SW1	SW2	SW3	SW4	SW5
4	Turbidity (NTU)	\$	4.2	4	5	21	9
5	pH	6.5-8.5	7.23	7.7	7.5	7.0	8.1
6	Total Hardness as CaCO ₃ (mg/l)	300	42.0	50.1	83	32.5	112
7	Iron as Fe(mg/l)	50	2.5	0.50	0.5	0.52	0.9
8	Chloride as Cl(mg/l)	600	14.2	16.1	10.2	21.4	6.5
9	Suspended Solids(mg/l)	\$	20.1	18.0	72	98	196.0
10	Dissolved Solids(mg/l)	1500	295.0	165	136	311	392
11	Dissolved Oxygen(mg/l)	4.0	5.9	7.2	8.0	5.2	7.5
12	BOD(3) days at 27 ^o c (mg/l)	3	18	13	11	21	11
13	COD(mg/l)	\$	35	31	39	37	25
14	Calcium as Ca(mg/l)	\$	15.2	12.3	28.1	7.4	58.1
15	Magnesium as Mg(mg/l)	\$	3.6	4.4	2.1	2.2	3.2
16	Copper as Cu(mg/l)	1.5	0.008	0.04	0.005	0.005	0.015
17	Manganese as Mn(mg/l)	\$	0.35	BDL	0.024	0.3	0.11
18	Sulphate as SO ₄ (mg/l)	400	5.5	5.7	4.1	16.5	3.9
19	Nitrate as NO ₃ (mg/l)	50	2.7	4.5	0.41	3.1	4.2
20	Fluoride as F(mg/l)	1.5	0.22	BDL	BDL	0.74	0.71
21	Phenolic Compound as C ₆ H ₅ OH(mg/l)	0.005	BDL	BDL	BDL	BDL	BDL
22	Mercury as Hg(mg/l)	\$	BDL	BDL	BDL	BDL	BDL
23	Cadmium as Cd(mg/l)	0.01	BDL	BDL	BDL	BDL	BDL
24	Selenium as Se(mg/l)	0.05	BDL	BDL	BDL	BDL	BDL
25	Arsenic as As(mg/l)	0.2	BDL	BDL	BDL	BDL	BDL
26	Cyanide as CN(mg/l)	0.05	BDL	BDL	BDL	BDL	BDL
27	Lead as Pb(mg/l)	0.1	0.03	BDL	BDL	0.003	0.002
28	Zinc as Zn(mg/l)	15	0.37	0.06	0.024	0.031	0.27
29	Anionic Detergent as MBAS(mg/l)	1.0	ND	Nil	ND	ND	ND
30	Hexa Chromium as Cr ⁺⁶ (mg/l)	0.05	BDL	0.005	0.02	0.007	0.05
31	Total Chromium(mg/l)	\$	0.026	0.014	0.033	0.012	0.2
32	Polynuclear Aromatic Hydrocarbon as PAH(g/l)	-	ND	ND	ND	ND	ND
33	Total Coliform (MPN/100ml)	5000	575	460	300	950	725

C/L- Colourless, U/O- Unobjectionable, BDL-Below Detectable Limit, ND-Not detectable

(b) Ground water quality

For assessing the ground water quality around the proposed project site, 6 locations were selected during the study period spread over the four seasons. Ground water samples were collected from the identified bore wells and open wells. Selection has been considered as per the utilization

pattern of the villagers for domestic and drinking purposes. The villages identified for ground water sampling are given below in Table 14.12. The people in the region identified these considering proximity to the project site, their activities and depending upon its utility. Ground water quality around the project site is presented in Table 14.13.

TABLE 14.12
GROUND WATER SAMPLING LOCATIONS

Sl. No.	Locations	Station Code	Distance from Site (km)	Direction from Site
1	Dug well of Village Kosala	GW1	2.8	NE
2	Dug well of Village Kunjabiharpur	GW2	4.7	N
3	Dug well of Village Dubanali	GW3	1.8	NW
4	Dug well of Village Raijharan	GW4	4.2	SE
5	Dug well of Village Durgapur	GW5	4.3	S
6	Dug well of Village Bakala	GW6	5.6	SW

TABLE 14.13
GROUND WATER QUALITY OF THE STUDY AREA

Sl. No.	Parameters	Standards as per IS -10500	Sampling Locations					
			GW1	GW2	GW3	GW4	GW5	GW6
1	Colour (Hazen)	5	C/L	C/L	C/L	C/L	C/L	C/L
2	Odour	U/O	U/O	U/O	U/O	U/O	U/O	U/O
3	Taste	Agri	Agri	Agri	Agri	Agri	Agri	Agri
4	Turbidity(NTU)	5	2.3	3.0	2	3.2	3.8	2.4
5	pH	6.5-8.5	7.85	7.3	7.4	6.87	7.12	7.4
6	Total Hardness as CaCO ₃ (mg/l)	300	245.5	44.5	84.2	191.5	253.5	181.1
7	Iron as Fe(mg/l)	0.3	0.22	0.26	0.24	0.25	0.19	0.21
8	Chloride as Cl(mg/l)	250	24	45.5	51.5	23.9	93.2	39.1
9	Dissolved Solids(mg/l)	500	421	335	380	362	412.0	401.2
10	Calcium as Ca(mg/l)	75	60.2	14.1	29.3	60.8	52.0	61.8
11	Magnesium as Mg(mg/l)	30	47.1	2.91	3.4	5.1	10.9	9.2
12	Copper as Cu(mg/l)	0.05	0.006	0.009	0.008	0.008	0.007	0.009
13	Sulphate as SO ₄ (mg/l)	200	82.1	0.386	3.2	14.8	69.4	27.25
14	Nitrate as NO ₃ (mg/l)	45	1.57	0.79	0.62	0.92	0.95	0.96
15	Fluoride as F(mg/l)	1.0	0.022	0.03	0.015	0.017	0.03	0.026
16	Phenolic Compound as C ₆ H ₅ OH(mg/l)	0.001	ND	ND	ND	ND	ND	Nil
17	Mercury as Hg(mg/l)	0.001	BDL	BDL	BDL	BDL	BDL	BDL

Sl. No.	Parameters	Standards as per IS -10500	Sampling Locations					
			GW1	GW2	GW3	GW4	GW5	GW6
18	Cadmium as Cd(mg/l)	0.01	BDL	BDL	BDL	BDL	BDL	BDL
19	Selenium as Se(mg/l)	0.01	BDL	BDL	BDL	BDL	BDL	BDL
20	Arsenic as As(mg/l)	0.05	BDL	BDL	BDL	BDL	BDL	BDL
21	Cyanide as CN(mg/l)	0.05	BDL	BDL	BDL	BDL	BDL	BDL
22	Lead as Pb(mg/l)	0.05	0.005	BDL	0.007	0.004	0.007	0.005
23	Zinc as Zn(mg/l)	5	1.6	0.72	0.62	0.63	0.91	0.78
24	Anionic Detergent as MBAS(mg/l)	0.2	ND	ND	ND	ND	ND	ND
25	Hexa Chromium as Cr ⁺⁶ (mg/l)	0.05	BDL	BDL	BDL	BDL	BDL	0.05
26	Polynuclear Aromatic Hydrocarbon as PAH(g/l)	-	BDL	BDL	BDL	BDL	BDL	BDL
27	Mineral oil(mg/l)	0.01	Absent					
28	Alkalinity as CaCO ₃ (mg/l)	200	50.3	44.9	38.0	49.2	48.2	49.0
29	Aluminium as Al(mg/l)	0.03	BDL	BDL	BDL	BDL	BDL	BDL
30	Manganese as Mn (mg/l)	0.1	BDL	BDL	BDL	BDL	BDL	0.211
31	Boron as B(mg/l)	1.0	0.004	0.008	0.006	0.004	0.006	0.005
32	Total Coliform (MPN/100ml)	<2	4	41	28	31	39	22

C/L- Colourless, U/O- Unobjectionable, BDL-Below Detectable Limit, ND-Not detectable

(c) Analysis of water quality data

The surface water samples collected from the above sources showed that the pH is ranging in between 7.0 to 8.1. This has reflected in alkalinity and hardness values. Water quality shows that the alkalinity and hardness values are consistent.

The contribution of calcium is more than magnesium to the total hardness, which is reflected clearly from calcium and magnesium values. The dissolved oxygen in the sources is ranging between 5.2 to 7.5 mg/l, which implies sustainability of aquatic life. However, all the values of physico-chemical parameters were found to be well within the prescribed limits. In general, the surface water quality within the study area is satisfactory and can be used for agriculture and other domestic purposes. In general, the ground water quality within the study area of proposed project site is satisfactory, except for total Coliform content and the quality is within the drinking water standards (IS 10500). It can also be used for drinking after pre-treatment. The water can be used for agriculture and other domestic purposes.

14.2.5 Climate

The climate of this region is mainly tropical type and is influenced to some extent by the conditions in Bay of Bengal. Broadly, year can be divided into three main seasons. The winter ranges from November to February. The summer spreads from March to May and rainy season lasts from June to September. The summer is severe during May-June with temperature as high as 45.50°C. A pleasant winter prevails from December to January. The average minimum temperature recorded during November 1996 & 2000 is 5.5°C. The relative humidity varies from 31% in (March) to 88% (September).

The following meteorological parameters have been studied on the basis of data recorded from the nearest IMD station Angul during 1994 to 2004.

The data in respect of various parameters are briefly discussed in the following paragraphs.

14.2.5.1 Temperature

The average daily maximum and minimum temperatures for each of the twelve months for the period 1994 - 2004 have been furnished in Table 14.14.

TABLE 14.14
AVERAGE DAILY MAX & MIN TEMPERATURE
FOR VARIOUS MONTHS FROM 1994-2004

Months	Temperature °C	
	Maximum	Minimum
January	28.85	15.61
February	32.41	18.19
March	37.34	18.63
April	39.31	20.00
May	40.21	21.46
June	35.18	21.23
July	31.78	20.57
August	31.86	20.81
September	32.99	20.47
October	32.64	18.21
November	31.17	14.59
December	28.63	12.69
Mean	33.53	18.54

From the above table, the mean of minimum temperatures recorded ranges from 12.69°C in December to 21.46°C in May. The mean of maximum temperature ranges from 28.63°C in December to 40.21°C in May.

14.2.5.2 Rainfall

Bulk of the rainfall in the study area is received during the SW monsoon between June to October.

About 90% of the rainfall is recorded in the months of June to September. The least rainfall was observed in the month of December. The month wise rainfall is given in Table 14.15.

TABLE 14.15
AVERAGE MONTHWISE RAINFALL DURING 1994-2004

Month	Rainfall (mm)
Jan.	17.03
Feb.	16.83
Mar.	21.31
Apr.	40.36
May	93.63
Jun.	212.11
Jul.	258.23
Aug.	317.33
Sep.	165.70
Oct.	93.68
Nov.	23.33
Dec.	7.33
Total average	1266.84

The rainfall data shows that the average monthly rainfall varies between 7.33 mm to 258.23 mm. The annual average rainfall for the years 1994 to 2004 was observed as 1266.84 mm.

14.2.5.3 Wind Speed and Wind direction

The wind direction in summer is predominantly from West followed by East and South.

14.2.5.4 Relative Humidity

The average daily relative humidity data has been studied during monitoring period which is given in Table 14.16.

TABLE 14.16
AVERAGE MONTHLY RELATIVE HUMIDITY DURING MONITORING

Relative Humidity (%)			
	March	April	May
Maximum	92	81	81
Minimum	15	14	14
Average	47	46	49

14.2.5.5 Human settlements

A socio-economic study has been carried for the study area. The data are based on 2001 Census report. The break-up of population for male, female is given in Table 14.17.

**TABLE 14.17
DISTRICT AND THANA WISE POPULATION IN THE STUDY AREA**

District	Thana	No. of villages	No. of Households	Total population	Male	Female
Angul	Jarapada(P)	33	5822	29351	14799	14552
Angul	Chhendipada	47	9063	43564	22236	21328
Angul	Handapa	7	588	2779	1360	1419

The employment pattern, break-up of main workers and SC/ST are given in Table 14.18.

**TABLE 14.18
EMPLOYMENT PATTERN IN STUDY AREA**

Occupation		Population	%
Main Workers		21669	28.63
Marginal workers		13440	17.75
Non workers		40585	53.62
Total		75694	100
Break-up of main workers			
Cultivators		11411	52.66
Agriculture labour		4342	20.04
HH Ind.		1483	6.84
Others		4433	20.46
Total		21669	100
Other Details			
Literate	Male	25495	33.68
	Female	15160	20.03
SC		14558	19.23
ST		8409	11.11

From the above table, it can be observed that about 53.62% of the population is non workers. Out of the total main workers, about 52.66% are involved as cultivators, agriculture 20.04%, House hold industries 6.84% and 20.46% in other source of livelihood. The literacy in the study area is about 53.71% as compared to the national rate of 65.28 % as per Census 2001 records.

14.2.5.6 Places of historical, tourist and religious importance

There is no such place within core or study area.

14.2.5.7 Mines within study area

There are no major industries in the buffer zone except Hingula Opencast coal mine of Mahanadi Coalfields Limited which is the nearest operating coal mine and located about 13Km east of Radhikapur (West) Coal Block.

14.2.5.8 Does area (Partly or fully) fall under notified area under water (Prevention & control of Pollution) Act 1974

No.

14.3 ENVIRONMENTAL IMPACT ASSESSMENT

Baseline information on various relevant environmental aspects generated and compiled for the project area, covering both core and buffer zones has been incorporated in para 14.1 and paragraphs there under. This information provides an outline of the prevailing environmental scenario at the mining site and its surroundings. Mining, like any other development activity, is bound to have some impact on the existing environment; both adverse and beneficial. The impacts on the physical, ecological and socio-economic environment of the area due to the proposed project are given in the following paragraphs:

14.3.1 Land environment**a) Land degradation and aesthetic environment**

The total mine lease area is 1048 Ha. Out of which, 760.43 Ha i.e. 72.56 % of land will be excavated at conceptual stage. As much as 952.54 ha (90.89%) will be disturbed and only 7.68% land will remain undisturbed. The disturbed area within ML will comprise excavated land, external dumps, area occupied by infrastructure, roads etc. Year/stage wise area excavated is given in Table 14.19. The anticipated land use at the end of mining operations is tabulated in Table 14.20.

TABLE 14.19
YEAR / STAGE WISE AREA EXCAVATED

Year	Area excavated (Ha.)	
	Progressive	Cumulative
1 st year	17.22	17.22
2 nd year	30.66	47.88
3 rd year	57.59	105.47
4 th year	67.08	172.55
5 th year	83.65	256.20
15 th year	344.00	600.20
Conceptual (25 th yr.)	150.72	750.92
Total	750.92	

TABLE 14.20
LAND USE WITHIN ML AREA AT END OF MINING

Particular	Area in ha
OC mine pit area	750.92
Washery	10.00
OB dump	100.00
Top soil stack	5.00
Raw coal stack	7
Facility area	10
CHP	1.00
Washed coal stack	6.00
Green belt	16.75
Settling pond	5.50
Reject	2.00
Road	12.00
Bund	15.7
Magazine	0.20
Undisturbed / Indirectly affected area	105.93
Total Block Area	1048.00

b) Impact due to solid waste

Years	Backfilling Area (Ha.)		Dump Area (ha.)		Top Soil Dump Area (Ha.)	
	Progressive	Cumulative	Progressive	Cumulative	Progressive	Cumulative
1 st year		0.000	6.32	6.32	20	20.00
2 nd year		0.000	14.67	20.99		20.00
3 rd year	17.48	17.480	5.45	26.44		20.00
4 th year	26.91	44.390	6.22	32.66		20.00
5 th year	62.51	106.900	0.00	32.66		20.00
15 th year	186.62	293.52	67.34	100	-15	5.00
Conceptual (28 th Yr.)	303.29	596.810	0.00	100		5.00
Total	596.81		100.00		5.000	

As can be seen from the above table, 100.00 ha area will be occupied by the surface dump. As much as **596.81** ha excavated area will be backfilled. Top soil stack will occupy 20 ha area in the initial stage but the same will reduce to 5 ha later.

c) Land profile

Presently, the core zone is virgin and plain terrain sloping towards North-East. The mining operations are not anticipated to cause any adverse impact on topography outside the core zone. Within core zone about 160 m deep void will be formed.

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Meager amount of sanitary waste, expected to be generated from various facilities will be treated properly through septic tanks and soak pits and is not anticipated to cause any water pollution.

14.3.4 Impact on noise level

Noise is unwanted and unpleasant sound which causes distraction, disturbance and annoyance. Continuous exposure to high level of noise can impair human hearing power.

The mining activities generate noise mainly on account of:

- Operating mining machinery
- Use of explosives
- Moving road vehicles

The impact of this airborne noise will be more on the operating personnel and on the persons working nearby and not so much on the surroundings.

The noise of activities also disturbs animals/birds living in the surroundings forcing them to change their habitat. In the present case, the noise caused will be mainly restricted to the core zone. However, the transportation activities will have impact on the noise levels on route to the railway siding or the desired destination. The noise level data recorded at various places in the study area is well within the desired limit. But, the future establishment of noise due the proposed project activity may pose some problem if project management does not adopt appropriate control measures.

14.3.5 Effect on vibration level (due to blasting)

No ground vibration study has been conducted hence the impact of the proposed activity on ground vibration cannot be exactly anticipated. But, based on experience of similar mines appropriate control measures have been spelt out in management plan.

14.3.6 Impact on water regime

No impact on the surface water resources is envisaged as no water is drawn specifically from any surface water source. However, in view of availability of ground water at shallow levels, most of water requirement is planned to be drawn from ground water (mine sump), which will have some impact on the ground water resources.

14.3.7 Impact on socio-economic environment

Human settlement

Displacement of about 400 households (about 2000 population) in the block area in three villages is anticipated. A proper rehabilitation programme will

be formulated and the land outsees will be given rehabilitation and resettlement benefits according to the Govt. of Orissa Policies and prevailing practice in industries in the vicinity.

On the other hand, the mining and allied activities will provide job opportunities for eligible persons and many will find employment in service sector and marketing of day-to-day needs viz. poultry and other agricultural products. The facilities and amenities like dispensary and communication, to be set up for the project will improve the basic infrastructure and these amenities can also be used by the people of the nearby villagers. The proposed long term activity will open up market and opportunities growth for self employed and cultivators. To this extent, the impact will be significantly beneficial since un-employment and under employment is the main socio-economic problem faced by the people in this area.

14.3.8 Impact on historical monument/ religious place/ tourist places

There is no such place within and outside the ML boundary up to 10 km radius. Hence, question of impact on historical monument does not arise.

14.4 ENVIRONMENTAL MANAGEMENT PLAN

The environmental impact assessment made in the preceding section has identified the areas where certain control measures are called for to minimise the negative impacts. Subsequent paragraphs deals with effective measures proposed to be taken up with regard to the following aspects so that the proposed mining and allied activities can be continued in an environment-friendly manner:

- Land use planning – Afforestation and landscape development
- Air pollution control
- Blasting and noise control
- Water pollution control
- Socio-economic aspects

14.4.1 Land use planning

i. Land degradation control measures

Land degradation is one of the major adverse outcomes of opencast mining activities and any effort to control adverse impacts is considered incomplete when appropriate land reclamation strategy is not adopted. Since the land degradation in this mine is partly in the form of excavated void and partly in the form of external and internal dumps, the reclamation strategy must include a programme for the reclamation of the disturbed land.

a) Mined area reclamation

The lessee will have to take necessary steps to keep the area under disturbance at any stage of mining operation to a minimum. This can be

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achieved by carrying out the reclamation programme simultaneously with excavation. The gap can be reduced between degradation and the reclamation by this programme. The post mining land use of core zone shows that all the disturbed areas will be reclaimed before abandoning the mine excluding the void.

b) Reclamation procedure

Reclamation procedure has been described stage wise in the following paragraphs. Year wise reclamation programme is as shown in Table 14.21.

TABLE 14.21
RECLAMATION PROGRAMME OF EXCAVATED AND
BACKFILLED AREA (CUMULATIVE)

Up to the end of Year	Area mined (Ha.)	Backfilled area (Ha.)	Total Planted area (Ha.)
1 st	17.22	0.000	0.00
2 nd	47.88	0.000	4.00
3 rd	105.47	17.480	4.50
4 th	172.55	44.390	14.22
5 th	256.20	106.900	14.22
15 th year	600.20	293.52	357.71
Conceptual (25 year)	750.92	596.810	730.31

ii. Top soil management

The average topsoil thickness over the whole pit area envisaged for mining is proposed to be removed to the extent of about 0.60 m. About 5.18 MCUM (L) of topsoil will have to be handled from areas to be excavated. About 0.48 MCUM stock (max.) of the topsoil will be kept over an area of 20 Ha. Extra generation of top soil will be utilized in two ways, part of the surplus top soil will be used for reclamation annually whereas the rest will be stacked at pit head temporarily for consecutive laying over backfilling. Usually about 0.6 m to 1.0m thick layer of topsoil will be laid for afforestation.

The topsoil shall be excavated by small hydraulic shovel/front end loader and transported by trucks/dumpers to the stack site located in the near the entry no. 1 and also over the area meant for dumping OB later. The height of the stacks will be kept less than 3m. For retaining fertility beyond one season, a vegetation cover will be created by growing local grass and shrubs.

iii. Post reclamation land use

The first step in a successful reclamation programme is to decide the post reclamation land use. The post mining land use with environment management is given in Table 14.22.

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TABLE 14.22
POST MINING LAND USE WITH ENVIRONMENT MANAGEMENT WITHIN
ML (HA) AT THE END OF MINE CLOSURE (49+3=52 YEARS*)

Particulars	Area	Plantation	Void	Public Use	Bund	Undisturbed/ Indirectly affected area
OC mine pit area	750.92	596.81	154.11	0	0	0.00
Washery	10.00	10	0	0	0	0.00
OB dump	100.00	100.00	0	0	0	0.00
Top soil stack	5.00	5	0	0	0	0.00
Raw coal stack	7	7	0	0	0	0.00
Facility area including inclines and shaft	10	7	0	3	0	0.00
CHP	1.00	1	0	0	0	0.00
Washed coal stack	6.00	6	0	0	0	0.00
Green belt	16.75	16.75	0	0	0	0.00
Settling pond	5.50	5.5	0	0	0	0.00
Reject	2.00	2	0	0	0	0.00
Road	12.00	8	0	4	0	0.00
Bund	15.7	0	0	0	15.7	0.00
Magazine	0.20	0.2	0	0	0	0.00
Undisturbed/ indirectly affected area	105.93	0	0	0	0	105.93
Total block area	1048.00	765.26	154.11	7	15.7	105.93

* Note: The OC mine exhausts at the end of 25th year and the OC mine closure concludes at the end of 30th year. The above table shows position at the end of 52nd year when UG mine closure also concludes

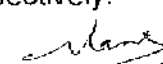
In case of this mine, it would be appropriate to restore the lands to the original land use to the extent possible due to following reasons:

Whole of the excavated area is proposed to be developed into a picnic spot due to the formation of water body created as a result of the left out void. The water body will be used for irrigation, watering the forest at earlier stages and it will also attract avifauna. The plan & sections showing the mine in the post mining stage is given in Plate XXII & XXIII respectively.

iv. Soil conservation measures

The following control measures to prevent soil erosion and wash off of fines from freshly excavated benches and dumps will be adopted:

- Garland drains will be provided around the mine whenever required to arrest any soil from the mine area being carried away by the rain water.
- The bench levels will be provided with water gradient against the general pit slope to decrease the speed of storm water and prevent its uncontrolled descent.


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- Special local stone paved chutes and channels will be provided wherever required, to allow controlled descent of water, especially from external dumps.
- Gullies formed, if any, on side of the benches shall be provided with check dams of local stone or sand filled bags.
- The inactive dump slopes will be planted with bushes, grass, shrubs and trees to prevent soil erosion after applying top soil.
- Retaining walls (with gabion, concrete or local stone) will be provided, wherever required, to support the benches or any loose material and also to arrest sliding of loose debris.

v. *Afforestation*

a) *Compensatory afforestation*

Compensatory plantation will be provided in line with the prevailing rules of forest department.

b) *Plantation during mining*

A plantation program over life of the mine has been planned in a phase wise manner. The plantation will be started from first year of mining along the boundary of ML area. A 7.5 m width of green belt development around the ML area will be carried out and more width of green belt will be taken up wherever space is available. Plantation over surface dump area will be commenced from 2nd year of mining. A thick plantation is proposed to be provided and maintained around the mining area and along the roads. No plantation over the backfilled area will be possible upto 5th year (including) due to strategy of advancing the surface dump over the backfill area. The yearly requirement of plants during the various years and stages of the mining project is as shown in the Table 14.23.

TABLE 14.23
REQUIREMENT OF PLANTS
(PROGRESSIVE YEAR/STAGE WISE AND LOCATION WISE)
(A) AT THE END OF 28TH YEAR (POST MINE CLOSURE OF OC MINE @ 25TH YEARS)

Year	Area (Ha.)						No. of trees @ 2500/Ha
	Green belt	Surface dump	Backfill	Facilities + CHP+ Washery + magzine	Settling pond + Stacks of TS, coal, reject + coal stacks+ Road	Total	
1 st year	3.35	0	0	0	0	3.35	8375
2 nd year	3.35	4	0	0	0	7.35	18375
3 rd year	3.35	0.5	0	0	0	3.85	9625
4 th year	3.35	9.72	0	0	0	13.07	32675

Year	Area (Ha.)						No. of trees @ 2500/Ha
	Green belt	Surface dump	Backfill	Facilities + CHP+ Washery + magazine	Settling pond + Stacks of TS, coal, reject + coal stacks+ Road	Total	
5 th year	3.35	0	0	0	0	3.35	8375
15 th year	0	85.78	257.71	0	0	343.49	858725
{16 to (25+3)} year)	0	0	339.10	0	5.0	344.10	860250
Total	16.75	100	596.81	0	5.0	718.56	1,796,400

(B) AT THE END OF 52ND YEAR (POST MINE CLOSURE OF UG MINE =49+3 YEARS)

Year	Area (Ha.)						No. of trees @ 2500/Ha
	Green belt	Surface dump	Backfill	*Facilities + CHP + Washery + magazine	**Settling pond + Stacks of TS, coal, reject + coal stacks + Road	Total	
1 st year	3.35	0	0	0	0	3.35	8375
2 nd year	3.35	4	0	0	0	7.35	18375
3 rd year	3.35	0.5	0	0	0	3.85	9625
4 th year	3.35	9.72	0	0	0	13.07	32675
5 th year	3.35	0	0	0	0	3.35	8375
15 th year	0	85.78	257.71	0	0	343.49	858725
Conceptual (52 year)	0	0	339.10	18.2	33.5	390.8	977000
Total	16.75	100	596.81	18.2	33.5	765.26	1913150

* (1 8.2 Ha=7 Ha facility +1 Ha CHP+10 Ha washery+0.2 Ha magazine)

** (33.5 Ha =5 TS+7Raw Coal+6 Washed Coal+2 Rejects+5.5 Set Pond+8 ha road)

To fulfill the requirements of nursery plants, a nursery will be established at the site. During peak requirements, additional plants will be transported from Govt. / Forest nurseries, located around the area. The common species used for plantation in the region are Sal, Mahua, Salai Gulmohar, Neem, Siris, Acacia, Casuarina, Pongamia, Mango, China-rose, Kaner, etc.

14.4.2 Air and dust pollution control measures

The SPM, CO, SO₂ and NO_x concentrations are within limits as already discussed earlier. The mining operations and related activities are anticipated to increase the levels of SPM and gaseous pollutants to a limited extent. The control measures to be adopted are mentioned in the following paragraphs:

i. Controlling fugitive dust

Dust particles, which are normally generated during mining operation and transportation, deteriorate the ambient air quality. Adequate control measures are, therefore, proposed to be taken during mining operations, transportation and crushing/loading operations. These control measures are discussed as follows:

a) Mines

- a) Dust suppression systems (like water spraying) will be adopted at:
 - a. Faces before and after blasting
 - b. Faces while loading
- b) Dust extraction systems will be used in drill machines and coal handling systems.
- c) Dust generation will also be reduced by using sharp drill bits for drilling holes, drills with flushing system.

b) Haul roads and stock-piles

- Dust suppression system (like water spraying) would be adopted at roads, which are used for transportation. Fixed sprinklers (Whirling) have been proposed with timers to be installed along the haul roads and coal transportation roads to suppress the dust.
- Transport vehicles shall be maintained leak proof.
- Suitable dust suppression systems such as mist sprays with or without chemical will be provided at appropriate places for preventing dust pollution during handling and stockpiling of coal.
- Transfer points of coal will be provided with appropriate hoods/chutes to prevent fugitive dust emission.

ii. Preventing dispersal of air borne dust

In addition to the control measures proposed during mining and transportation operations, following steps will be taken to prevent air pollution due to airborne dust:

- Dense tree belts will be planted around the mine and sites housing handling/ loading facilities.
- Plantation over already mined out area will be done after backfilling as per schedule (with minimum gap between excavation and afforestation)
- Dust masks will be provided as safety measure to the workers, engaged at dust generation points like drills, loading/unloading points, crushers etc.

iii. Measures to mitigate CO levels

It has already been discussed that the concentration of CO in the ambient air is negligible and is far below the prescribed limit of CPCB and is not anticipated to exceed it in future.

Still all heavy and light vehicles shall be tested for pollutants concentration in their exhausts regularly and well maintained. Strict vigil will be kept in and around the operational area for any fire which shall be immediately controlled.

iv. Measures to mitigate NO_x levels

The main reasons of production of NO_x gases are:

- a. Poor quality of explosive having large oxygen imbalance which can be due to following reasons:
 - Manufacturing defect
 - The use of expired explosives in which disintegration of ingredients has taken place.
- b. Incomplete detonation is caused mainly due to low primer: column ratio.

To ensure that NO_x levels do not increase during the proposed mining operations, the following control measures will be adopted:

- a. Good quality explosives will be used for which the oxygen balance will be checked from time to time. The expired explosives will not be used for which a strict vigil will be kept on the date of manufacture. Even as a normal procedure, all explosives will be subjected to a visual inspection and if disintegrated ingredient are spotted, the explosives will not be used even if it is within expiry date.
- b. Primer: Column ratio will be rationalized. The ratio thus established, for producing minimum NO_x, will be adhered to.

The mine ambient air quality will be regularly tested to detect the presence of any pollutants above prescribed limits and appropriate measures will be adopted.

14.4.3 Noise and blasting

a) Measures to control noise pollution

The following control measures will be adopted to keep the ambient noise levels below permissible limits of 75 dB (A).

- i. Provision and maintenance of thick tree belts to screen noise.

- ii. Avenue plantation within the project area to dampen the noise.
- iii. Proper maintenance of noise generating machinery including the transport vehicles will be ensured.
- iv. Provision of the air silencer to modulate the noise generated by the machines will be made wherever required.

To protect the workers from exposures to higher noise levels, the following measures will be adopted:

- i. Provision of protective devices like ear muffs/ear plugs to those workers who cannot be isolated from the source of noise.
- ii. Confining the noise by isolating the source of noise.
- iii. Reducing the exposure time of workers to the higher noise levels.

b) Measures to reduce ground vibrations due to blasting and prevent fly rocks

The vibrations due to blasting will be studied during stages of mining operations and the recommendations/ suggestions given as per the result of the said study will be strictly adhered to especially the charge per delay.

c) General recommendations and suggestion

- i. The peak particle velocity (PPV) of ground vibration will be kept below permissible limits by controlled blasting techniques.
- ii. Suitable powder factor will be adopted for overburden and coal.
- iii. Drilling and charging pattern will be modified, if required, based on the vibration study to be carried out.
- iv. Short delay detonators will preferably be used in blasting rounds rather than detonating fuse as trunk line.
- v. To contain fly rocks, stemming column will not be less than burden of the hole and the blasting area will be muffed.
- vi. Each blast will be carefully planned, checked, executed and observed. Blasting data will be recorded. During blasting, a responsible officer will be supervising the whole operation.
- vii. Covering the detonating fuse, in case it is used, at least with 150 mm thick cover of sand or drill cuttings.
- viii. Blasting will be carried out at mid-day and never at night.
- ix. Blasting will not be carried out when strong winds are blowing towards the inhabited areas.

Apart from the above, in order to ensure slope stabilisation, controlled production blasting will be adopted to avoid tension cracks and back breaks. Such cracks filled with water reduce stability of excavated slopes and angle of slopes. Good drainage system will be provided in and around the mine.

14.4.4 Water pollution control measures

a) Effluent from mine

- i. To prevent surface and ground water contamination by oil/grease and sewage waste, following control measures are proposed to be implemented:
 - Leak proof containers will be used for storage and transportation of oil/grease. In the store also, the container containing oil/grease will be kept in empty safe open containers of higher volume than the containers to avoid oil/grease spillage. The area over which oil/grease is handled will be kept effectively impervious. Any wash off from the oil/grease handling area or workshop will be drained through impervious drains, collected in specially constructed pit and treated appropriately to remove any oil/grease and the water will be recycled. The oil grease will be sold to authorized vendors and sludge disposed off in specially constructed pit.
 - The sewage waste generated will be drained by underground impervious drains, lead to appropriately designed septic tanks and soak pits to prevent any pollution of surface or ground water.
- ii. The surface and ground water in and around the mine, loading plant and infrastructure will be regularly tested and appropriate control measures adopted in case of any pollutant is detected above the prescribed limit.
- iii. All stacking and loading areas will be provided with proper garland drains equipped with baffles to prevent wash offs from reaching the downstream natural channels.
- iv. A domestic waste water treatment plant will be provided in colony so that the water after treatment can be reused.

b) Storm water

Control measures to be adopted are briefly discussed below:

- Check dams will be provided to prevent solids from wash off and screen if any from the mine related activities.
- Peripheral bunds will be erected on the outer edge of the abandoned benches before reclamation so that the soil is not carried away by storm water.

- A water gradient of about 1 in 100 will be kept at every bench towards inside of the bench to prevent formation of gullies in the bench slopes causing serious erosion.
- Chutes will be constructed by using local stone or masonry to guide the water in areas with loose soil to prevent erosion and uncontrolled descent of water wherever necessary.
- Construction of garland drains around freshly excavated and dumped areas so that flow of water with loose material is prevented. The mine water will be passed through specially constructed settling ponds to arrest any loose material being carried away with water.
- Any areas with loose debris within the lease hold will be planted.

c) Measures to minimise adverse effects on water regime

During the process of mine rehabilitation and with the completion of backfilling, a water body will be created in the mined out pit which will act as water reservoir improving the ground water recharge; source of attraction for fauna and will help in the maintenance of afforested areas. To enhance aesthetic appearance, parks and lawns will be made around the water body.

14.4.5 Socio-economic aspects including resettlement and benefits

It is expected that there will be displacement of about 400 houses in three villages. A proper rehabilitation programme will be formulated and the land outsees will be given rehabilitation and resettlement benefits according to the Govt. of Orissa Policies and prevailing practice in industries in the vicinity. Advisory Committee will be formed by Collector/ Revenue Divisional Commissioner. The development in the area which is predominantly backward, will largely benefit the local population. Preference will be given to the local people for gainful employment in the unskilled and semi-skilled categories as and when the need arises.

Due to development activity in the rural and backward area, traders and private enterprises will grow in the region, which will provide indirect employment to the local people.

The company will arrange medical camps, sports competitions and awareness programme for the benefit of the local people.

14.5 MONITORING SCHEDULE OF EMP

- In order to keep a watch on the environmental control measures discussed about air quality, water quality and noise level monitoring shall be done regularly every year by taking measurements near the mine and residential areas preferably close to some of the earlier stations so as to keep a comparative check with respect to the base line data. For air quality monitoring, continuous monitoring on 24 hours

sampling basis should be done for two days per week and analytical checks made for SPM, SO₂, NO_x and CO.

- For effective management of the environment, it is envisaged to have an organisational set-up under the administrative supervision of the Mines Management where responsibilities can be delegated to technical personnel like Mining Engineer, Geologist/Chemist and Horticulturist with regard to specific aspects of environment management plan.

Conclusion

1. Displacement of villagers in three villages is anticipated.
2. Compensatory plantation is to be planned in line with Forest Department Rules.
3. Agricultural land shall be converted to industrial or mining site during mining tenure.
4. After the change in land use, the mining will provide the opportunity to create a water storage reservoir and comparatively higher tree plantation and greenery will improve the general quality of the environment. In the process, sustained production of energy vital for the power industry and economy of the area will be ensured.
5. Meteorology and general air quality of the area will not suffer and the planned operations will not have any significant adverse impact on the hydrograph and water quality in the area.
6. Only minor nature of air pollution is visualized for which more than adequate preventive measures have been contemplated.


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CHAPTER 15

PROGRESSIVE AND FINAL MINE CLOSURE PLAN

15.1 INTRODUCTION

15.1.1 Name and address of the owner

Registered Office:	Communication Address:
Radhikapur (West) Coal Mining Pvt. Ltd. Plot No. 52, Shaheed Nagar Bhubaneswar-751007 Orissa, India Phone : 0674-2546661 Fax : 2674-2540061 Email : rungtas@satyam.net.in	Radhikapur (West) Coal Mining Pvt. Ltd. Rungta House Chaibasa - 833201 Jharkhand, India Phone : 06582-256321/621 Fax : 06582-257521 Email : rungtas@satyam.net.in

15.1.2 Location

The Radhikapur (West) Coal Block spans over an area of 10.48 Sq.km between Latitude 20° 57' 28" & 20° 59' 42" North and Longitude 84° 51' 00" & 84° 54' 47" East. The block is covered under Survey of India Toposheet no. 73 D/13 on R.F. 1:50000, and special toposheet nos. M-1, M-2, L-1 and L-2 on R.F. 1:10,000 and falls within Angul district of Orissa state. The maximum extents of the block are about 5 km strike direction and about 3.5 km in dip direction.

The limits of Radhikapur (West) Coal Block are as given below:

East	: Western bank of Naubanda nala / Utkal P block
West	: Eastern bank of Singhada Jhor/ Balipata Block
North	: Southern bank of Singhada Jhor
South	: Arbitrary boundary demarcated roughly on coinciding the line joining borehole no. CMTR-062 and the trace of incrop of seam Local 2/ Nuapada Block

The Location map has been shown as Plate I in the mining plan.

15.1.3 Extent of ML area and present land use

Summary of the village wise ownership of land and land use wise details are given in Table 15.1 and 15.1A respectively.

TABLE 15.1
VILLAGE WISE OWNERSHIP OF LAND IN MINING LEASE AREA

Sl. No.	Name of the Village	Private Lands (In Acres)	Government Lands (in Acres)					Grand Total (In Acres)
			Community	Leasable	Gochar	Village Forest	Total Govt.	
1	Barapada	584.263	75.249	32.342	43.832	55.919	207.342	791.605
2	Kusakila	609.170	37.570	39.240	47.510	34.420	158.740	767.910
3	Naupada	330.100	17.000	45.100	39.120	21.370	122.590	452.690
4	Kusakila Jungle Bar	225.582	3.550	98.150	36.180	69.960	207.840	433.422
5	Jhintipal	25.267	2.940	21.169	15.537	4.362	44.008	69.275
6	Putagadia	38.680	0.480	0.000	0.000	22.210	22.690	61.370
7	Balipata	9.211	0.173	0.000	0.040	1.289	1.502	10.713
8	Kosala	2.621	0.000	0.000	0.000	0.000	0.000	2.621
Total		1824.894	136.962	236.001	182.219	209.530	764.712	2589.606 (1048 Ha)

TABLE 15.1A
EXISTING LAND USE DETAILS OF MINING LEASE AREA

Type of land use	Pvt. land	Govt. land	Forest land	Total
Habitation	42.4081	22.2119	0	64.62
Agriculture land	502.1153	0.7035	0	502.819
Non agriculture land	185.1066	72.6948	0	257.801
Water body(Pond, Nala Well etc.)	8.602	26.6134	0	35.2154
Temple/Worship place	0.0445	0.709	0	0.7535
Gochar	0.0324	73.7424	0	73.7748
Road	0.2185	22.3339	0	22.5524
Community land		1.0825		1.0825
Samansana		4.5854		4.5854
Forest				
i Bada jungle			8.3325	8.3325
ii Chhota Jungle			9.3037	9.3037
iii Garmya Jungle			65.4557	65.4557
iv Jungle			1.703	1.703
Total	738.5274	224.6768	84.7949	1048

15.1.4 Reasons for closure

It is a new allotted block. Therefore Progressive Mine Closure Plan is described along with the coverage of activities to be taken care of at the closure stage. Reasons for Mine Closure can be exhaustion of mineral, lack of demand, uneconomic operations, natural calamity or directives from a statutory organization.

15.1.5 Statutory obligations

It is a new block allotted hence, there are no statutory obligations imposed by any authority except that there is one allotment letter from the Ministry of Coal.

MOC allotment letter no. 13016/33/2005-CA-1 Dated 25-04-2006 and No. 13016/77/2006-CA-1 Dated 21-12-2009 from Government of India, Ministry of Coal. **Annexure 1-1.**

The main points of the letter are as follows:

Point 1.:- A joint venture Company will be formed between M/s Rungta Mines Ltd., M/s OCL, India Ltd. and Ocean Ispat Ltd. The equity holding in the joint venture company will be in proportion to their share of coal requirement of the companies.

Compliance 1.:- A joint venture Company has been formed between M/s Rungta Mines Ltd., M/s OCL, India Ltd. and Ocean Ispat Ltd. The equity holding in the joint venture company is in proportion to their share of coal requirement of the companies.

Point 2.:- The joint venture Company shall be registered by the allocattees.

Compliance 2. The joint venture Company has been registered by the allocattees.

Point 3.:- The mining lease shall be obtained in the name of the joint Venture Company and extracted coal from the mine shall be distributed between the allocattees in the proportion of their assessed requirement.

Compliance 3. The mining lease has been applied in the name of the joint Venture Company and extracted coal from the mine shall be distributed between the allocattees in the proportion of their assessed requirement.

Point 4.:- The coal block will be for captive use only.

Compliance 4. Will be complied

Point 5.:- The coal produced from the block shall not replace any coal linkage given by CIL or SCCL

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नयाँ दिल्ली-११००२९

Compliance 5. Will be complied

Point 6.:- A Bank Guarantee (BG) worth Rs 73.24 crores will be given by Joint Venture Company within 3 months from the date of issue of the allotment letter.

Compliance 6. The BG has been given in July 2010.

Point 7.:- The company shall submit Mining Plan for approval of the competent authority within 6 months after the preparation of geological report.

Compliance 7. The Re-submission of Mining plan (after incorporation of suggestions given by The Standing Committee) has been submitted in March 2011.

Compliance 8. The allotment may be cancelled on violation of the terms and conditions of the allotment letter.

Ans. 8:- Noted

ii. Other obligations

Other obligations will be there as a result of the following approvals:

- a. Mining Plan approval letter from MOC
- b. Environmental clearance letter from MOEF
- c. Forestry clearance letter from Forest Deptt, MOEF
- d. No objection certificate from State Pollution Control Board

All the obligations spelt out in the above letters/ clearances will be complied by the Company.

15.1.6 Closure plan preparation

The Progressive Mine Closure Plan and Mine Closure Plan have the approval of the authorised signatory of the Company and the relevant document is attached as Annexure 15-2.

15.2 DESCRIPTION OF GEOLOGICAL FORMATIONS

Radhikapur (West) Coal Block is almost totally covered by soil and therefore, is devoid of insitu exposures for geological mapping. Such soil and weathered mantle is followed by Barakar Formations as has been reported from borehole cores. None of the borehole has encountered Talcher and Karharbari Formations. Karharbari Formation is known to contain better quality of coal seam (Seam I) as reported from southern eastern part of the coalfield as well as in the northern part of the coalfield. In the absence of direct evidence, the Karharbari Formation could not be established from the block. The same is true for Talcher and Metamorphics

also. As such, the lithological and other characteristics of Metamorphic, Talcher and Karharbari formations are expected to be similar to those described under regional geological settings. The Barakar Formation occurring in the block contains seams II A to XI. The younger group of seams is comparatively more potential than older seams. The Barakar boundary zone is expected to be conglomeratic in nature and contains well rounded quartz and quartzite clasts of various sizes embedded in a sandy matrix. This however, is not encountered in any of the boreholes in this block. The lithology of Barakar Formation contains medium to coarse grained greyish feldspathic sandstone, grey to dark grey shale, carbonaceous shale, thick coal seams mostly interbanded with dirt bands of various thickness.

Considering the information available through sub-surface exploration and the information collected from neighbouring blocks including geological mapping to the extent possible, following stratigraphic succession has been established in Radhikapur (West) Coal Block.

TABLE 15.2
STRATIGRAPHIC SUCCESSION, RADHIKAPUR (WEST) COAL BLOCK,
TALCHER COALFIELD

Group	Age	Formation	Lithology
Gondwana	Recent	Recent Deposit	Soil, Sub-soil etc.
	Lower Permian	Barakar Formation	Medium to coarse grained greyish feldspathic sandstone, grey to dark grey shale and coal seams.
	Lower Permian	Karharbari Formation	Pale brownish yellow coloured massive medium to coarse grained sandstone-containing clasts of Talchir shale and coal seams.
	Upper Carboniferous to Lower Permian	Talchir formation	Diamictite, sandstone, needle shale, turbidite, rhythmites and varves.
Unconformity			
	Archaean (?) to Lower Proterozoic	Pre-Cambrian Metamorphosis	Granites, gneisses and associated supracrustals.

The carbonaceous horizons occurring within Barakar and Karharbari Formations have been designated as coal seams (horizons) depending upon its thickness, stratigraphic position quality and consistency in occurrence over considerable part of the coalfield. In Talcher coalfield, Karharbari Formation contains only one coal seam i.e. seams I, whereas, in Barakar Formation, there are 13 nos. of regionally correlatable coal seams occurring from seams II to XIV. Radhikapur (West) Coal Block contains regionally correlatable coal seams from seam II to XI of Barakar Formation with numerous splits. The presence of seams I of Karharbari Formation has not been established within the block and there is possibility of non-

development of seam I as evidenced from boreholes drilled in neighbouring areas.

15.3 SEQUENCE OF COAL SEAMS

In Radhikapur (West) Coal Block, Barakar Formation contains seams II A to XI in different splits. Altogether, 20 nos. of seams / split seams are reported in Barakar Formation. Among these, seam IX is the most potential coal horizon in this block. The sequence of coal seams is given in Table 15.3.

TABLE 15.3
SUCCESSION OF COAL SEAMS IN RADHIKAPUR (WEST) COAL
BLOCK, TALCHER COALFIELD.

Seam/ parting	Thickness (m)	
	Minimum	Maximum
Soil	0.00	18.00
WM	0.00	37.83
XI	0.11	5.92
PA11	2.01	16.97
LOC1	0.09	1.55
PA12	7.05	20.09
X	0.12	6.20
PA13	23.24	50.37
IX	1.08	41.84
PA14	0.79	23.59
VIII TOP	0.10	2.66
PA15	1.08	10.24
VIII BOT	0.07	1.09
PA16	1.04	22.65
VII B	0.08	4.06
PA 17	2.63	18.14
VII A	0.04	3.68
PA 18	4.58	15.57
VI B	0.05	0.47
PA 19	5.33	18.60
V B	0.13	1.16
PA 20	3.68	16.01
V A	0.05	1.40
PA 21	0.72	10.92
IV B	0.15	1.37
PA22	7.39	2.05
LOC 2	0.05	3.12
PA 23	6.90	26.17
III E	0.10	8.90
PA 24	15.66	32.40
III D	0.11	2.11

Seam/ parting	Thickness (m)	
	Minimum	Maximum
PA 25	3.57	14.50
III A TOP	0.15	2.04
PA 26	1.07	12.28
IIIA (BOT)	0.34	7.99
PA27	19.90	27.45
II C	0.30	1.65
PA 28	38.36	28.36
II B	0.42	4.71
PA 29	4.57	4.57
II A	1.67	1.67

Note :- 1. The above thickness of coal seams is inclusive of dirt bands.

2. The majority of coal reserves of the block are contributed by seam IX and, to some extent by seams III A Bottom, VII B, III E, and III A Top.

15.4 CHARACTERISTICS OF INDIVIDUAL COAL SEAMS

Seam - XI

Seam XI is the topmost seam available in Radhikapur (West) Coal Block and was encountered in northern part of the block. It does in crop within the block and attains a thickness put 5.92 metres. The seam is developed towards eastern part of the block there it attains effective thickness of 1 meter to above 6 metres. The maximum depth of occurrence of the seam within the block, as encountered in the boreholes, is 91.75 metre. The combustible as well as non-combustible dirt bands within seam constituting maximum upto 50%. The proximate analysis on 60% RH and 40°C of the seam on I₁₀₀ sample shows moisture%, ash% and volatile matter% as 5.6-6.6, 44.9-49.1 and 23.4 respectively. Determined Gross CV on I₁₀₀ samples of the seam is 3200 kcal/kg with its corresponding DMMF value of 7419 kcal/kg. The UHV on I₁₀₀ samples of the seam varies from 1351 kcal/kg – 1848 Kcal/kg (Grade G). The grade of seam is generally G on I₁₀₀ samples.

Local - I

A local seam, Local 1, occur below seam XI with parting above ranging from 2.01 metres to 16.97 metres. This Local 1 seam is inconsistent and generally less than 1 metre in thickness. The effective thickness of the seam is found to be less than 1 metre in all the cases. As such, the seam Local 1 has not been considered for reserves estimation and other detailing:

Seam - X

Seam X is one of the younger seams available in Radhikapur (West) Coal Block and was encountered in 44 no. of boreholes. It does incrop within the block towards north. The seam develops workable thickness in the north-eastern part and sporadically in the north-central part of the block. Over majority area of the block, the effective thickness of the seam remains less

than 1 metre. It attains maximum effective seam thickness of 2.15 metres in the western part of the block. The maximum depth occurrence of the seam within the block, as encountered in the boreholes is 109.51 metres. The combustible as well as non-combustible dirt bands within seam constituting maximum upto 20%. The proximate analysis on 60% RH and 40°C of the seam on I₁₀₀ samples shows moisture%, ash%, and volatile matter% as 5.8-6.7, 47.7- 48.2 and 22.7 respectively. The grade is generally G on I₁₀₀ samples.

Seam - IX

The seam IX is the most potential seam available in Radhikapur (West) Coal Block and was encountered as full seam in 68 no. of boreholes and as incrop in 26 no. of boreholes. The seam occurs in northern half of the block. It incrops within the block and attains a full seam thickness of maximum 41.84 metres. The maximum depth of occurrence of seam is 157.90 metres. The seam is highly interbanded and contains as much as 19.82 metres in-seam dirt bands in different sections. The in-seam dirt bands constitute upto 69% of the seam. The proximate analysis on 60% RH and 40°C of the seam on I₁₀₀ samples shows moisture%, ash%, and volatile matter as 5.2-7.8, 38.9- 51.7 and 21.6-24.8. The grade varies from F to un-graded.

Seam – VIII Top

Seam VIII Top occurs below seam IX in Radhikapur (West) Coal Block and was encountered in 93 nos. of boreholes in northern half of the block. It incrops within the block and attains maximum thickness of 2.66 metres. The maximum depth of occurrence is 201.94 metres as recorded in boreholes. The proximate analysis on 60% RH and 40°C of the seam on I₁₀₀ samples shows moisture %, ash % and volatile matter % as 5.8- 9.0, 37.9-49.1 and 22.0-27.1 respectively. The grade is ungraded to F to ungraded.

Seam - VIII Bottom

Seam VIII Bottom occurs below seam VIII Top with parting ranging from 1.08 metres to 10.24 metres. The thickness of VIII Bottom seam varies from 0.07 metre to 1.09 metres. This seam is inconsistent and less than 1 metre in thickness except in one borehole. As such, the seam VIII Bottom has not been considered for reserve estimated and other detailing. However, all the available information, generated during the exploration of the block, are available.

Seam - VII B

Seam VII B occur below inconsistent seam VIII Bottom in Radhikapur (West) Coal Block. It incrops within the block and attains maximum thickness of 4.06 meters. The maximum depth of occurrence of seam is 206.29 meters. The proximate analysis on 60% RH and 40°C of the seam on I₁₀₀ samples shows moisture%, ash% and volatile matter% as 5.7-10.8,

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24.9-49.0 and 23.2 -31.5 respectively. The grade on I₁₀₀ sample varies from E-G.

Seam - VII A

Seam VII A occurs below seam VII B with parting above ranging from 2.63 metres to 18.14 metres. The thickness of VII A seam varies from 0.04 metre to 3.68 metres. But, this seam is not only inconsistent, but also it never attains 1 metres and above effective thickness in this block. As such, the seam VII A has not been considered for reserve estimation and other detailing. However, all the available information, generated during the exploration of the block, are available.

Seam - VI B

Seam VI B occurs below seam VII A with parting above ranging from 4.58 metres to 15.57 metres. The seam VI B is not only inconsistent, its thickness varies from 0.04 metre to 0.47 metres. As such, the seam VI B has not been considered for reserve estimation and other detailing. However, all the available information, generated during the exploration of the block, are available.

Seam - V B

Seam V B occurs below seam VI B with parting above ranging from 5.33 metres to 18.60 metres. The thickness of V B seam varies from 0.13 metre to 1.16 metres. This seam is inconsistent and less than 1 metre in thickness, except in one borehole. As such, the seam V B has not been considered for reserves estimation and other detailing. However, all the information, generated during the exploration of the block, are available.

Seam - V A

Seam V A occurs below seam V B with parting above ranging from 3.68 metres to 16.01 metres. The thickness of V A seam varies from 0.05 metre to 1.40 metres. This seam is inconsistent and its effective thickness is less than 1 metre, except in one borehole. As such, the seam V A has not been considered for reserve estimation and other detailing. However, all the information, generated during the exploration of the block, are available.

Seam - IV B

Seam IV B is comparatively better developed seam below seam VII B in comparison to the coal seams in lying between. There are four no. of seams occurring between seams VII B & IV B, viz. VII A, VI B and V B and V A, which do not appear to have any potentiality. Seam IV B incrop within the block and attains a thickness of 1.37 metres as per borehole record within the block. However, considering borehole data of immediate neighboring block of Utkal E, the effective thickness upto 3 meters has been projected towards north- eastern part of the block. The proximate analysis on 60% RH

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and 40°C of the seam on I₁₀₀ sample shows moisture %, ash %, volatile matter % as 5.6 - 8.2, 26.4 - 49.0 and 23.3-25.0 respectively. The grade of the seam varies from E to G.

Local - 2

Seam Local 2 is a thin seam developed in northeastern corner of the block. It incrops within the block and attains a thickness of maximum 3.12 metres. The maximum depth of occurrence of seam is 256.65 metres. The proximate analysis on 60% RH and 40°C of the seam on I₁₀₀ sample shows moisture%, ash% and volatile matter% as 5.7 - 6.5, 41.7 - 46.4 and 22.1-24.9 respectively. The grade of the coal seam is generally G.

Seam - III E

Seam III E is developed in the north - eastern part of the block. It does not incrop within the block and thickness upto 8.90 metres. The seam occurs at depth range of 66.01 metres to 270.65 metres. The proximate analysis on 60% RH and 40°C of the seam on I₁₀₀ sample shows moisture%, ash% and volatile matter% as 5.2 - 6.0, 43.9 - 49.1 and 22.1 - 25.2 respectively. The grade of the coal seam is G.

Seam III D

Seam III D occurs between seams III E above and III A Top below. The seam is developed towards north-eastern and north-central part of the block. It does not incrop within the block and attains thickness upto 2.11 metres. The seam occurs at depth range of 143.68 metre to 300.00 metres. The proximate analysis on 60% RH and 40°C of the seam on I₁₀₀ sample shows moisture %, ash % and volatile matter % varies from 5.2 - 6.7, 30.7 - 49.6 and 22.2 - 26.7 respectively. The grade of the coal seam varies from E to G.

Seam - III A Top

Seam III A Top is developed towards northern & north-eastern part of the block. It does not incrop within the block and attains a thickness of maximum 2.04 metres. The seam occurs at depth range of 152.44 metres to 307.36 metres. The proximate analysis on 60% RH and 40°C of the seam on I₁₀₀ sample shows moisture %, ash % and volatile matter % as varies from 2.8 - 9.1, 38.6 - 64.8 and 22.0 - 26.2 respectively. The grade of the coal seam varies from F to ungraded.

Seam - III A Bottom

Seam III A Bottom is the lowermost potential seam proved to be exploited within the Radhikapur (West) Coal Block. The seam is generally well developed within the block and has over 1 m thickness over the entire area except extreme southern part. The seam occurs at depth range of 162.17 metres to 310.35 metres. It does not incrop within the block.

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Seam II C occurs below seam III A Bottom with parting above ranging from 19.90 metres to 27.45 metres. Seam II C was encountered in only two boreholes and was found to be not developed in seven other boreholes. Rest of the boreholes were not deepened enough to drill upto the seam due to depth limitation and other obvious constraints. The thickness of II C seam in these two boreholes as 0.03 metres and 1.65 metres. Due to lack of sufficient information, seam II C has not been considered for reserves estimation and other detailing.

Seam - // B

Seam II B is the oldest potential seam indicated in Radhikapur (West) Coal Block and was encountered in 5 numbers of boreholes only in northeastern part of the block. It does not incrop within the block and attains maximum thickness of 4.71 metres. The seam occurs at depth range of 212.14 metres to 269.50 metres. The depth of occurrence of seam varies from 212.14 metres to 269.50 metres. The proximate analysis on 60% RH and 40°C of the seam on I₁₀₀ sample shows moisture %, ash % and volatile matter % as 5.8 - 6.1, 38.4 - 39.1 and 25.3 respectively. The average grade is F. In the absence of adequate data on thickness and quality, the reserves of coal seam has been placed under 'Indicated' category.

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Seam II A is the lowermost known coal horizon in Barakar Formation in this part of the coalfield. It occurs below seam II B separated with a parting above of about 5 metres. Seam II A was encountered in only one boreholes and was found to be not developed in two other boreholes. Rest of the boreholes were not deepened enough to drill upto the seam due to depth limitation and other obvious constraints. The thickness of II A seam is found in this one borehole as 1.67 metres. Due to lack of sufficient information, seam II A has not been considered for reserves estimated and other detailing. However, all the information generated during the exploration of the block, are available.

Radhikapur (West) Coal Block covers an area of 10.48 Sq.km where 20 nos. of regionally correlatable coal horizons have been established to occur within the block. The seam I is reported to be thin and has not been confirmed by any of the boreholes drilled within the block. Many of the coal

horizons, namely IIA, IIC, VA, VB, VIB, VIIA and VIII Bottom and Local 1, are either thin or developed in isolated small patches. These seams do not offer much mining potentiality and hence, are not considered for reserves estimation.

As such, rest 12 nos. of coal seams have been dealt in detail.

Net proved opencast coal reserve of 288.440 million tonnes upto seam III A Bottom and Gross Indicated coal reserves of 23.596 million tonnes of seam II B have been estimated for the entire block from seams XI to IIB. The details of the reserves are given in Table 15.4 & 15.5 respectively.

TABLE 15.4
SEAM-WISE AND CATEGORY-WISE GEOLOGICAL RESERVES,
RADHIKAPUR (WEST) COAL BLOCK, TALCHER COALFIELD

Seam	Net Proved Reserves (mt.)	Gross Indicated Reserves (mt.)	Total Reserves (mt.)
XI	4.128	0.000	4.128
X	1.291	0.000	1.291
IX	194.835	0.000	194.835
VIII Top	1.840	0.000	1.840
VII B	18.793	0.000	18.793
IV B	2.209	0.000	2.209
Local 2	3.687	0.000	3.687
III E	12.473	0.000	12.473
III D	3.949	0.000	3.949
III A Top	7.300	0.000	7.300
III A Bot	37.935	0.000	37.935
Total (Proved)	288.440	0.000	288.440
II B	0.000	23.596	23.596
Total (Proved + Indicated)	288.440	23.596	312.036

Seam Group-wise Total Net Proved Reserves and seam-wise Total Net Proved Reserves of the block are shown respectively.

The seam-wise and grade-wise net proved geological reserves of Radhikapur (West) Coal Block is shown as under:-

TABLE 15.5
SEAM-WISE AND GRADE-WISE NET PROVED GEOLOGICAL RESERVES,
RADHIKAPUR (WEST) COAL BLOCK, TALCHER COALFIELD

Seam	Grade-wise Net Proved Reserves in million tonnes				Net Proved reserves (mt.)	Seam-wise percentage of reserves	UHV K.Cal/Kg.	GCV K.Cal/Kg.
	D	E	F	G				
XI	0.000	0.000	0.023	4.105	4.128	1.431	1351-2235	3120-3670
X	0.000	0.000	0.000	1.291	1.291	0.448	1324-3049	3040-4174
IX	0.000	0.000	0.368	194.467	194.835	67.548	1034-3366	2807-4375
VIII Top	0.000	0.005	0.109	1.726	1.840	0.638	1517-3090	3000-4203
VII B	0.000	0.709	5.901	12.183	18.793	6.515	1351-3973	3092-4751
IV B	0.000	0.183	1.550	0.476	2.209	0.766	1365-2442	3125-4877

Seam	Grade-wise Net Proved Reserves in million tonnes				Net Proved reserves (mt.)	Seam-wise percentage of reserves	UHV K.Cal/Kg.	GCV K.Cal/Kg.
	D	E	F	G				
Local 2	0.000	0.000	0.000	3.687	3.687	1.278	1889-2248	3315-3760
III E	0.000	0.000	0.000	12.473	12.473	4.324	1338-2028	2995-4040
III D	0.005	0.294	1.686	1.964	3.949	1.369	2083-3739	3680-4345
III A Top	0.000	0.000	1.901	5.399	7.300	2.531	1945-3145	2050-4093
III A Bot	0.000	5.183	30.141	2.611	37.935	13.152	2248-3725	3630-4882
Total	0.005	6.374	41.679	240.382	288.440	100.00		
Grade-wise Percentage	0.002	2.210	14.450	83.338	100.00			

15.5.1 Reserves estimation of individual coal seams

Seam folio plans showing the block boundaries, seam incrop, isochors and isograds on I_{100} samples with data of effective thickness, UHV, Grade and in-seam dirt band thickness were used as the base for the estimation of coal reserves and volume of coal having less than 1 metre and ungraded coal as well as in-seam dirt band. The intersections of all the parameters within a seam folio plan have generated numbers of polygons. The area of each polygon in Sq.km was measured by the digital planimeter. The area in Sq.km, thus obtained were multiplied by average thickness value of the two enclosing isochors in metres to obtain the volume of coal in million cubic metre, which in turn is multiplied by specific gravity of coal pertaining to the grade of the polygon. Thus, gross reserves of respective coal seam occurring within that polygon were obtained. The reserves of all the polygons were added to calculate Gross coal reserves. A deduction of 10% was made to obtain the net reserve of the seam. The deduction is made to account for unforeseen geological features within the block.

Specific gravity for each grade had been calculated from the following formula by taking average ash% for each grade:

$$\text{Sp. Gr.} = 1.29 + 0.01 \times \text{Ash}$$

The following Table 15.6 shows average grade-wise specific gravity, thus arrived and considered for reserve estimation for different grades of coal.

TABLE 15.6
SEAM-WISE GRADE-WISE AVERAGE SPECIFIC GRAVITY,
RADHIKAPUR (WEST) COAL BLOCK, TALCHER COALFIELD

Seam	Specific gravity for I_{100} samples s per Grade			
	Grade D	Grade E	Grade F	Grade G
XI	-	-	1.68	1.75
X	-	-	-	1.75
IX	-	-	1.68	1.75
VIII Top	-	1.61	1.68	1.75
VII B	-	1.61	1.68	1.75
IV B	-	1.61	1.68	1.75
Local 2	-	-	-	1.75

Seam	Specific gravity for I ₁₀₀ samples s per Grade			
	Grade D	Grade E	Grade F	Grade G
III E	-	-	-	1.75
III D	1.55	1.61	1.68	1.75
III A Top	-	-	1.68	1.75
III A Bottom	-	1.61	1.68	1.75
II B	-	-	1.68	1.75

15.6 MINING METHOD

15.6.1 Justification of method of mining

Opencast mining

The mine will be worked by opencast method upto seam IX and seams below seam IX by underground, because stripping ratio below seam IX being over 16.

- Since the strike length is over 5 km, for a production level of 6 MTPA, it will require two access trenches to reduce the hauling distance.
- The external dumping will be on the southern portion of the block with a height upto 100m
- It is proposed to adopt shovel dumper combination along with drilling and blasting for OB removal and shovel dumper/surface miner for coal extraction.
- Back filling will start during the 3rd year of mine operation.
- Feeder breaker to be installed at the top of the two access trenches for sizing of coal
- The extractable coal reserves and OB removal will be 140.293 Mt (I₁₀₀) and 514.76 MCUM respectively above seam IX.
- With the use of CSM, it will be possible to mine the in-seam dirt bands of >20cm separately hence the coal reserves will become 125.03 MT(I₂₀) and the corresponding OB removal will become 523.48 mcum.
- There may be further increase in coal extraction by adopting new technology like high wall mining/ auger mining for the coal blocked under batter, barrier, nala etc

Recoverable reserves, waste quantity and stripping ratio

The recoverable reserves of coal are about 140.293 MT(I₁₀₀) after considering coal blocked in barriers 11.413 MT, in batter (41.164 MT) and mining losses of 5% (7.384 MT) and the corresponding waste quantity will be 514.76 MCUM resulting into an OB coal ratio of 3.67:1.

However, with the use of CSM, coal (I₂₀) will become 125.03 MT(I₂₀) and the corresponding OB removal will become 523.48 mcum

Shovel dumper combination and continuous surface miners have been envisaged. Annual capacity for 3 models of CSM with suitable evacuation system will be as given in Table 15.7.

TABLE 15.7
ANNUAL CAPACITY OF CCM

Particulars	2200 (W)	2100 (W)	202 M (B)
Annual production (MT)	1212 x 4200	794 x 4200	1312 x 4200
At 100% capacity (MT)	5.09	3.34	5.51
At 50% capacity(MT)	2.545	1.67	2.755

It is considered prudent to provide CSM on the basis of final field efficiency of only as 50%. Therefore, the annual capacity in tonne @ 1.75 te/m³ will be about 2.545, 1.67 and 2.755 MTPA respectively for the three models. Since the application of CSM is proposed to be in thick seam, 2 nos. of 2200 (W) type may be considered for use in coal by which overall annual production of around 4.675MT(4 MT I₂₀ coal plus 0.675 MT in seam dirt bands) will be achieved by surface miners with about 9% cushion.

Year wise development of the first five years

Adequate area will be kept reserved at the southern portion of the ML for providing all the facilities of opencast as well as underground mining operations including Inclines. This area is selected in non coal bearing part of the block. The development works during the first year include making access road to the site, obtaining 1st set of mining equipment, top-soil removal and driving box-cut and taking up other construction activities. The works to be completed during the second year are obtaining second set of mining equipment and progressive removal of over-burden. As described in earlier pages, the coal seams in this property are of relatively poor quality and intercalated with dirt bands.

A coal washery is proposed in the block for improving the quality of coal so that it can be effectively utilized in the power generation. The transportation will be affected either by trucks or conveyors directly to coal washing plant. Similarly, the road infrastructure upto the coal washery would need to be made before it becomes fit for large scale coal transportation. Keeping all the above in view, the build-up in coal production will be made. The mining will begin with an aim of producing 6.00 MTPA from 5th year onwards. The total coal production in the first five years will be 16.2 MT. The year wise development of the mine in the first five years is shown in Plate IX to XVIII.

Year 1

The initial mine entries will be made in the seam IX in the incrop in southern part of the ML area in a low lying terrain. Entry no. 1 will be 600m west of borehole No. CMRT-60 and Entry No. 2 will be 175m north east of the same

In 5th year the pits of both the entries will merge into each other. There will be 5 and 7 benches in the western side and 7 benches in the eastern side of the merged pit. The coal will be mined from seam IX. The waste generation is 25.94 Mcum(B) and coal production is 6.00 MT. The pit configuration at the end of this year is shown in (Plate XVII). Minimum floor will be at 110MRL. Backfilling will be 26.10 mcum(L) and there will not be any surface dumping in this year.

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Calendar programme of excavation

Year wise production for the life of the mine is tabulated in Table 15.8.

TABLE 15.8
BANK CALENDAR PROGRAMME OF MINING BY OC METHOD

Year	Opencast					
	Prog. Coal (MT)	Cumi. Coal (MT)	Prog. OB Cum	Cumi. OB Cum	Prog. Ratio	Cumi. Ratio
1	0.30	0.30	3.08	3.08	10.26	10.26
2	1.80	2.10	7.67	10.75	4.26	5.12
3	3.30	5.40	14.29	25.04	4.33	4.64
4	4.80	10.20	26.26	51.30	5.47	5.03
5	6.00	16.20	25.94	77.24	4.32	4.77
6	6.00	22.20	24.84	102.08	4.14	4.60
7	6.00	28.20	24.18	126.26	4.03	4.48
8	6.00	34.20	23.52	149.78	3.92	4.38
9	6.00	40.20	23.52	173.30	3.92	4.31
10	6.00	46.20	23.52	196.82	3.92	4.26
11	5.80	52.00	22.75	219.57	3.92	4.22
12	5.48	57.48	21.52	241.09	3.93	4.19
13	5.30	62.78	22.79	263.88	4.30	4.20
14	5.30	68.08	22.79	286.67	4.30	4.21
15	5.30	73.38	22.79	309.46	4.30	4.22
16	5.30	78.68	22.79	332.25	4.30	4.22
17	5.30	83.98	22.79	355.04	4.30	4.23
18	5.30	89.28	22.79	377.83	4.30	4.23
19	5.30	94.58	22.79	400.62	4.30	4.24
20	5.30	99.88	22.79	423.41	4.30	4.24
21	5.30	105.18	22.79	446.20	4.30	4.24
22	5.30	110.48	22.79	468.99	4.30	4.25
23	5.30	115.78	22.79	491.78	4.30	4.25
24	5.30	121.08	22.79	514.57	4.30	4.25
25	3.95	125.03	8.91	523.48	2.26	4.19
Total	125.030		523.48		4.19	

Proposed rate of production when the mine is fully developed

Coal production	-	6.00 MT
Overburden excavation	-	25.14 Mcum. (average)
Average OB : Coal	-	4.19 : 1

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Mineable reserves and anticipated life of the mine

The recoverable (extractable) reserves are already given in Table 15.8 in as 125.03 MT by opencast mining.

Proposed method of working

It is proposed to adopt mechanised opencast method on three shift basis with the deployment of CSM, drill machines, loaders, shovels, dumpers, B.Ds etc.

Opencast working

The overburden comprises soil cover underlain by weathered mantle which is in turn underlain by comparatively stronger OB strata.

The 8 m to 10 m bench in waste material specifically soil and weathered mantle will not require any drilling/blasting where as the underlying stronger strata of OB will be drilled by rotary blast hole drill using a bit size of 200-250mm. The blast hole will be loaded with explosive and blasted. Hydraulic excavators equipped with 8m³ & 6m³ cum bucket capacity will be used for OB. The dumpers will haul the material either to the surface waste dump or to previously mined pit section for backfilling. At the dump site, dozer will be used for the purpose of grading the dumps. Transport will be affected by 100 T & 50T rear dumpers.

surface waste dump or
ump site, dozer will be
ort will be affected by

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used to excavate coal in other two seams XI & X. For these two seams 110/115 mm dia drills will be used for blast hole drilling and the blasted coal will be loaded in 15/20 T dumpers (coal body) by 1.5 cum hydraulic backhoe and 0.9 cum hydraulic backhoe initially.

The coal benches will also be maintained at their prevalent thickness. All haulage roads and dumps will be maintained at a gradient of not less than 1 in 16. (Refer Plate IX to XX).

Extent of mechanisation

Mining and transport of coal and OB will be fully mechanised. The mine will operate 300 days an year and 3 shifts per day.

The production capacity of 8m³ Electric Hydraulic shovel with 100 T RD in OB will be:

i) 8 m ³ Electric Hydraulic backhoe +100 T RD	2.20 mil cum
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The production capacity of 6m³ Electric Hydraulic shovel with 50 T RD in OB will be:

i) 6 m ³ Electric Hydraulic backhoe +50 T RD	1.60 mil cum
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The production capacity of 1.5m³ Hydraulic backhoe with 15T RD in coal will be:

ii) 1.5 m ³ Electric Hydraulic backhoe +15 T RD	0.65 mil Te
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The production capacity of 0.9 m³ Hydraulic backhoe with 15T RD in coal will be:

ii) 1.5 m ³ Electric Hydraulic backhoe +15 T RD	0.35 mil Te
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Mining and transport of coal and OB will be fully mechanised. The details of equipment are given in Table 15.9.

TABLE 15.9
LIST OF PRODUCTION AND AUXILIARY EQUIPMENT

Sl. No.	Particulars	Unit	Quantity
I.	Heavy Earth Moving Machinery		
A.	Coal		
a)	Hydraulic shovel 1.5m ³ (Diesel)	Nos.	2
b)	Hydraulic Shovel 0.9 m ³ (Diesel Operated) with one backhoe	Nos.	1
c)	15/20 T.R.D. trucks (Diesel Operated)	Nos.	12
d)	R.B.H drills 110/150 mm (Diesel Operated)	Nos.	3
e)	Dozer 275-320 HP (two with ripper attachment)	Nos.	2
f)	Continuous surface miners(2200W)	Nos.	2

Sl. No.	Particulars	Unit	Quantity
B.	Overburden		
a)	Hydraulic shovel front end 8 m ³ (Diesel Operated)	Nos.	10
b)	Hydraulic Shovel 6 m ³	Nos.	2
c)	100 T.R.D.	Nos.	40
d)	50 T.R.D. trucks (Diesel Operated)	Nos.	8
e)	R.B.H drills 200/250 mm (Diesel Operated)	Nos.	11
f)	Dozer 410 HP (Diesel Operated)	Nos.	7
g)	Dozer 275-320 HP (Diesel Operated)	Nos.	5
II.	Auxiliary & Service Equipment		
a)	3.5 m ³ front end loader (Coal) (Diesel Operated)	Nos.	3
b)	6 m ³ front end loader (Coal) (Diesel Operated)	Nos.	3
c)	Graders 145 HP (Diesel Operated)	Nos.	2
d)	Diesel Bouser	Nos.	2
e)	Construction backhoe -0.9 CUM (Diesel Operated)	Nos.	1
f)	Water sprinkler (26 KL) (Diesel Operated)	Nos.	6
g)	TOW truck on 70T truck chassis (Diesel Operated)	Nos.	1
h)	100 T tractors (Diesel Operated)	Nos.	1
i)	Rough terrain crane - 40T mobile (Diesel Operated)	Nos.	1
j)	Lattice crane 70 T	Nos.	1
k)	Service trucks		
	Fuel trucks (Diesel Operated)	Nos.	4
	Wash trucks (Diesel Operated)	Nos.	2
	Mobile maintenance trucks (Diesel Operated)	Nos.	4
	Lube trucks (Diesel Operated)	Nos.	2
	Fire trucks (Diesel Operated)	Nos.	1
	Explosive van (Diesel Operated)	Nos.	2
	Site mix trucks	Nos.	2
l)	Portable air compressor	Nos.	1
m)	Tyre handler	Nos.	2
	Reclamation		
	2.5 cum front end loader	Nos.	1
	10 T Truck	Nos.	4
	0.9-1.2 cum hydraulic excavator	Nos.	1

All material handling will be carried out on contract basis & other jobs will be done departmentally.

Drilling

Crawler-mounted pneumatically operated down the hole drilling rigs with hole diameter of 200-250 mm and those rigs are capable to meet the future requirement of 8 m/hr will be deployed for OB & R.B.H drills will be used for drilling 110/115 mm dia. holes in coal.

Loading

The excavation shovels deployed for coal will be used for loading the coal at the face.

Haulage/Transport

The OB will be transported by 100 T & 50 T R.D. trucks to surface dumps and later on, as soon as decoaled area is available suitable for backfilling, to the site of backfilling. The coal will be transported by 50 T R.D. trucks to the coal receiving pit/crusher and the proposed washery, at the pit head and the washed coal will be transported to the plant by the trucks. A coal stack facility has also been provided for accommodating one week's production. FE loading machines with 6 m³ coal bucket will load the coal into trucks for haulage to plant or railway station. This system will offer mobility or flexibility.

The production from each seam will be mined in the ratio's of thickness to ensure near consistency of quality over the life of the mine.

Underground mining

The remaining coal other than opencast upto the lower most seam IIIA (Bot.) will be extracted by underground working. The lay and disposition of Seams is suitable for underground mining due to higher stripping ratio below seam IX. Hence various parameters for mining the block have been dealt in accordance with the requirements for underground mining also.

Reserves, mode of entry and selection of mining method**(i) Reserves for Under Ground Mining**

This mining plan is prepared for a thickness range of more than 1.8 meters as typical mining practice for thin seams of less than 1.8m is not popular in India due to heavy cost parameters involved for current available technologies and grade of available coal. So the following base line reserves are considered at Radhikapur (west) coal block for underground mining in lower seams of coal block.

The Radhikapur (west) Coal block is divided for underground mining as well as opencast mining. The calculated vertical UG reserves can be seen in Table 15.10.

The vertical reserves for underground mining are blocked under certain constraints. This includes blockage of coal in small patches of about 3.45MT in all the seams due to uneconomical access by long drive in stone. The thickness wise and grade wise vertical reserves considered for mining are summarised as given in Table 15.10 & 15.11 respectively.

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TABLE 15.10
THICKNESS WISE VERTICAL RESERVES AT RADHIKAPUR (WEST)
COAL BLOCK IN MT

Seam	Net Proved Reserves as per GR	Not Workable Reserves of <1.8M Thickness	Workable Reserves of >1.8 m Thickness						
			1.8-2m	2-3m	3-4m	4-5m	5-6m	6-7m	Total
VIII Top	1.84	1.76	0.03	0.05	0.00	0.00	0.00	0.00	0.08
VII B	18.793	11.57	2.10	3.11	0.65	1.36	0.00	0.00	7.23
IV B	2.209	0.91	0.27	0.42	0.60	0.00	0.00	0.00	1.30
Local 2	3.687	3.55	0.07	0.06	0.00	0.00	0.00	0.00	0.13
IIIE	12.473	3.42	0.64	1.43	2.00	1.94	2.91	0.13	9.06
IIID	3.949	3.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IIIA Top	7.3	7.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IIIA Bot.	37.935	4.87	0.95	5.67	8.16	11.19	4.80	2.29	33.06
Total	88.186	37.34	4.07	10.74	11.41	14.49	7.72	2.42	50.85

TABLE 15.11
GRADE WISE VERTICAL RESERVES IN MORE THAN 1.8M THICKNESS
AT RADHIKAPUR (WEST) COAL BLOCK IN MT

Seam	Grade Wise Quantity in MT			Total
	E	F	G	
VIII TOP	0.00	0.00	0.08	0.08
VII B	0.99	1.76	4.48	7.23
IV B	1.22	0.00	0.08	1.30
LOCAL2	0.00	0.00	0.13	0.13
IIIE	0.00	0.00	9.06	9.06
IIID	0.00	0.00	0.00	0.00
IIIA TOP	0.00	0.00	0.00	0.00
IIIA BOT.	0.00	31.83	1.23	33.06
Total	2.21	33.59	15.05	50.85

The above reserves excludes the reserves under different constraints like Nala barrier, 7.5m barrier from block boundary etc. In addition to these the following constraints also restricts the mining in Radhikapur (west) coal block:

1. Only seams VII BOT., IIIE and IIIA BOT. are mineable as the other seams have the scattered small patches of reserves with more than 1.8m in thickness. The cost of waste rock drivages for the entry to these seams does not permit the mining in these patches.
2. The parting between the floor of conceptual pit up to seam IX and underground working in seam VII B is only 10m to 20m. This parting will be disturbed in either case of mining first in this area. So only

possible recovery from seam VIIB is through development up to maximum thickness up to 3.00m before the opencast mining in this area.

3. No depillaring will be done in underground until the opencast working over the depillaring area is completed as it may affect the over laying strata.
4. The dewatering operations will continue in open cast mining (conceptual pit) till the end of underground mining operations.
5. The entry to seam IIIE and VIIB is through rising drifts in north eastern part of the block. So ventilation in this area requires specific arrangements. A peripheral ventilation shaft will be sunk in North east part of the block adjoining to the block boundary barrier pillar. It will be protected through protection pillars throughout the life of the mine. The timing of reaching in seam VIIB through ventilation shaft will be so arranged that the rising drifts from lower seams IIIA (B) via seam IIIE reaches in seam VIIB at the same time.

TABLE 15.12
MINEABLE RESERVES AT RADHIKAPUR (WEST) COAL BLOCK

Seam	Net Available Reserve for UG	Blocked Reserves in <1.8M Thickness in & Unviable Patch	Blocked Reserves in Unworkable Patches	Net Mineable Reserves
	1	2	3	(4=1-2-3)
VIII TOP	1.84	1.76	0.08	0.00
VIIB	18.793	11.57	1.60	5.63
IVB	2.209	0.91	1.30	0.00
LOCAL2	3.687	3.55	0.13	0.00
IIIE	12.473	3.42	0.34	8.71
IIID	3.949	3.95	0.00	0.00
IIIA TOP	7.3	7.30	0.00	0.00
IIIA BOT.	37.935	4.87	0.00	33.06
Total	88.186	37.34	3.45	47.40

It has been assumed that the workable thickness by underground mining will be restricted to 1.8m (due to poor grade of coal and also to avoid dinting). Iso line of 1.8m have, therefore, been drawn on seams to calculate the reserves in less than 1.8m thickness and to exclude the same (refer Plate XXIVA to XXIVC for workable area of Seam VIIB, IIIE and IIIA Bot).

The above mineable reserves will be won through two distinct activities i.e., Development and depillaring. The total extractable reserves will not be more than 60% of mineable reserves. So these are further calculated for these activities also. These are given in Table 15.13.

TABLE 15.13
EXTRACTABLE RESERVES AT RADHIKAPUR (WEST) COAL BLOCK (MT)

Seam	Net Available Reserve for UG	Total Blocked Reserves	Net Mineable Reserves	Expected Extractable Reserves @60% of Mineable Reserves in the Seam
VIII TOP	1.84	1.84	0.00	0.00
VIIB	18.793	13.16	5.63	3.38
IVB	2.209	2.21	0.00	0.00
LOCAL2	3.687	3.68	0.00	0.00
IIIE	12.473	3.76	8.71	5.23
IIID	3.949	3.95	0.00	0.00
IIIA TOP	7.3	7.30	0.00	0.00
IIIA BOT.	37.935	4.87	33.06	19.84
TOTAL	88.186	40.79	47.40	28.44

As mentioned earlier, the parting between the floor of conceptual pit up to seam IX through opencast mining and underground working in seam VIIB is only 10m to 20m. This parting will be disturbed in either case of mining first in this area. So the only possible recovery from seam VIIB is through development up to maximum thickness of up to 3.00m before the opencast mining is done in this area.

TABLE 15.14
EXTRACTABLE RESERVES IN DEVELOPMENT AND DEPILLARING AT RADHIKAPUR (WEST) COAL BLOCK (MT)

Seam	Net Available Reserve for UG	Total Blocked Reserves	Net Balance Reserves for (Free From Blockage)	Expected Mineable Reserves @60% of Balance Reserves Seam wise	Expected Extractable Coal Through Development	Expected Extractable Coal Through Dippilaring	Total extractable reserves
VIII TOP	1.84	1.84	0.00	0.00	0.00	0.00	0.00
VIIB	18.793	13.16	5.63	3.38	1.41	0.00	1.41
IVB	2.209	2.21	0.00	0.00	0.00	0.00	0.00
LOCAL2	3.687	3.68	0.00	0.00	0.00	0.00	0.00
IIIE	12.473	3.76	8.71	5.23	1.74	3.49	5.23
IIID	3.949	3.95	0.00	0.00	0.00	0.00	0.00
IIIA TOP	7.3	7.30	0.00	0.00	0.00	0.00	0.00
IIIA BOT.	37.935	4.87	33.06	19.84	6.61	13.23	19.84
Total	88.186	40.79	47.40	28.44	9.76	16.72	26.48

In the above table expected extractable reserves through development from seam VIIB are considered @25.5% of extractable reserves for development in pillar size 35mX35m. As the depillaring is not proposed in this seam due

to less parting, there will be no coal received from depillaring. For other two seams IIIE and IIIA(B), extraction through development will be @20.2% for pillar sizes 45mX45m. And rest of the coal will be won through depillaring. The final coal produced quantity from underground mining of Radhikapur (west) Coal Block will be 26.48 MT These reserves will be won from a pair of inclines named as Incline No. 1 & 2 in southern side of the block. The rated targeted production from underground mine is planned @ 0.70MTPA.

(ii) Mode of mine entry

Following considerations have been given while locating the main entry to the proposed mine.

1. The entry to be central, allowing access to both extremities and the majority of the reserves almost at equal distance on either side of the main entry.
2. The main entry should serve for the whole mine, if possible and support evacuation of the total extractable coal reserve on a long term economically.
3. The existing surface features should make it feasible to acquire land over adequate area for locating the basic infrastructure at the main mine entry.
4. The location of the Mine entry should facilitate maximum percentage extraction of the coal reserve and ensure minimum sterilization of coal to be left in barriers for protection of existing surface structures.
5. The location of the Mine entry should take advantage of existing infrastructure facilities like highways, power lines, drainage, roads, availability of water, and industrial development in the neighbourhood etc. to make operational costs optimum.
6. The coal transportation should be economical and take advantage of the existing infrastructure
7. The block includes multiple seams. The selection of main entry needs to take into consideration accessibility to various coal seams for mining to ensure highest overall percentage of extraction.
8. The adequacy of ventilation from single intake and return for all seams.

In view of the above facts that the access to the coal reserve is considered through inclines only. The strike length of the block is about 5 km. Though there are 8 seams (VIII TOP, VIIB, IVB, Local 2, IIIE, IIID, IIIA TOP and IIIA BOT.) but the mineable areas (>1.8m) are not symmetrical in all the seams on both sides and they are irregular. The seam IIIA BOT is occupied the workable area in almost half of northern part of the block whereas the seam IIIE and VIIB is workable in north eastern part only. Since the seam IIIA BOT. is the most potential seam, the entry is made in the almost centre of

the block from surface to this seam. The seam IIIE and VIIB will be connected to this seam through drifts at a rising gradient of 1 in 4.5.

Pair of Inclines will be opened up in the south central part at 45m apart named 1 & 2 Inclines. The stone drifts will be driven in 1 in 4.5 to touch coal. Length of loose earth will be totally excavated and properly designed concrete / brick wall sides and concrete roofing of size 4.5m X 3m at inclination of 1 in 4.5 will be done till drifting work in hard rock could be taken up and continued in the same size and the gradient till coal is touched. The lengths of Incline 1 & 2 will be 846m each. In addition to these, one ventilation incline with same specification will be also driven at 45m apart from these inclines and 100m away from block boundary.

(iii) Selection of underground mining technology

There are two primary methods of underground mining viz. Longwall and Bord & Pillar or Room & Pillar. Both the methods of mining are being practiced in India. The selection of the most suitable method of mining in Radhikapur (west) block is to be considered under the parameters prevailing at the block. These are summarized as below:

1. The depth range of occurrence of the workable coal Seams below seam IX for a thickness range of more than 1.8m in Radhikapur (west) block is 173m to 325m.
2. The geology of the block exhibits a simple structure with no faults, however presence of minor slips are not ruled out.
3. Only seam VII B, IVB, IIIE and IIIA B are workable seams by underground mining system.
4. The working thickness considered for the coal seams vary from 1.8m to 7.00m
5. The gradient of the coal Seams vary from 8° in the eastern part to 3° in the western part.

Longwall Method

- A globally recognized mining method with very high potential production rates up to 1 million tones per month (in China – with Western equipment).
- Some Seams can only be extracted by longwall method and most suitable for depths exceeding 450 m.
- High capital cost.
- High risk.
- Equipment is designed site specific and for a set of seam parameters and as such cannot be adopted easily for a different site.

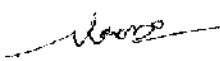
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- Very dependant upon excellent geological condition and mine infrastructure.
- Sophisticated system requiring strong management techniques and discipline.
- Requires very strict operator discipline.
- Not very successful in Indian applications in the past due mainly to unsuitable geological conditions.

Longwall technology is not essential for the mining parameters prevailing at Radhikapur (west) block considering depth range of the coal Seams is only 173m to 325m. Other geo-mining conditions and particularly highly varying thickness range of the coal seams are not favourable for application of longwall technology. As such longwall technology is not proposed for Radhikapur (west) coal block.

Bord & Pillar / Room & Pillar Technology

- Globally recognized method of mining and practiced in India over 200 year
- Mechanized Bord & Pillar method is highly productive mining method up to 120,000 tonnes per month in South Africa
- Very flexible system and can be designed and adopted in varying thickness range of the coal Seams or working below surface features.
- Easier to manage than longwall
- Much lower capital cost than longwall
- Low cost production / competitive with longwall
- Pillar extraction possible
- Very suited to Radhikapur (west) geological conditions


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Accordingly Bord & Pilar (B&P) or Room & Pillar (R&P) Methods are only proposed for Radhikapur (west) Coal block.

The seam IIIA (Bot.) is the highest potential seam of the Radhikapur (west) coal block with a strike length of 4 to 5KM in a width of 1.5 to 2 KM. The block is free from faults and mineable thickness ranges from 1.8m to 7.00m. The dip of the coal seams is 8°(1 in 7.11) in the eastern part to 3°(1 in 19.08) in the western part.

Because of the prevailing mining parameters mainly arising out of varying seam gradients geology, need for economic exploitation of the multiple seams with maximum percentage of extraction possible, optimum

production and productivity two proven B&P technology methods are considered suitable for application in Radhikapur (west).

1. Mechanized R&P method with application of continuous miner without blasting.
 2. Semi mechanized B&P method with application of blasting with explosives and LHD.
- Very successful and economic to date in Indian applications
 - Universal acceptance of the technology
 - Higher percentage of extraction both in first extraction and final extraction is achievable
 - More productive than any lonwall in India
 - Pillar extraction achieved successfully
 - Production levels being maintained till the life of the machine by involving manufactures in maintenance of the equipment
 - Huge potential to improve performance
 - Does not require blasting and as such better roof control
 - Since no blasting is required, this method is preferable in working underneath populated surface features like villages, highways etc.
 - Dispensation from DGMS have been available in India for developing coal seams with gallery widths up to 6.5m and heights up to 4.5m where mining conditions permit, thus allowing much higher percentage of extraction in first extraction which is particularly advantageous in developing coal seams below surface features like villages provided adequate long term factor of safety is maintained.

The disadvantages are

- Productivity decreases rapidly with increases in gradient above 1 in 5.5 and the limiting gradient is 1 in 4.
- The continuous miner equipment approved for use in India by DGMS has a working height range of 2m to 4.5m. For a different working height range, fresh approval will be required which may require some time.
- This method requires an adequately trained and competent term to operate and maintain the equipment and high level of management skill for effective utilization and optimum productivity.

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It is proposed to employ mechanized R&P technology for extraction of all seams in Radhikapur (west) coal block on contract mining basis to ensure highest economy and productivity throughout the life of the equipment. Though the maximum dip of the coal seams is 1 in 7.11, the panels will be developed along apparent dip direction to get the optimum gradient in almost all over the seams. The production equipment package will comprise of one continuous miner, two shuttle cars, one twin boom roof bolter equipment one LHD, one feeder breaker and associated electrical accessories. The equipment to be selected would have the specification to cover a seam height range in single lift varying from 1.80m to 3.5m (12CM12B) and 2.5m to 5m (12CM27D). The development will be carried out in a height range of seam thickness to maximum up to 3.00m. The DGMS has already approved the application of Continuous Miner in a thickness range of 2m to 4.50m for use in India. During depillaring it should be possible to extract up to a height of at least 0.5m with these equipment. The development may be carried with gallery height of up to 4.5 m and widths up to 6.5 m which may be permitted by DGMS under special dispensation allowed for mechanized extraction by CM in India. We are proposing the gallery size of 3.00m height and 4.8m width. The centre to centre pillar dimensions shall be as per CMR 99. The five heading dip drives will be also developed with continuous miner. The method of development and depillaring with Continuous Miner technology is discussed in detail later. The general specification of the equipment is given in para 5.6.

One set of continuous miner equipment package can achieve an annual production capacity from 0.30MTPA to 0.40 MTPA.

In this coal block, the winning of coal is proposed to be carried out with continuous miner technology. For the seam height above 5.5m winning in two lifts will be necessary. In such areas, the seam will be first development and then depillared in a height of 3m along the roof of the seam and the roof will be caved on the balance thickness of coal. After allowing about a year for the caved roof to consolidate, the seam will be developed along the floor of the seam leaving a parting of about 1.5 to 2m as may be permitted by DGMS, against the caved upper roof.

Support

In the mechanized R&P technology area, all the supports will be carried out with full column resin grouted roof bolts installed by mechanized roof bolter which is supplied as a part of the continuous miner package. Depillaring is also carried with resin roof bolts.

Scientific studies will need to be carried out to assess the support requirement and design by measurement for the pattern of roof bolting and their specifications. During both development and depillaring monitoring of effectiveness of supports will have to be carried out by actual measurements.

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the haulage to the equipment. This vehicle is also used to carry out electrical move ups of the load centre/transformer complex.

- One "Feeder/Breaker" mounted on tracks to size and feed the tipped coal from the shuttle car on to the conveyor at a consistent controlled rate. The feeder/breaker has a hopper sufficient to hold a complete shuttle car load. The shuttle car is capable of tipping at two speeds. With a feeder/breaker in the system the shuttle car can tip at high speed into the hopper, the feeder/breaker (or with just a breaker plate) then sizes the coal (possibly to 150mm) and feeds the conveyor at a controlled even rate thus preventing belt damage, maximizing conveyor capacity and allowing the shuttle car to travel back to the continuous miner for loading in the shortest time possible.
- Complete set of special maintenance tools with secure storage box.
- Hand tools, shovels, picks, brushes, pinch bars for scaling roof and an assortment of pulling, jacks and lifting tools.

Typical Development Mining Method

Strike Development

It is proposed that the "strike" or "near strike" development and bulk tonnage producing areas be mined by continuous miners and ancillary equipment where the face equipment is, installed, maintained and operated by the Contractor as described above. The standard layout consists of a five road development, with the main conveyor and feeder breaker positioned in the Central roadway {Plate XXVIA (FIG 1)}

Place Changing

Place changing is where the continuous miner cuts for a specific distance beyond the last row of support (up to a maximum 15m, called a "Place") using radio remote control of the continuous miner. The workforce at all times operates under supported roof. A lesser distance may be advanced depending on DGMS approvals. The time to cut a place is largely dependant upon the efficiency of shuttle car operation (wheeling"). Once a "Place" is cut the continuous miner is trammed to an adjacent heading to commence the cutting cycle over again. A roof bolting machine then supports the area mined by the continuous miner as a separate operation then the roadway is cleaned by LHD and ventilation extended in preparation for the continuous miner returning. The machines therefore operate independently and hence with greater flexibility for both cutting and roof bolting operations.

The work of the LHD cannot be understated. The quality of floor is one of the keys to success in place changing. A clean and well maintained floor provides a safer working environment, enables shuttle cars to operate at fast speeds, lessens the potential for cable damage and allows for unhindered continuous miner and bolter relocations.

Mining Geometry

The continuous miner typically have a cutting head 3.3m to 3.5m wide. The machine is usually "sumped in" between 0.5m and 0.75m at roof level, the rear stab jack on the machine lowered and the head sheared down to floor level. This cycle is repeated 3 to 4 times, the roof and floor trimmed and the operation repeated.

"Bord Width"- Indian Coal Mines Regulations restrict "bord", "room" or "roadway" width to a maximum of 4.8m. The continuous miner and all ancillary equipment proposed by JOY is able to operate at this dimension however productivity and safety around moving equipment is greatly enhanced with wider roads.

Since the coal is cut and not blasted, the pillar sides are far stronger. It is estimated that blasting effectively increases the bord width by at least 0.5m on each side of the drive due to the shattering effect of the explosives on the pillar sides. Blasting would therefore effectively create a bord width of 5.8m in a nominal 4.8m wide bord driven using drill and blast methods. It is proposed to work generally with a 6.0m bord width and to optimize the system based on the technical study by a scientific consultant and envisages that DGMS will be approached for an exemption to regulations to permit a bord width up to 6.5m wide.

The effect of increasing bord width would be to.

- Increase production and productivity of the mining system
- Improve safety of men and machines since there would be greater clearances for equipment to operate and for people to travel in the district.

Mining Height

Indian Coal Mines Regulations restrict the mining height during development to 3m. This is understandable for traditional systems of drill, blast and support where access to the roof for support and manual drilling holes etc. in thick seams is onerous and extremely difficult. With the equipment and systems proposed coal winning and support and achieved mechanically and can be undertaken safely and efficiently within the operating range of the equipment. The mining height should therefore be restricted by the operating range of the equipment which in most cases exceeds 3m. It is good practice to mine and support as one phase. Removal of support, particularly cement or resin grouted roofbolts is not possible without blasting. This then further weakens the roof and exposes the work force to unnecessary exposure to unsupported roof.

The impact on strata control of working at increased height will be assessed by the scientific consultant and the contractor envisages that the DGMS will be approached for exemption to permit the mining height during the

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development phases be restricted by the operating range of the equipment or seam height whichever is greater.

Pillar Dimensions

Indian Coal Mines Regulations define pillar dimensions in terms of depth of workings and bord width. In the case where the bord width is 4.8m the distance between the centres of any two adjacent pillars shall not be less than:

Depth	Centres
Not exceeding 60m	19.5m
Exceeding 60m but not exceeding 90m	21.0m
Exceeding 90m but not exceeding 150m	24.5m
Exceeding 150m but not exceeding 240m	34.5m
Exceeding 240m but not exceeding 360m	45.0m
Exceeding 360m	48.0m

It is likely that the continuous miner will be operating at depths around 173 to 325m. The pillar sizes, under current Indian regulations should therefore be 34.5m to 45.0m (centre to centre) with 4.8m bord width to comply with the Indian Coal Mines Regulations. Scientific studies and practices to date in India indicate that the legislated design criteria are very conservative. These pillar dimensions are considered excessive for the desired Factor of Safety and the contractor envisages that application will be made to DGMS to reduce the pillar dimensions in order to increase the productivity of the purposed system. Optimization of the bord width, mining height and pillar sizing may be carried out by calculating and using safety factors from established formulae.

Typical method of support

A typical support system consists of 4 X 1.8m full column resin grouted roofbolts, the roofbolts being installed and tensioned by the roofbolter. It is anticipated that with bord widths exceeding 4.8m an additional bolt would be required.

Pillar extraction generates additional roof stresses and the additional support applied before bed separation can take place, during the development phases, would be beneficial in the long term.

It is necessary that Coal Company retain the responsibility for the management the legal aspects of the mine. It is therefore the responsibility of Coal Company to ensure that any support system suggested by the contractor is adequate and approved by the DGMS.

Typical Pillar Extraction Methods

Pillar removal plans are an important part of the continuous miner operations and must be fully considered prior to the mining of the advancing panel. There are many different methods of pillar removal and these must be assessed to determine the most appropriate to suit the conditions at the mine. This requires full assessment of the mining height, depth, roof strata, floor strata, immediate roof and floor properties, rib stability, pillar size and roadway width. All continuous Miners supplied to India have radio remote control operation ensuring that the operators are always standing in a place of safety under fully supported ground, some 15 to 30 meters behind the working face. The Mine Managers safety and mining rules should specify where the operators must position themselves.

The size of pillar and the roadway width depends on the depth and geological conditions, as well as the proposed method of de-pillaring. The safety factors, method of operation and layout of de-pillaring have a marked effect on the choice of roadway width and pillar size on development.

Knowledge of the composition of the overburden is important in deciding whether to carry out retreat mining. This affects pillar dimensions, roof control plans and selection of the technique. The overburden should be strong enough, given the pillar sizes and temporary support, to allow the development work to be carried out safely, yet weak enough to fall at the proper time during retreat. If this is not the case, then variations to the pillaring plan, such as increasing or decreasing pillar dimensions or utilizing a different sequence of cuts must be employed.

The composition of the floor under the coal is another important consideration. The floor is often weaker than the roof and if mixed with water can create mud and poor mining conditions. Plastic flow of the floor can cause instability in the pillars. A full geological survey and interpretation of the conditions is necessary to establish the pillar sizing, roadway width and retreat mining sequence of extraction.

The seam gradient is another factor that requires careful consideration, with slight grades affecting haulage effort and time for operations, which in turn affects the productivity. Also the gradient may have an effect on the shape of the pillars and layout and direction of the panel with main working along the line of strike and cross cuts angled to reduce the angle of apparent dip.

There are many different methods of pillar removal and these must be assessed to determine the most appropriate to suit the conditions at the mine. Typical layouts for Depillaring are shown in Fig 2, 3 and 4 in Plate XXVIA.

Operating Methods for De-pillaring

The standard operating method in India is to fully develop the panel, with typically 5 entries on advance, to the panel boundary. At the boundary, the

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panel may be connected to other 'bleeder' ventilation roadways depending on the mine layout. Height of development and extraction is usually the full seam section or 4.6m (the maximum extraction height of the only approved continuous miner operating in India).

During retreat from the panel, the pillars are split (either a single split as in Fig 2 or two splits as in Fig 3 (Plate XXVIA), depending on panel size and caving conditions) and extracted on their side or at angles to take the ribs in an arranged and safe extraction method. Extra roofbolting is used at the edges of the pillars to provide an effective 'breaker line' and ensure that after the extraction sequence is complete the roof collapses in a controlled manner up to the roof bolt breaker line.

In poor ground conditions different methods of pillar extraction or partial pillar extraction, such as the Nevid method, as in Fig 4 (Plate XXVIA), may be more appropriate. This method has been extensively used in South Africa and allows a series of cuts into the pillar sides in a sequential manner ensuring minimum tramming distances for the continuous miner and improved safety for the operator. Depending upon the depth and width of the cuts, the central core of the pillar is also kept intact, resulting in a higher factor of safety and better control of caving in areas of weak roof.

During retreat mining/pillar removal the aim is to keep active working places (where the continuous miner is operating) away from the caved areas. Also the length of time that openings are maintained must be kept to a minimum and workplaces should be concentrated in a limited area.

The infrastructure, conveyors, material transport system, power, water, pumping and ventilation are in place from the development phase.

The same equipment is required for pillar extraction as for development.

Pillar extraction techniques may follow the traditional 45° "steeping" line, or the preferred straight line method employed with continuous miners.

Two pillars are mined simultaneously using either system.

The disadvantage of the traditional "45° System" with FULLY mechanized equipment is the creation of excessive tramming distances which effectively restricts production.

The protection afforded by the 45° line was originally developed for a hand loading scenario due to the long time period the pillar had to stand whilst being extracted and the number of working places required by the cyclic, drill, blast and hand load method.

The straight line method reduces both tramming distances and cable lengths to a minimum whilst optimizing tramming routes.

Percentage extraction

The "IN PANEL" extraction is estimated with both the 45° and straight line methods as shown above to typically be 80% by area, this may increase by "robbing snooks" (pillar remnants) whilst retreating from the pillar.

Conveyor

A 1000mm "fire resistant" conveyor at around 3m/s with a duty equivalent to average 500 tonnes per hour (tph) should be installed in the centre roadway to ensure equal tramming distances and cable lengths on each side of the loading point. Peaks of 750 tph are expected.

The conveyor should be equipped with a look take-up at least of sufficient capacity to hold belt stretch for one week and preferably to hold one roll (usually 300m) of conveyor belting for extension and retreat of the conveyor.

At the inbye end of the conveyor, a sledge mounted and guarded return pulley frame, graduated loading section (at least 3m in length) equipped with impact rollers, and anchor chains should be provided.

The "head" end of the conveyor should be equipped with a suitable loading section on to the trunk conveyor, dust suppression equipment, belt alignment, belt slack and belt slip detectors. The "gate" belt should be electrically interlocked with the "trunk" conveyor to automatically stop the gate belt should the trunk belt stop.

Communication and continuous signaling and "stop pulls" should be provided along the length of the conveyor. The conveyor should also be provided with an effective bottom belt scrapper.

One side of the conveyor should be designated as the "man walkway" into the district. To prevent "Tripping and Falling" accidents, this walkway should be kept clear of any supplies, materials, be clean, level and well illuminated.

District materials should not as far as possible be transported along the conveyor belt route.

Material transport

Materials such as timber, roof bolts, grouts/resins, spare parts, cables, lubricants, ventilation stopping materials etc. are to be transported by the mine to within one split of the gate belt "tail end".

It is proposed that a method is used with which the mine is familiar such as an endless rope haulage system using 15 kg track with a 0.6m gauge. The track and return wheel should lag no more than 2 pillars behind the conveyor tail end.

Production from underground mines

The production from one continuous miner will be 0.30 (12CM12B) to 0.4 MTPA (12CM27D). There will be two continuous miners operational at any time with following capacity.

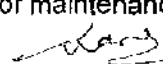
Production from one set of JOY 12CM12B standard	=	0.30MTPA
Production from one set of JOY 12CM27D standard	=	0.40MTPA
Total	=	0.70MTPA

The main dip drives will be also driven with continuous miners. All the workable seams will be developed and depillared with continuous miners along with two shuttle cars in each set of continuous miner. Accordingly, this mining plan has proposed 0.70 MTPA production from underground mining which will be easily achieved.

List of equipments

The following are the main equipments required for fully mechanised bord and pillar method deployed with Continuous Miner in Table 15.15 at Radhikapur (west) East Coal block.

**TABLE 15.15
EQUIPMENT CONFIGURATION FOR FULLY MECHANISED PANEL**

Sl. No.	Name of Equipment	No.	Broad Specification	Remark
1.	Continuous Miner	2	Remote controlled	Brief technical specification are enclosed
2.	Shuttle Cars	4	2.5cum capacity	Brief technical specification are enclosed
3.	Twin Mast Roof Bolter	2	Rotary wet flush drilling	Brief technical specification are enclosed
4.	Electric cable reel with LHD	2		This is essential for efficient panel operation and shifting of materials.
5.	Feeder/Breaker	2	Crushing coal - 150mm	Brief technical specification are enclosed
6.	Load centre and transformer	2	3.3kV/1130 V 1500kVA TX	Brief technical specification are enclosed
7.	Special Maintenance tools along with Hand tools, shovels, picks, brushes, pinch bars & jacks etc.	Complete Set with secure storage box for each miner	-	Required for maintenance  श्री. एस. जे. सिंह ज्येष्ठ सॉल्यूशंस कोयला, मंत्रालय/Ministry of Coal सरकार/GOVT. OF INDIA दिल्ली/NEW DELHI

Year wise development during initial years

The open cast workings are first started and underground activities are started in 8th year. Accordingly the combined calendar programme is envisaged for Radhikapur (west) Coal Block. The year wise major activities

at Radhikapur (west) Coal Block will be as under (Refer Plate XXVII to XXXIC for 1st 5 years of underground mining):

1st to 2nd Year of underground mining or 9th to 10th year of mining operation:

The pair of Inclines No. 1 & 2 along with ventilation Incline will be started @ 35m per month. Both the inclines and ventilation Incline will touch the floor of seam IIIA (Bot) in 24 months.

3rd Year of underground mining or 11th year of mining operation:

Drivage in coal seam IIIA (Bot) in four heading by Continuous Miner in a section 4.8 X 3m will be undertaken for a duration of about 8 months. The production starts from this seam in 11th year by development of four heading dip drives. Though it is planned to get 0.30 MTPA from this pair of inclines but we may get only 0.20 MT in 3rd year of underground mining (11th year of overall mine operation). During the last 4 months of this year, drivage of crossmeasure drift will be started from seam IIIA(Bot) towards seam IIIE at 4.5:1 gradient. Sinking operation of ventilation shaft will also start from 10th month of this year

4th Year of underground mining or 12th year of mining operation:

During the 4th year of underground operation, drivage of crossmeasure drift will be advanced from seam IIIA(Bot) towards seam IIIE at 4.5:1 gradient and further continued and completed upto the upper seam VIIB. A production of 0.52 MT will be achieved by 2 CMs from seam IIIA(B). The sinking operation of ventilation shaft will be completed at the end of this year and it will touch seam VIIB.

5th Year of underground mining or 13th year of mining operation:

Drivage in less than 1.8m thickness coal to connect the other workable patch (west side) in seam VIIB in a section 4.8m X 2m will be started during this year which will be completed upto half of its length (total length 1163.). Coal production of 0.70 MT will be achieved by 2 CMs from seam IIIA(Bot.).

The Conceptual stage plan at the end of 9th year can be seen in Plate XXXIIA for Seam VIIB. Further stage plans for this seam are not shown as the life of this seam is 9th year.

Conceptual stage plan at the end of 14th year can be seen in Plate XXXIIB for Seam IIIE. Further stage plans for this seam are not shown as the life of this seam is 14th year.

15th, 25th, 35th year stage plans can be seen in Plate XXXIII to XXXV for Seam IIIA and Conceptual stage of this seam (41st year) is given in Plate XXXVI.

15.6.3 Calendar programme of underground production

The coal production from underground mining envisaged as per the following calendar programme is given in Table 15.16.

TABLE 15.16
CALENDER PROGRAMME FOR COAL PRODUCTION FROM UNDERGROUND MINES

YEAR OF OVERALL MINE OPERATION	YEAR OF UG MINE OPERATION	SEAM IIIA BOT.			SEAM IIIE			SEAM VII B			TOTAL	
		DEV	DEP	TOTAL	DEV	DEP	TOTAL	DEV	DEP	TOTAL	DEV	TOTAL
1.		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2.		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3.		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6.		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7.		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8.		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9.	1											
10.	2											
11.	3	0.200	0.000	0.200	0.000	0.000	0.000	0.000	0.000	0.000	0.200	0.200
12.	4	0.400	0.000	0.400	0.120	0.000	0.120	0.000	0.000	0.000	0.520	0.520
13.	5	0.333	0.000	0.333	0.300	0.000	0.300	0.067	0.000	0.067	0.700	0.700
	SUB TOTAL OF 1ST 5 YEARS	0.933	0.000	0.933	0.420	0.000	0.420	0.067	0.000	0.067	1.420	1.420
14.	6	0.000	0.000	0.000	0.300	0.000	0.300	0.400	0.000	0.400	0.700	0.700
15.	7	0.000	0.000	0.000	0.300	0.000	0.300	0.400	0.000	0.400	0.700	0.700
16.	8	0.000	0.000	0.000	0.300	0.000	0.300	0.400	0.000	0.400	0.700	0.700
17.	9	0.000	0.000	0.000	0.300	0.257	0.557	0.143	0.000	0.143	0.443	0.257
18.	10	0.000	0.000	0.000	0.120	0.580	0.700	0.000	0.000	0.000	0.120	0.580
19.	11	0.000	0.000	0.000	0.000	0.700	0.700	0.000	0.000	0.000	0.000	0.700
20.	12	0.000	0.000	0.000	0.000	0.700	0.700	0.000	0.000	0.000	0.000	0.700
21.	13	0.000	0.000	0.000	0.000	0.700	0.700	0.000	0.000	0.000	0.000	0.700
22.	14	0.147	0.000	0.147	0.000	0.553	0.553	0.000	0.000	0.000	0.147	0.553
23.	15	0.700	0.000	0.700	0.000	0.000	0.000	0.000	0.000	0.000	0.700	0.700
	SUB TOTAL OF 6 TO 15 YEARS	0.847	0.000	0.847	1.320	3.490	4.810	1.343	0.000	1.343	3.510	7.000
24.	16	0.700	0.000	0.700	0.000	0.000	0.000	0.000	0.000	0.000	0.700	0.700

[illegible]

15.6.4 Combined calendar programme of production

The Radhikapur (west) coal mining block is proposed for both underground as well as open cast mining. The cumulative coal production will be as per the following combined calendar programme:

TABLE 15.17
COMBINED CALENDAR PROGRAMME OF COAL PRODUCTION

Year	Opencast Coal (MT)	OB Cum	Ratio	Underground Coal (MT)	Total OC & UG Coal (MT)
1	0.30	3.08	10.26		0.3
2	1.80	7.67	4.26		1.8
3	3.30	14.29	4.33		3.3
4	4.80	26.26	5.47		4.8
5	6.00	25.94	4.32		6
6	6.00	24.84	4.14		6
7	6.00	24.18	4.03		6
8	6.00	23.52	3.92		6
9	6.00	23.52	3.92	Start of Inclines	6
10	6.00	23.52	3.92	Driving incline	6
11	5.80	22.75	3.92	0.20	6
12	5.48	21.52	3.93	0.52	6
13	5.30	22.79	4.30	0.70	6
14	5.30	22.79	4.30	0.70	6
15	5.30	22.79	4.30	0.70	6
16	5.30	22.79	4.30	0.70	6
17	5.30	22.79	4.30	0.70	6
18	5.30	22.79	4.30	0.70	6
19	5.30	22.79	4.30	0.70	6
20	5.30	22.79	4.30	0.70	6
21	5.30	22.79	4.30	0.70	6
22	5.30	22.79	4.30	0.70	6
23	5.30	22.79	4.30	0.70	6
24	5.30	22.79	4.30	0.70	6
25	3.95	8.91	2.26	0.70	4.65
26	0	0	0	0.70	0.7
27	0	0	0	0.70	0.7
28	0	0	0	0.70	0.7
29	0	0	0	0.70	0.7
30	0	0	0	0.70	0.7
31	0	0	0	0.70	0.7
32	0	0	0	0.70	0.7
33	0	0	0	0.70	0.7
34	0	0	0	0.70	0.7
35	0	0	0	0.70	0.7
36	0	0	0	0.70	0.7

Year	Opencast Coal (MT)	OB Cum	Ratio	Underground Coal (MT)	Total OC & UG Coal (MT)
37	0	0	0	0.70	0.7
38	0	0	0	0.70	0.7
39	0	0	0	0.70	0.7
40	0	0	0	0.70	0.7
41	0	0	0	0.70	0.7
42	0	0	0	0.70	0.7
43	0	0	0	0.70	0.7
44	0	0	0	0.70	0.7
45	0	0	0	0.70	0.7
46	0	0	0	0.70	0.7
47	0	0	0	0.70	0.7
48	0	0	0	0.70	0.7
49	0	0	0	0.56	0.56
Total	125.03	523.48	4.19	26.48	151.51

Mineral beneficiation

The coal produced at mine will be washed before dispatch so provision has been made for coal washery in the block area.

15.7 CLOSURE PLAN

15.7.1 Mined out land

i. Land degradation control measures

Land degradation is one of the major adverse outcomes of opencast mining activities and any effort to control adverse impacts is considered incomplete when appropriate land reclamation strategy is not adopted. Since the land degradation in this mine is partly in the form of excavated void and partly in the form of internal dumps, the reclamation strategy must include a programme for the reclamation of the disturbed land.

The land use during mining is given below in Table 15.18.

TABLE 15.18
LAND USE DURING MINING (AT THE END OF 25TH YEAR)

Sl. No.	Particulars	Area	Plantation	Void	Company use Use	Bund	Undisturbed/ Indirectly affected
1.	OC mine pit area	750.92	596.81	154.11	0	0	0
2.	Washery	10	0	0	10	0	0
3.	OB dump	100	100	0	0	0	0
4.	Top soil stack	5	0	0	5	0	0
5.	Raw coal stack	7	0	0	7	0	0
6.	Facility area including inclines	10	0	0	10	0	0

Sl. No.	Particulars	Area	Plantation	Void	Company use Use	Bund	Undisturbed/ Indirectly affected
	and shaft						
7.	CHP	1	0	0	1	0	0
8.	Washed coal stack	6	0	0	6	0	0
9.	Green belt	16.75	16.75	0	0	0	0
10.	Settling pond	5.5	0	0	5.5	0	0
11.	Reject	2	0	0	2	0	0
12.	Road	12	0	0	12	0	0
13.	Bund	15.7	0	0	0	15.7	0
14.	Magazine	0.2	0	0	0.2	0	0
15.	Undisturbed/indirectly affected area	105.93	0	0	0	0	105.93
Total block area		1048	713.56	154.11	58.7	15.7	105.93

TABLE 15.18A
LAND USE AFTER OC MINE CLOSURE (25+3=28 YEARS)

Sl. No.	Particulars	Area	Plantation	Void	Company use Use	Bund	Undisturbed/ Indirectly affected
1.	OC mine pit area	750.92	596.81	154.11	0	0	0
2.	Washery	10	0	0	10	0	0
3.	OB dump	100	100	0	0	0	0
4.	Top soil stack	5	5	0	0	0	0
5.	Raw coal stack	7	0	0	7	0	0
6.	Facility area including inclines and shaft	10	0	0	10	0	0
7.	CHP	1	0	0	1	0	0
8.	Washed coal stack	6	0	0	6	0	0
9.	Green belt	16.75	16.75	0	0	0	0
10.	Settling pond	5.5	0	0	5.5	0	0
11.	Reject	2	0	0	2	0	0
12.	Road	12	0	0	12	0	0
13.	Bund	15.7	0	0	0	15.7	0
14.	Magazine	0.2	0	0	0.2	0	0
15.	Undisturbed/ indirectly affected area	105.93	0	0	0	0	105.93
Total block area		1048	718.56	154.11	53.7	15.7	105.93

a) Mined area reclamation

The lessee will take necessary steps to keep the area under disturbance at any stage of mining operation to a minimum. This can be achieved by carrying out the reclamation programme simultaneously with excavation. The gap can be reduced between degradation and the reclamation by this programme. The post mining land use of core zone shows that all the disturbed areas will be reclaimed before abandoning the mine excluding the void.

b) Reclamation procedure

Reclamation procedure has been described stage wise in the following paragraphs. Year wise reclamation programme is as shown in Table 15.19.

**TABLE 15.19
RECLAMATION PROGRAMME OF EXCAVATED AND
BACKFILLED AREA (CUMULATIVE)**

Up to the end of Year	Area mined (Ha.)	Backfilled area (Ha.)	Total Planted area (Ha.)
1 st	17.22	0.000	0.00
2 nd	47.88	0.000	4.00
3 rd	105.47	17.480	4.50
4 th	172.55	44.390	14.22
5 th	256.20	106.900	14.22
15 th year	600.20	293.52	357.71
Conceptual (25 year)	750.92	596.810	730.31

ii. Post reclamation land use

The first step in a successful reclamation programme is to decide the post reclamation land use. The post mining land use with environment management is given in Table 15.20.

**TABLE 15.20
POST MINING LAND USE (CLOSURE YEAR 49+3=52) WITH
ENVIRONMENT MANAGEMENT WITHIN ML HA)**

Sl. No.	Particulars	Area	Plantation	Void	Public Use	Bund	Undisturbed/ Indirectly affected area
1.	OC mine pit area	750.92	596.81	154.11	0	0	0.00
2.	Washery	10.00	10	0	0	0	0.00
3.	OB dump	100.00	100.00	0	0	0	0.00
4.	Top soil stack	5.00	5	0	0	0	0.00
5.	Raw coal stack	7	7	0	0	0	0.00
6.	Facility area including inclines and shaft	10	7	0	3	0	0.00
7.	CHP	1.00	1	0	0	0	0.00
8.	Washed coal stack	6.00	6	0	0	0	0.00
9.	Green belt	16.75	16.75	0	0	0	0.00
10.	Settling pond	5.50	5.5	0	0	0	0.00
11.	Reject	2.00	2	0	0	0	0.00
12.	Road	12.00	8	0	4	0	0.00
13.	Bund	15.7	0	0	0	15.7	0.00
14.	Magazine	0.20	0.2	0	0	0	0.00
15.	Undisturbed/indirectly affected area	105.93	0	0	0	0	105.93
Total block area		1048.00	765.26	154.11	7	15.7	105.93

* Note: The OC mine exhausts at the end of 25th year and the OC mine closure concludes at the end of 30th year. The above table shows position at the end of 52nd year when UG mine closure also concludes

In case of this mine, it would be appropriate to restore the lands to the original land use to the extent possible due to following reasons:

Whole of the excavated area is proposed to be developed into a picnic spot due to the formation of water body created as a result of the left out void. The water body will be used for irrigation, watering the forest at earlier stages and it will also attract avifauna. The plan showing mine closure at the abandoned stage is given Plate XXII.

iii. Afforestation

a) Compensatory afforestation

Compensatory plantation will be provided in line with the prevailing rules of forest department.

b) Plantation during mining

A plantation program over life of the mine has been planned in a phase wise manner. The plantation will be started from first year of mining along the boundary of ML area. A 7.5 m width of green belt development around the ML area will be carried out and more width of green belt will be taken up wherever space is available. Plantation over backfilled area will be commenced from 2nd year of mining. A thick plantation is proposed to be provided and maintained around the mining area and along the roads. The yearly requirement of plants during the various years and stages of the mining project is as shown in the Table 15.21.

TABLE 15.21
REQUIREMENT OF PLANTS
(PROGRESSIVE YEAR/STAGE WISE AND LOCATION WISE)
(A) AT THE END OF 28TH YEAR (POST MINE CLOSURE OF OC MINE =25+3 YEARS)

Year	Area (Ha.)						No. of trees @ 2500/Ha
	Green belt	Surface dump	Backfill	Facilities + CHP+ Washery + magzine	Settling pond + Stacks of TS, coal, reject + coal stacks+ Road	Total	
1 st year	3.35	0	0	0	0	3.35	8375
2 nd year	3.35	4	0	0	0	7.35	18375
3 rd year	3.35	0.5	0	0	0	3.85	9625
4 th year	3.35	9.72	0	0	0	13.07	32675
5 th year	3.35	0	0	0	0	3.35	8375
15 th year	0	85.78	257.71	0	0	343.49	858725
{16 to (25+3)} year)	0	0	339.10	0	5.0	344.10	860250
Total	16.75	100	596.81	0	5.0	718.56	1,796,400

(B) AT THE END OF 52ND YEAR (POST MINE CLOSURE OF UG MINE =49+3 YEARS)

Year	Area (Ha.)						No. of trees @ 2500/Ha
	Green belt	Surface dump	Backfill	*Facilities + CHP + Washery + magazine	**Settling pond + Stacks of TS, coal, reject + coal stacks + Road	Total	
1 st year	3.35	0	0	0	0	3.35	8375
2 nd year	3.35	4	0	0	0	7.35	18375
3 rd year	3.35	0.5	0	0	0	3.85	9625
4 th year	3.35	9.72	0	0	0	13.07	32675
5 th year	3.35	0	0	0	0	3.35	8375
15 th year	0	85.78	257.71	0	0	343.49	858725
Conceptual (52 year)	0	0	339.10	18.2	33.5	390.8	977000
Total	16.75	100	596.81	18.2	33.5	765.26	1913150

* (18.2 Ha=7 Ha facility +1 ha CHP+10 ha washery+0.2 ha magazine)

** (33.5 Ha =5 TS+7 Coal+6 Coal+2 Rejects+5.5 Set Pond+8 ha road)

To fulfil the requirements of nursery plants, a nursery will be established at the site. During peak requirements, additional plants will be transported from Govt. / Forest nurseries, located around the area. The common species used for plantation in the region are Sal, Mahua, Gulmohar, Neem, Siris, Acacia, Casuarina, Pongamia, Mango, China-rose, Kaner, etc.

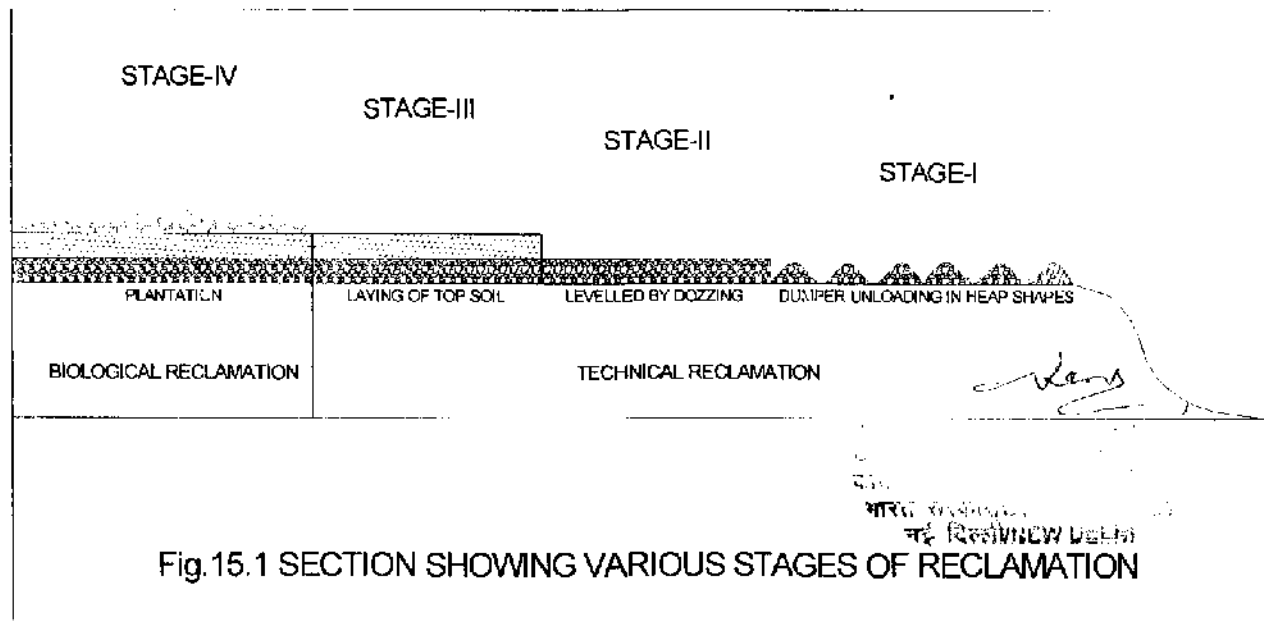


Fig.15.1 SECTION SHOWING VARIOUS STAGES OF RECLAMATION

15.7.2 Water quality management

Brahmani river, flowing approximately north to south direction along the eastern boundary of the Talcher coalfield, provides the main drainage of the region. This river is fed by seasonal nalas, viz., Tikra Jhor, Singhada Jhor,

Bangaru Jhor, Nandira Jhor and a few other nalas. From the eastern boundary of Radhikapur (West) Coal Block, the Brahmani river lies eastwards at a distance of about 35 km.

Singhada Jhor flows eastwards in the eastern and northern extremities of the block and forms the eastern and northern boundary of the block as well. The Singhada Jhor merges in its down stream into Brahmani river at the north eastern part of the coalfield. Nuabanda nala, which forms the eastern boundary of the block, flows into Singhada Jhor at the north-eastern corner of the block and controls the drainage pattern of the block. Nuabanda nala originates from a large water body at the south-central part of the block. The water collected within the water body are being utilized for irrigation and other purposes by the local villagers during dry seasons.

Small ponds and dug wells are common in this block and are utilized as well for irrigation and drinking purpose. Morrum and mud roads are very common in and around villages within the block, viz. Nuapada, Kushila and Barpada.

a) Water balance

Total requirement of water for mining and allied activities are estimated as 1581 m³/day which includes 1024 cum per day industrial water. The requirement of water for drinking purpose @ 557 CUM/day will be met from borewell initially and later from the treated mine water. The water requirement for other purposes will be met from mine sump and surface water reservoir. The break up of the required water for different activities is as follows:

TABLE 15.22
BREAK UP OF THE REQUIRED WATER FOR OC AND UG OPERATIONS

Underground Spraying (after blasting (not common), conveyor transfer points etc)	=	10.00
Underground water requirement for continuous miner @ 250 lpm/machine for 2 units assuming 50% effective operational time	=	360
Fire water makeup	=	10.00
Plantation @ 15 cum/ hac for 30 hac.=450- recirculated water from colony STP 276=174 CMD	=	174.0
Vehicles washing @ 2.0 m ³ /vehicle/day for 30 vehicles, considering 50% recirculation	=	30.00
Coal washery	=	440
Drinking at working place @ 45 lpd/head for 1702x45LPD	=	77.00
For colony (total manpower in mine 1702 of which colony provision has been made for 50% i.e. 851x 135lpd x4 members =460	=	460
For peripheral villages (potable)	=	20.00
Total KL Per Day	=	1581

b) Effluent from mine

No acid mine drainage is anticipated based on the experience of mines in the similar geological conditions.

- i. To prevent surface and ground water contamination by oil/grease and sewage waste, following control measures are proposed to be implemented:
 - Leak proof containers will be used for storage and transportation of oil/grease. In the store also, the container containing oil/grease will be kept in empty safe open containers of higher volume than the containers to avoid oil/grease spillage. The area over which oil/grease is handled will be kept effectively impervious. Any wash off from the oil/grease handling area or workshop will be drained through impervious drains, collected in specially constructed pit and treated appropriately to remove any oil/grease and the water will be recycled. The oil grease will be sold to authorized vendors and sludge disposed off in specially constructed pit.
 - The sewage waste generated will be drained by underground impervious drains, lead to appropriately designed septic tanks and soak pits to prevent any pollution of surface or ground water.
- ii. The surface and ground water in and around the mine, loading plant and infrastructure will be regularly tested and appropriate control measures adopted in case of any pollutant is detected above the prescribed limit.
- iii. All stacking and loading areas will be provided with proper garland drains equipped with baffles to prevent wash offs from reaching the downstream natural channels.
- iv. A domestic waste water treatment plant will be provided in colony so that the water after treatment can be reused.

c) *Storm water*

Control measures to be adopted are briefly discussed below.

- Check dams will be provided to prevent solids from wash off and screen if any from the mine related activities.
- Peripheral bunds will be erected on the outer edge of the abandoned benches before reclamation so that the soil is not carried away by storm water.
- A water gradient of about 1 in 100 will be kept at every bench towards inside of the bench to prevent formation of gullies in the bench slopes causing serious erosion.
- Chutes will be constructed by using local stone or masonry to guide the water in areas with loose soil to prevent erosion and uncontrolled descent of water wherever necessary.

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- Construction of garland drains around freshly excavated and dumped areas so that flow of water with loose material is prevented. The mine water will be passed through specially constructed settling ponds to arrest any loose material being carried away with water.
- Any areas with loose debris within the lease hold will be planted.

d) Measures to minimise adverse effects on water regime

During the process of mine rehabilitation and with the completion of backfilling, a water body will be created in the mined out pit which will act as water reservoir improving the ground water recharge, source of attraction for fauna and will help in the maintenance of afforested areas. To enhance aesthetic appearance, parks and lawns will be made around the water body.

15.7.3 Air quality management

i. Air quality

Ambient air quality monitoring was undertaken at 8 different stations within the study area during winter season (March to May 2010). The location details are given in Table 15.23 and analysis results with respect to SO₂, NO_x and SPM are summarised in Table 15.24, while the air quality monitoring locations are shown in Key Plan. Respirable particulate matter measurements have been made at core zone during monitoring period.

**TABLE 15.23
AMBIENT AIR QUALITY MONITORING LOCATIONS**

Name	Location	Distance	Direction
CA1	Core Zone	Adjoining	-
BA1	Kisinda	3.1	W
BA2	Palsabani	1.2	WNW
BA3	Nuapada	0.2	W
BA4	NE of Jhintipal	0.6	E
BA5	Putgaria	1.5	S
BA6	Gopiballabhpur	3.3	E
BA7	Dubanali	0.4	NW

The monitoring results are given in Table 15.24.

**TABLE 15.24
AMBIENT AIR QUALITY DURING SUMMER SEASON**

Location	Minimum	Maximum	Mean	75 Percentile	98 Percentile	Standard
SPM						
Kisinda	76	130	108.96	119.75	129.50	200
Palsabani	88	136	110.23	118	133	200
Nuapada	76	135	109.23	123.50	134	200

Location	Minimum	Maximum	Mean	75 Percentile	98 Percentile	Standard
NE of Jhintipal	68	132	105.08	120.75	130.75	200
Putgaria	68	142	104.15	121.25	137	200
Gopiballabhpur	73	156	116.69	129.50	146	200
Dubanali	66	138	98.38	108.25	135	200
Kuskila village (Core Zone)	85	131	108.12	117.25	128	200
RSPM						
Kisinda	40	69	55.77	62	67.50	100
Palsabani	46	66	56.96	61.75	65.50	100
Nuapada	38	72	54.85	60.00	70.50	100
NE of Jhintipal	35	69	55.31	62.75	69	100
Putgaria	40	69	55.04	60.75	68	100
Gopiballabhpur	36	72	60.35	66	71	100
Dubanali	32	73	54	60.75	72.50	100
Kuskila village (Core Zone)	46	66	57.42	61	65.50	100
NO_x						
Kisinda	9.20	13.70	11.14	12.20	13.55	80
Palsabani	9.50	13.7	11.18	12.03	13.65	80
Nuapada	9.80	13.80	12.07	12.50	13.65	80
NE of Jhintipal	9.50	13.80	11.47	12.08	13.40	80
Putgaria	9.00	12.00	10.22	10.73	11.80	80
Gopiballabhpur	10.00	13.80	12.18	12.88	13.65	80
Dubanali	9.00	12.00	9.63	10	11.60	80
Kuskila village (Core Zone)	9.00	12.40	10.17	10.78	12.25	80
SO₂						
Kisinda	BDL	BDL	BDL	BDL	BDL	80
Palsabani	BDL	BDL	BDL	BDL	BDL	80
Nuapada	BDL	BDL	BDL	BDL	BDL	80
NE of Jhintipal	BDL	BDL	BDL	BDL	BDL	80
Putgaria	BDL	BDL	BDL	BDL	BDL	80
Gopiballabhpur	BDL	BDL	BDL	BDL	BDL	80
Dubanali	BDL	BDL	BDL	BDL	BDL	80
Kuskila village (Core Zone)	BDL	BDL	BDL	BDL	BDL	80
CO						
Kisinda	BDL	BDL	BDL	BDL	BDL	4 mg/m ³

Location	Minimum	Maximum	Mean	75 Percentile	98 Percentile	Standard
Palsabani	BDL	BDL	BDL	BDL	BDL	4 mg/m ³
Nuapada	BDL	BDL	BDL	BDL	BDL	4 mg/m ³
NE of Jhintipal	BDL	BDL	BDL	BDL	BDL	4 mg/m ³
Putgaria	BDL	BDL	BDL	BDL	BDL	4 mg/m ³
Gopiballabhpur	BDL	BDL	BDL	BDL	BDL	4 mg/m ³
Dubanali	BDL	BDL	BDL	BDL	BDL	4 mg/m ³
Kuskila village (Core Zone)	BDL	BDL	BDL	BDL	BDL	4 mg/m ³

As is apparent from the analytical data, the ambient air quality in the region is well within the standards specified as per the Air (Prevention & Control of Pollution) Act, 1981.

However, air quality may come under a little pressure after commencement of the proposed mechanized mining operations, unless ameliorative measures are taken to control dust.

Although all pollutants are generated during blasting and while operating diesel equipment, these will be kept at minimum levels by ensuring good blast design and good equipment maintenance. Adequate arrangement for water sprinkling has been foreseen to prevent and suppress dust due to mining and transportation. Part of the operations are proposed to be by UG method which are comparatively less polluting.

The control measures to be adopted are mentioned in the following paragraphs:

i. Controlling fugitive dust

Dust particles, which are normally generated during mining operation and transportation, deteriorate the ambient air quality. Adequate control measures are, therefore, proposed to be taken during mining operations, transportation and crushing/loading operations. These control measures are discussed as follows:

a) Mines

- a) Dust suppression systems (like water spraying) will be adopted at:
 - a. Faces before and after blasting
 - b. Faces while loading
- b) Dust extraction systems will be used in drill machines and coal handling systems.
- c) Dust generation will also be reduced by using sharp drill bits for drilling holes, drills with flushing system.

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b) Haul roads and stock-piles

- Dust suppression system (like water spraying) would be adopted at roads, which are used for transportation. Fixed sprinklers (Whirling) have been proposed with timers to be installed along the haul roads and coal transportation roads to suppress the dust.
- Transport vehicles shall be maintained leak proof.
- Suitable dust suppression systems such as mist sprays with or without chemical will be provided at appropriate places for preventing dust pollution during handling and stockpiling of coal.
- Transfer points of coal will be provided with appropriate hoods/chutes to prevent fugitive dust emission.

ii. Preventing dispersal of air borne dust

In addition to the control measures proposed during mining and transportation operations, following steps will be taken to prevent air pollution due to airborne dust:

- Dense tree belts will be planted around the mine and sites housing handling/ loading facilities.
- Plantation over already mined out area will be done after backfilling as per schedule (with minimum gap between excavation and afforestation)
- Dust masks will be provided as safety measure to the workers, engaged at dust generation points like drills, loading/unloading points, crushers etc.

iii. Measures to mitigate CO levels

It has already been discussed that the concentration of CO in the ambient air is negligible and is far below the prescribed limit of CPCB and is not anticipated to exceed it in future.

Still all heavy and light vehicles shall be tested for pollutants concentration in their exhausts regularly and well maintained. Strict vigil will be kept in and around the operational area for any fire which shall be immediately controlled.

iv. Measures to mitigate NO_x levels

The main reasons of production of NO_x gases are:

- Poor quality of explosive having large oxygen imbalance which can be due to following reasons:
 - Manufacturing defect
 - The use of expired explosives in which disintegration of ingredients has taken place.

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- b. Incomplete detonation is caused mainly due to low primer: column ratio.

To ensure that NO_x levels do not increase during the proposed mining operations, the following control measures will be adopted:

- a. Good quality explosives will be used for which the oxygen balance will be checked from time to time. The expired explosives will not be used for which a strict vigil will be kept on the date of manufacture. Even as a normal procedure, all explosives will be subjected to a visual inspection and if disintegrated ingredient are spotted, the explosives will not be used even if it is within expiry date.
- b. Primer: Column ratio will be rationalised. The ratio thus established, for producing minimum NO_x , will be adhered to.

The mine ambient air quality will be regularly tested to detect the presence of any pollutants above prescribed limits and appropriate measures will be adopted.

15.7.4 Waste management

a) Nature of top soil and overburden / waste

In this mine, main waste is overburden in the form of top soil, alluvium and weathered mantle. Only 0.6m average thickness of top soil has been considered for separate removal and stacking for use in mine reclamation later. The maximum depth of weathered mantle recorded in boreholes data is 37.83m.

b) Year/stage wise waste generation

The waste generation year/stage wise is given in Table 15.25.

TABLE 15.25
WASTE GENERATION (TOPSOIL & OVERBURDEN) IN MCUM (BANK)

Year	Excavated area (Ha)- Progressive	Topsoil generated- Progressive	Pure OB generated- Progressive	Total waste generated	
				Progressive	Cumulative
1 st year	17.22	0.10	2.98	3.08	3.08
2 nd year	30.66	0.18	7.49	7.67	10.75
3 rd year	57.59	0.35	13.94	14.29	25.04
4 th year	67.08	0.40	25.86	26.26	51.30
5 th year	83.65	0.50	25.44	25.94	77.24
15 th year	344.00	2.06	230.16	232.22	309.46
Final Year (25 year)	150.72	0.90	213.12	214.02	523.48
Total	750.92	4.51	518.98	523.48	

c) Waste disposal sites

There is one waste disposal site within the block area and one top soil disposal site as follows:

i. The surface dump located inside the block boundary

The Surface dump of OB generated will be made on South-West side of the Block. The location of the surface dump is over non coal bearing area. The height of the dump will be 100m and its capacity is 45.75 MCUM (L).

ii. Backfill dump

Backfilling will start from 3rd year of the project operation with a quantity of 9.96MCUM (B). 56.41 MCUM (L) material will be backfilled till 5th year. With the advance of mining operations, the internal backfill quantities will progressively increase and full-scale backfilling will be achieved from 7th year onwards.

iii. Crown dump

Crown dump of height 60m will be made over the backfilled area on both sides of haul road through entry no. 1.

iv. Top soil dump

Top soil disposal sites will be 2 at the initial stage-one near the entry no.1 (permanant over 5 ha area) while the other temporary (15 ha) will be over part of the area of proposed surface dump. Both the top stack areas will be utilised upto 5th year as more storage area will be required due to less utilization in reclamation. The temporary stack will be totally utilised by the 10th year and the area freed by it will be utilised for constructing the surface waste dump.

v. The void

The remaining void area (154.11 ha) of the excavated pit will ultimately become a water reservoir, having a maximum depth of about 160m. This void area will also be suitably sloped, bounded and fenced.

Plate XXII shows the final stage at the end of mine operations with external dump and final void. The generation and disposal of total waste quantities for the life of the mine are shown in Table 15.26.

TABLE 15.26
WASTE DISPOSAL (PURE OB) IN MCUM (BANK)-PROGRESSIVE

Year	Total surface dump	Total backfill	Total bund	Topsoil used	Total OB and TS disposal
1 st year	2.64	0.00	0.33	0.00	2.98
2 nd year	7.49	0.00	0.00	0.03	7.52

Year	Total surface dump	Total backfill	Total bund	Topsoil used	Total OB and TS disposal
3 rd year	3.99	9.96	0.00	0.00	13.95
4 th year	12.20	13.66	0.00	0.08	25.94
5 th year	0.00	25.44	0.00	0.00	25.44
15 th year	24.94	205.22	0.00	2.99	233.14
Final year (25 Year)	0.00	213.12	0.00	1.39	214.51
Total	51.25	467.39	0.33	4.50	523.48

15.7.5 Topsoil management

The average topsoil thickness over the whole pit area envisaged for mining is proposed to be removed to the extent of about 0.60 m. About 5.18 MCUM (L) of topsoil will have to be handled from areas to be excavated. About 0.48 MCUM stock (max.) of the topsoil will be kept over an area of 20 Ha. Extra generation of top soil will be utilized in two ways, part of the surplus top soil will be used for reclamation annually whereas the rest will be stacked at pit head temporarily for consecutive laying over backfilling. Usually about 0.6 m to 1.0m thick layer of topsoil will be laid for afforestation. The topsoil shall be excavated by small hydraulic shovel/front end loader and transported by trucks/dumpers to the stack site located in the near the entry no. 1 and also over the area meant for dumping OB later. The height of the stacks will be kept less than 3m. For retaining fertility beyond one season, a vegetation cover will be created by growing local grass and shrubs.

15.7.6 Management of coal rejects from washery

Washery of 6.00 MTPA capacity is envisaged at the site. The details are given in Chapter 10. Provision has been made for stacking coal rejects over an area of 2 ha. The rejects will be used for power generation.

15.7.7 Infrastructure

Public road

District headquarter Angul, located on National Highway 42 (Manguli Chowk to Sambalpur), is the nearest town at a distance of about 24 km from the southern boundary of the block. The Angul-Rengali metalled road is around 2 km away from the eastern boundary of the block. Mud roads and morrum roads are the medium of accessibility within and between the villages in this block.

Railway line

The nearest railhead Jarapadal is situated at a distance of about 11 km from the southern boundary of the block and is connected to Sambalpur-Bhubaneswar railway line of east coast railways.

Morrum and mud roads are very common in and around villages within the block, viz. Nuapada, Kuskila and Barpada. These roads will be rendered useless after the whole area is occupied for mining/ quarrying and the concerned villages rehabilitated in line with the applicable Policy. The dismantling of kachha roads and low tension lines will be taken up before the mine related operations reach the concerned place.

The required 15 MW (overall for OC and UG) power supply at 33 KV will be drawn from nearest sub station to the local sub-station from where the power will be supplied to the mine and other functional buildings. An emergency arrangement for power supply has been made by providing a set of 2x1000 KVA and 2x500 KVA DG sets which will take care of ventilation and pumping.

It is a new proposed Greenfield project hence, there are no existing facilities of the mine within ML. Infrastructure like office, rest shelters, canteen, magazine, V.T. Centre, dispensary, workshop, store, colony etc. have been envisaged to be constructed before starting the mine within ML area.

Dismantling of some of the pit head facilities will only be involved in the post mining stage for which provision has been made.

15.7.8 Disposal of mining machinery

It is a new proposed mine and hence any dismantling of mine machinery will be involved only after exhausting the mine i.e 25 years after the OC operations cease. The UG operations will continue from 9th year to 49th year in parallel to open cast working. The disposal of equipment or machinery will take place after completion of its life or post mining stage. It will be done as per the established norms in the company. The machinery will either be shifted to other mines of the company or will be disposed of by auction. All the machinery will, thus be removed from the ML area and non left behind.

15.7.9 Safety and security

The life of the mine operations is 49 years. During the ^{life of mine} ~~term of mining~~ operations, the following safety precautions will be implemented:

- i. Erecting barbed wire fencing around the areas being excavated
- ii. Erecting barbed wire fencing around the areas being dumped
- iii. Erecting bunds/ toe walls around the surface dumps to prevent damage to property or injury to persons by rolling stones

After finishing the mining operations, all areas which are inaccessible and are dangerous (excavated, dumps etc) will be fenced. In the post mining scenario, proper approach to the water body will be made for men and animals and the route will be thrown open for the public.

15.8 ECONOMIC REPERCUSSIONS OF CLOSURE OF MINE AND MANPOWER RETRENCHMENT

Manpower as available at the closure stage will be absorbed at alternative locations of the company if available. Those required to be relieved, will be compensated in line with the applicable laws at that time. Gain from development activities in the region will be additional opportunity for local people.

The disturbed land would be made fertile by use of reuse of top soil and fertilisers under expert's guidance and use of available water in the void firstly for the land which remained undisturbed and also for the land which will partly be recovered after dismantling infrastructures and implemented.

15.9 TIME SCHEDULING FOR ABANDONMENT

The abandonment activities of the OC mine will start 5 years prior to the abandoning of the mine i.e. from 21st year. Study Report of the existing status of the project and tasks required for final abandonment will be identified along with their possible time frame for implementation will be undertaken. Items among others could be as under:

- i) Disposal of HEMM and other equipments (electrical/mechanical) of the mine either through transfer to other working projects, sale or disposal as scraps.
- ii) Dismantling schedule of permanent and temporary structures excepting few which may have utility in the revised scheme for managing abandoned area.
- iii) Winding up all H. T & L.T electrical lines, delivery pipe lines for sprinklers and other varied uses other than those which may be required for development of the abandoned area.
- iv) Identifying areas and spots in the developed forest and lagoon (water body) spread for undertaking beautifying works as picnic spots, boating and any other spots to attract visitors and tourists and preparing required schemes for implementation.
- v) Scheme for undisturbed and recovered land development programme for making the land more fertile by use of fertilisers and other measures under expert's guidance to sustain affected population after abandonment of the mine.
- vi) Related matter of land development is also developing irrigation system by following drip irrigation system.
- vii) Any other matter related for gainful development.

The minute details will be worked out in the 21st year. The execution of abandonment activities of the OC mines will be started about four years before the mines get abandoned. One year time is assigned for study of

items as indicated above in i to vii and for preparation of detailed schemes and reports for implementation. Many of the required activities will be carried out during last four years of the mine operation. Some abandonment activities will have to be continued for about two to three years more after the mine operations get fully closed by retaining only few temporary essential office / residential structures.

The following facilities will be retained at site (refer earlier Table 15.20 of this chapter):

Office, VT Centre : 3.00 Ha

Roads : 4.00 Ha

It is proposed that the residential quarters can be given on rent to the people which may be engaged at that time by the future mines in the surrounding area which will sustain the maintenance of the facilities proposed to be retained at site. However, it is proposed that a corpus fund of Rs 10 lakh will be provided which will easily earn an annual interest of Rs 1 lakh to maintain the retained facilities.

Some of the important activities which will be carried during the post closure period will be part of the items under i, ii & iii and also on iv & v as indicated above on action identified in working locations towards end.

Details of expenditure on Progressive and Post Mine Closure activities are given in Annexure 15-1 along with the time schedule bar chart. The cost calculation is based on present price index as on 1st May, 2010. The Post Mine Closure Plan at the end of 25th + 3 years is shown in Plate XXII.

15.10 ABANDONMENT COST

15.10.1 Activities and cost

There is a large list of activities which are to be undertaken for mine closure plan during the mining period and at the end of the mining operations both opencast as well as underground. All the related details of activities have been tabulated in Annexure 15-1 along with volume of work and cost of each activity with Bar Chart. The summary is given below in Table 15.27.

TABLE 15.27
EXPENDITURE ON PROGRESSIVE AND POST MINE CLOSURE

Activities	Amount (Rs. Lakh)
A. OPENCAST	
I. Progressive mine closure plan	
Barbed wire fencing around the dump	91.19
Barbed wire fencing around the pit	221.29
Garland drain around dump	30.27
Rehabilitation/ plantation	1135.64

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Activities	Amount (Rs. Lakh)
Settling Pond	110.00
Toe wall around the dump	60.45
Top soil management	2040.00
Sub Total (I)	3688.83
II. Post mine closure plan	
Rehabilitation/ plantation	312.42
Toe wall around the dump	0.00
Top soil management	225.00
Concrete wall (0.4m wide, 1.5m high) fencing around the pit	500.50
Rearranging water pipe line from earlier alignment to the dump top parks	20.00
Ghat No-1 for boating	20.00
Beautification of parks over the dumps	60.00
Environmental monitoring (air, water, noise, soil)	30.00
Construction of view point tower no.1	20.00
Rehabilitation/ plantation (TS dump)	20.00
Cost of boats and their parking	20.00
Ghat-2 for boating	20.00
Construction of view point tower No. 2	20.00
Ghat-3, 4 and 5 for boating	60.00
Construction of view point tower No. 3	20.00
Sub Total (II)	1347.92
Total of opencast (A)	5036.75
B. Underground post mine closure plan	
Barbed wire around inclines, around ventilation shaft (500m) @ Rs 1500/m	15.00
Under Ground stoppings and sealings for prevention of future fire etc (LS)	20.00
Dismantling ventilation fan	1.00
Dismantling of conveyors (inclines and in seam about 5000m @ 2000/m)	100.00
Dismantling of rail tracks 5000m @ Rs 500/M	25.00
Dismantling of Pumps (LS)	5.00
Dismantling of CHP (LS)	10.00
Dismantling of part of the facilities (buildings & workshop etc) (LS)	40.00
Dismantling of HTL/LTL	5.00
Plugging of 1 pair of incline @ Rs 4 lakh	4.00
Plugging of 1 ventilation shaft	2.00
Rehabilitation/ plantation (facilities)	47.00
Others (Miscellaneous)	20.00
Total of underground (B)	294.00
Grand total for OC & UG (A+B)	5330.75

15.10.2 Escrow account amount

Out of 1048 ha area of ML, the area used by OC and UG mining related operations / activities will be as follows which forms the basis of Escrow amount calculations is given in Table 15.28.

**TABLE 15.28
AREA APPLICABLE FOR ESCROW AMOUNT CALCULATION (HA)**

Sl. No.	Particulars	Total Area	OC	UG
1.	OC mine pit area	750.92	750.92	0
2.	Washery	10	10	0
3.	OB dump	100.00	100.00	0
4.	Top soil stack	5	5	0
5.	Raw coal stack	7	7	0
6.	Facility area	10	6.55	3.45
7.	CHP	1	1	0
8.	Washed coal stack	6	6	0
9.	Green belt	16.75	16.75	0
10.	Settling pond	5.5	5.5	0
11.	Reject	2	2	0
12.	Road	12	12	0
13.	Bund	15.7	15.7	0
14.	Magazine	0.2	0.2	0
15.	Balance	105.93	0	105.93
	Total	1048	938.62	109.38

OC mining related activities - 938.62 ha

UG mining related activities - 109.38 ha

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The economic involvement will be as follows:

In line with the Guidelines, it has been estimated by MOC that typically closure cost of an OC mine will be about Rs 6 lakh/ ha and of an UG mine it will be Rs 1.0 lakh/ha.

Total cost to be deposited in Escrow account in 28 years (as the life of the OC mine will be 28 years) will be as follows:

For OC mining: $938.62 \text{ ha} \times \text{Rs } 6.0 \text{ lakh} = \text{Rs } 5631.72 \text{ lakh}$ ----- (1)

The annual amount for OC mine to be deposited in the 1st year = $5631.72 / 25 = \text{Rs } 225.27 \text{ lakh}^*$

* Note: To calculate the Escrow amount of 1st year the amount at (1) above will have to be divided by 25 or the life of OC whichever is less as per MOC guidelines.

For UG mining: $109.38 \text{ ha} \times \text{Rs } 1.0 \text{ lakh} = \text{Rs } 109.38 \text{ lakh}$ ----- (2)

The annual amount for UG mine to be deposited in the 1st year = $109.38 / 25 = \text{Rs } 4.375 \text{ lakh}^{**}$

**Note: To calculate the Escrow amount of 1st year the amount at (2) above will have to be divided by 25 or the life of UG whichever is less as per MOC guidelines.

The cost to be deposited in every subsequent year will be 5% higher than the cost of the previous year and so on as follows (Table 15.29):

TABLE 15.29
YEARLY AMOUNT TO BE DEPOSITED IN ESCROW ACCOUNT

Year	Opencast	Underground	Total, (Rs. Lakhs)
1	225.27	0	225.27
2	236.53	0	236.53
3	248.36	0	248.36
4	260.78	0	260.78
5	273.82	0	273.82
6	287.51	0	287.51
7	301.88	0	301.88
8	316.98	0	316.98
9	332.83	4.375	337.20
10	349.47	4.59	354.06
11	366.94	4.82	371.76
12	385.29	5.06	390.35
13	404.55	5.32	409.87
14	424.78	5.58	430.36
15	446.02	5.86	451.88
16	468.32	6.16	474.48
17	491.74	6.46	498.20
18	516.32	6.79	523.11
19	542.14	7.13	549.27
20	569.25	7.48	576.73
21	597.71	7.86	605.57
22	627.59	8.25	635.84
23	658.97	8.66	667.64
24	691.92	9.10	701.02
25	726.52	9.55	736.07
26	0	10.03	772.87
27	0	10.53	811.52
28	0	11.06	852.09
29	0	11.61	11.61
30	0	12.19	12.19
31	0	12.80	12.80
32	0	13.44	13.44
33	0	14.11	14.11
34	0	14.82	14.82
35	0	15.56	15.56
36	0	16.33	16.33
37	0	17.15	17.15
38	0	18.01	18.01
39	0	18.91	18.91
40	0	19.85	19.85
41	0	20.85	20.85
42	0	21.89	21.89

Year	Opencast	Underground	Total, (Rs. Lakhs)
43	0	22.98	22.98
44	0	24.13	24.13
45	0	25.34	25.34
46	0	26.61	26.61
47	0	27.94	27.94
48	0	29.33	29.33
49	0	30.80	30.80
Total	10751.49	559.315	13715.67

Thus the total amount which will be deposited upto the end of mine closure will be Rs 137.16 Crores which will be used for technical and biological reclamation, landscaping, plantation, water coursing, dismantling of unwanted structures, creating safe and beautiful ambience etc. However, the total amount and life will reduce if annual production is increased in future.

15.11 FINANCIAL ASSURANCE

- i. The mining company shall open an Escrow account, with the Coal Controller Organisation (on behalf of the Central Govt.) as executive beneficiary. The mining company shall cause payments to be deposited in such Escrow account at the rate computed as indicated in table given above.
- ii. When implementation of the final mine closure scheme is undertaken by the mine owner starting 5 years before the scheduled closure of the mining operations, the Coal Controller may permit withdrawals (4 year before final mine closure date) from the Escrow account proportionate to the quantum of the work carried out as reimbursement. The withdrawn amount each year will not exceed 20% of the total amount deposited in the account. In respect of OC mine, the withdrawal of 20% of deposited amount will be applicable from 22nd Year of Quarry operation as the life is only 25 years. However the withdrawal in respect of UG mine will be possible only from the 46th year as the life is upto 49th years.
- iii. An agreement, outlining the detailed terms and conditions of operating the Escrow account, shall be executed between the Mining company, Coal Controller and the concerned bank in order to give effect to this. The agreement will be executed before the grant of the permission by the Coal Controller to open the mine.

15.12 RESPONSIBILITY OF THE MINE OWNER

It is the responsibility of the mine owner to ensure that the protective measures contained in the Mine Closure Plan including reclamation and rehabilitation works have been carried out in accordance with the approved mine Closure Plan and Final Mine Closure Plan.

The owner shall submit an yearly report to the Coal Controller before 1st July of every year setting forth the extent of protective and rehabilitative works carried out as envisaged in the approved mine closure plan (Progressive and Post mine Closure Plan).

15.13 PROVISION FOR MINE CLOSURE

The mine owner will be required to obtain a mine closure certificate from Coal Controller to the effect that the protective, reclamation and rehabilitation works in accordance with the approved mine closure plan/ Final mine Closure Plan have been carried out by the mine owner for surrendering the reclaimed land to the State Govt. concerned.

15.14 CSR ACTIVITIES

The proposed project will generate employment for 1702 (OC & UG) people and also indirect employment. They will be trained as per job requirement. The area being a mining intensive, a large employment opportunity will be available to local people. About half of the employees will be from out side. They will be staying in the company colony outside the ML area. So, additionally the company will also be building school, hospital, etc for employees which will be available for use to locals also under various schemes. Detailed activities under the programme for local people with education, skill development & training programme under CSR plan will be formulated and a copy of the same will be submitted to MOC.


वी. एस. राणा/V. S. RANA
अवर सचिव/UNDER SECRETARY
कोयला मंत्रालय/MINISTRY OF COAL
भारत सरकार/GOVT. OF INDIA
नई दिल्ली/NEW DELHI

**S-1 Certified block boundary issue for CMPDIL (Plat no II)
of GR DRG No. R7/GEO/RP/GR/05/2 date 20-03-2005**

यो. *Shree*
 जबर ता. *SECRET*
 कोषाया. *MINISTRY OF DEFENSE*
 भारत सरकार GOVT. OF INDIA
 नई दिल्ली NEW DELHI

6.2.511.1000
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ANNEXURES TO CHAPTER - 1

- 1-1 Block allocation letters dt 25-04-2006, 21-12-2009 and 02-02-2006
- 1-2 Letter of GR and Receipt of cost paid to CMPDIL
- 1-3 RQP Certificate from Ministry of Coal and Mines
- 1-4 Detailed calculation of quantity of rejects required for power generation


श्री. एस. राणा/V. S. RANA
अवर सचिव/UNDER SECRETARY
कोयला मंत्रालय/MINISTRY OF COAL
भारत सरकार/GOVT. OF INDIA
नई दिल्ली/NEW DELHI


B. D. SHARMA
222

No 13016/33/2005-CA-1
Government of India
Ministry of Coal

New Delhi, the 25th April, 2006.

To

1. M/s Rungta Mines Ltd.,
Rungta House,
Chaibasa - 833 202,
Jharkhand.
2. M/s. OCL India Ltd.,
11th Floor, Narain Mandal,
23-Banakhamba Road,
New Delhi - 110 001.
3. M/s. Ocean Ispat Ltd.,
203, Kushal Bazar,
32-33, Nehru Place,
New Delhi.

दी. एच. एम. ए. ए. ए. ए.
अथवा सी. ए. ए. ए. ए. ए.
कोयला विभाग/विभाग
भारत सरकार/GOVT. OF INDIA
नई दिल्ली/NEW DELHI

Subject: Allocation of Radhikapur (West) block in the State of Orissa for working by M/s. Rungta Mines Ltd., as Leader, M/s. OCL India Ltd. and M/s. Ocean Ispat Ltd., as an associate, in Orissa, under Option-III.

Sir,

I am directed to refer to the request of M/s. Rungta Mines Ltd., M/s. OCL India Ltd. and M/s. Ocean Ispat Ltd., for allocation of coal blocks in the MCL area and to state that the requests of these companies have been considered by the Central Government and it has been decided to allocate 50.4 million tonnes of coal reserve from the Radhikapur (West) block at 100 % satisfaction to M/s. Rungta Mines Ltd. for their 0.42 mtpa capacity sponge iron plant in Orissa and also to allocate the Radhikapur (West) coal block jointly to M/s. Rungta Mines Ltd. as leader, M/s. OCL India Ltd. and M/s. Ocean Ispat Ltd., as associates under Option-III from the Radhikapur (West) coal block to meet their coal requirement of 119 mtpa, 40 mtpa and 48 mtpa respectively. The coal requirement of 119 million tonnes in respect of M/s. Rungta Mines Ltd., is for their 1.05 mtpa capacity of expansion of sponge iron plant. This allocation is in pursuance of the provisions contained in Section 3(3)(a)(iii) of the Coal Mines (Nationalisation) Act, 1973 and is subject to the following conditions :-

- i) The allocation of the Radhikapur (West) coal block to M/s. Rungta Mines Ltd., M/s. OCL India Ltd. and M/s. Ocean Ispat Ltd. has been made under Option III to meet the coal requirement of their proposed sponge iron plants, captive power generation and production of cement.
- ii) The allocation of the coal block to the leader company and the associate companies i.e. sponge iron plants, captive power plants and production of cement.

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कोयला विभाग
भारत सरकार

- xii) The leader company shall submit a bank guarantee for Rs. 39 crore (equal to one year's royalty amount based on mine capacity of 6 mtpa assessed by CML/DIL, grades of coal from A to G grades and the weighted average royalty @ Rs. 65 per tonne within three months from the date of this letter. Subsequently upon approval of mining plan the Bank Guarantee amount will be modified based on the final peak/rated capacity of the mine.
- xiii) The leader company shall submit a mining plan for approval by the competent authority under the Central Government within six months from the date of this letter. The mining plan shall be so made as to take care of the requirement of M/s. OCL India Limited and M/s. Ocean Ispat Limited, the associate companies.
- xiv) The progress of the mine will be monitored annually with respect to the approved mining plan, which will mention the zero date. In case of any lag in the production of coal, a percentage of the bank guarantee amount will be deducted for the year. This percentage will be equal to the percentage of deficit in production for the year with respect to the rated/peak capacity of the mine, e.g., if rated/peak capacity is 100, production as per the approved mining plan for the relevant year is 50 and actual production is 35, then $(50-35)/100 \times 100 = 15\%$ will lead to deduction of 15% of the original bank guarantee amount for that year. Upon exhaustion of the Bank Guarantee amount the block shall be liable for de-allocation/cancellation of mining lease. M/s. Rungta Mines Ltd., shall ensure that the Bank Guarantee remains valid at all times till the mine reaches its rated capacity or till the Bank Guarantee is exhausted.
- xv) No coal shall be sold, delivered, transferred or disposed of except for the stated captive mining purposes, and except with the previous approval of the Central Government.
- xvi) Mining of coal from the allocated captive coal block shall be carried out in accordance with the applicable Statutes/Rules/Orders/Directions governing the mining of coal in the country.
- xvii) Those of the above conditions relevant at the time of grant of mining lease shall be included as additional conditions in the mining lease in addition to any further conditions imposed by or agreed to by the Central Government.
- xviii) The State Government at the time of seeking previous approval for the grant of mining lease shall submit a draft of the mining lease containing the above relevant conditions for vetting by the Central Govt. The final mining lease shall be as vetted/modified by the Central Govt. Any deviation from the vetted/modified draft shall render the mining lease deed *ab-initio* null and void and without effect.
2. Allocation / mining lease of the coal block may be cancelled, inter-alia, on the following grounds :-
1. Unavailability of power for the plant / power plant/cement plant.
 2. Unsatisfactory progress in the development of coal mining project.

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No 13016/77/2006-CA-I
Government of India
Ministry of Coal

..... New Delhi, dated the 14 December, 2009.

To

(1) M/s Rungta Mines Ltd.,
Rungta House, Chaibasa-833202,
Jharkhand

(3) M/s Ocean Ispat Pvt. Ltd.,
203, Kushal Bazar,
32-33, Nehru Place, New Delhi.

(2) M/s OCL India Ltd.,
11th Floor, Narain Mandal,
23, Barakhamba Road, New Delhi.

श्री. एस. राणा/M. S. RANA
अवर सचिव/UNDER SECRETARY
मंत्रालय, नई दिल्ली
नई दिल्ली/NEW DELHI

Subject : Change of option and partial modification of allocation of Radhikapur(West) coal block.

Sir,

I am directed to refer to this Ministry's allocation letter No.13016/33/2005-CA-I dated 25th April, 2006 on the above mentioned subject, and to state that Radhikapur (West) coal block was allocated jointly to M/s Rungta Mines Ltd., M/s OCL India Ltd. and M/s Ocean Ispat Pvt. Ltd. under Option-III with the terms and conditions. However, the joint allocatees challenged the matter in respect of allocation under Option-III before the High Court of Orissa. All the joint allocatees have now reached an out-of-court settlement to develop the coal block under Option-I. Accordingly, the joint allocatees have entered into a Joint Venture Agreement on 31.08.2009 to develop the said block jointly by constituting a joint venture company. In the light of this, the Hon'ble High Court of Orissa has disposed of the W.P.(C) No.12416 of 2006 on 14.09.2009 with the directions that the terms and conditions mentioned in the memo do form part of the record. As per memo filed before the High Court there is common consensus to develop the block under Option-I.

2. The case has been re-examined on the directions dated 14.09.2009 of the Hon'ble High Court of Orissa in WP (C) No.12416 of 2006 and in the light of the Joint Venture Agreement submitted by the allocatees and it has been decided to change the option for development of coal block and accordingly modify the terms and conditions of allocation of Radhikapur (West) coal block in the following manner :-

i) The allocation of Radhikapur(West) coal block to M/s Rungta Mines Ltd., M/s OCL India Pvt. Ltd. and M/s Ocean Ispat Pvt. Ltd. is changed from option-III to Option-I(One).

ii) Coal requirement of 119 mtpa, 40 mtpa and 48 mtpa as was mentioned in the 8th line of the first paragraph of allocation letter may be read as 119 MT, 40 MT and 48 MT respectively.

iii) A joint venture company be formed and registered by the allocatees within 60 days from the date of issue of this letter. The equity holding in the joint venture company will be in proportion to the assessed coal requirement of the companies.

श्री. एस. राणा
अवर सचिव/UNDER SECRETARY
मंत्रालय, नई दिल्ली
नई दिल्ली/NEW DELHI

No. 13016/33/2005-CA-I
Government of India
Ministry of Coal

New Delhi, the 2nd February, 2006.

To

✓ M/s. Rungta Mines Ltd.,
Rungta House,
Chaibasa - 833 202,
Jharkhand.

Dear Sir,

You have been identified as one of the joint allocattees for a captive coal block of Radhikapur (West) in MCL area. In the meeting dated 7th June, 2005, you were apprised of the three options being contemplated and were requested to send in your views in writing. Having received views of most of the identified applicant groups have been made coal block-wise. The grouping has been done having regard to :-

- i) the block-wise satisfaction levels being as near as possible to the overall satisfaction level (which is the total extractable reserves available in all the blocks as a percentage of the total net balance assessed requirement of identified applicants).
- ii) preference for blocks, accommodated as far as possible, given by the applicants at the application stage, Screening Committee meeting stage, on 7th June, 2005 and thereafter by way of feed back to the Ministry of Coal.
- iii) preference indicated for working jointly with other applicants.

2. One identified applicant in each block has been designated leader based on the financial strength (net worth, turnover and profits), past mining experience, willingness to

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अध्यक्ष, राणा
कोयला मंत्रालय
भारत

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assume leadership role etc. The relevant grouping along with other relevant details is annexed.

- g) It is requested that the groups identified may :-
- i) jointly indicate the willingness to form a joint venture company for mining under Option I and the arrangement for equity and production sharing, rights and liabilities, penalties etc., in writing, or
 - ii) in case a joint venture company is not contemplated among the group members, then a draft agreement between the identified leader and the remaining members as associates detailing rights, liabilities, penalties, etc. including those of non-production (leaders) and non-offtake (associates) under which the production sharing would take place at a transfer price to be determined by the Government block-wise, Option II, or
 - iii) in case Option III is preferred, then a draft tripartite agreement between the leaders, associates and the local Coal India subsidiary as in para 3 (ii) above such that no liability devolves on the local CIL subsidiary in any case including in cases of no or less production by the leaders or none or less offtake by the associates, and CIL subsidiary is fully indemnified against any liability. Role of CIL subsidiary will be limited to distribution of surplus coal for a commission.

4. You are requested to submit your response within two weeks. Your early response would enable this Ministry to proceed further in the matter.

Yours faithfully,

(Premraj Kumar)
Section Officer.

Encls. As above.

B.D. SHARMA
RQP

SPP

MCL

BLOCK	RADHIKAPUR(West)			RADHIKAPUR(East)		
E RESERVE (Mt)			160			115
LEADER		RUNGTA	50.4*	119	TSIL	76
ASSOCIATES		OCL		40	SCAW	60
ASSOCIATES		OCEAN		48	SPS	32
ASSOCIATES						
T. REQUIR- MENT			207			168
% SATISFACTION			77			68

* Extractable reserves of Radhikapur (West) block is 210 mt. out of which 50.4 Coal reserve was allotted by the Screening Committee in its 20th meeting held on 6.6.2003 to M/s Rungta Iron & Steel in respect of their 0.42 mtpa sponge iron production and it will not be affected by the level of satisfaction in the block whereas 19 mt coal reserve is in respect of their expansion sponge iron capacity of 1.05 million tonne.

B.D.SHARMA
RQP
[Signature]



CMPDI
ISO 9001 Company

सी.एम.पी.डी.आई सेन्ट्रल माइन प्लानिंग एण्ड डिजाइन इंस्टीट्यूट लिमिटेड
गोन्दवाना प्लेस, कॉन्के रोड, रांची - 834 008 (झारखण्ड) भारत

Central Mine Planning & Design Institute Limited
Gondwana Place, Kankar Road, Ranchi-834008, Jharkhand, India



DG/ 693(A) / 1254

Dt.11-05-2006

To,
Dr. CS Rao,
Chief General Manager,
Rungta Mines Ltd.
Rungta House,
Chaibasa - 833201
Jharkhand

Rao
की प्रतः रांची में भेजी जा रही है।
सम्बन्धी प्रमाणपत्र के साथ।
कृपया अवगत करवा दें।
भारत सरकार/GOVERNMENT OF INDIA
नई दिल्ली/NEW DELHI

Sub: Geological Report Of Radhikapur Block.

Ref: Your Letter No RML(BD) / Radhikapur(W)/06-07/151 Dt. 10-05-06

Dear Sir,

A copy of the GR of the above block is hereby being handed over to you for your exclusive use. Kindly note that the report should not be reproduced in any form or a copy given to any person or organization. It is clarified that the GR of Radhikapur is the same as Radhikapur West

The original money receipt No A 6188 Dt 11-05-06 for Rs 7,66,15,940/- (Rupees Seven Crores Sixty Six Lakhs Fifteen Thousand Nine Hundred Forty) only towards the Exploration Cost of the above block intimated to you (vide our letter No.DG/033.4/1208-09 Dt 08-05-06) has already been issued to you by FM(Cash), CMPDI HQ,Ranchi for your records.

Thanking You,

Yours Truly,

(CS Mehra)
Dy. CG

11/5/06

B.D. Sharma
B.D. SHARMA
ROP

No.13016/18/2004-CA
Government of India
Ministry of Coal & Mines
Department of Coal

New Delhi, dated the 19th August, 2004.
24th

To

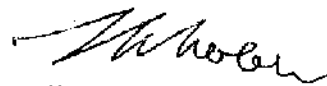
Shri B.D.Sharma,
M/s Min Mec Consultancy Pvt. Ltd.
A-121, Parayavaran Complex, IGNOU Road,
New Delhi - 110 030.

Subject: Grant of recognition as competent person to prepare mining plan.

Sir,

I am directed to invite your attention to our letter of even number dated 01.06.2004 on the subject mentioned above and to state that the Government has widened the scope of recognition to prepare mining plan. Under this decision you can prepare mining plan for coal and lignite for any block up to 10 (ten) years from the date of last recognition i.e., 01.06.2004.

Yours faithfully,



(S.K.Kakkar)

Under Secretary to the Govt. of India

B.D.SHARMA



DETAILED CALCULATION OF QUANTITY OF REJECTS REQUIRED FOR POWER GENERATION

PARTICULARS	UNITS	VALUE		OCL	OSIL
Capacity	MW	108		60	48
Hours in a Year	Hrs	8760		8760	8760
Total Power Generation	kWh	946080000		525600000	420480000
Factor Coal Cons. (1 Kg/kWh) of 2500 kCal/Kg C	Ton/kWh	0.001		0.001	0.001
Coal Quntity for 2500 kCal/Kgality	Ton	946080		525600	420480
Coal Quntity for 2000 kCal/Kgality	Ton	1182600		657000	525600
PLF for above	%	80%		80%	80%
If PLF is 85%	%	85%		85%	85%
Coal Quntity for 2000 kCal/Kgality	Ton	1005210		558450	446760
Rejects of Cement (see Coal Req. sheet)	Ton	247500	50% of 4,95,000	137500	110000
Rejects of DRI (see Coal Req. sheet)	Ton	648000	60% of 10,80,000	360000	288000
Total Rejects (with average kCal of 2000)	Ton	895500		497500	398000
Net Additional Req. of coal (2000 kCal)	Ton	109710		60950	48760
Coal Factor for 2500 kCal/Kg Coal	kg/kWh	1			
Coal Factor for 2000 kCal/Kg Coal	kg/kWh	1.25			
Theoritical Power Per 1 MW CPP	Lac kWh	8760000			
PLF Factor	%	85%			
Actual Power Genration from 1 MW CPP	Lac kWh	7446000			
Coal Req. for 1 MW CPP	T	9307.5			

डॉ. एम. राजेश्वर राय
 अध्यक्ष, फंडेशनल सेल
 कोयला विभाग, भारत सरकार
 भारत सरकार/GOV. OF INDIA
 नई दिल्ली/NEW DELHI

B.D. SHARMA
 (C)

TABLE SHOWING CALCULATIONS OF IMPROVEMENT IN COAL QUALITY BY CSM SELECTIVE MINING AND WASHERY

I. COAL QUALITY PARAMETERS BASED ON GEOLOGICAL REPORT

Average quality parameters of Seam-IX*

Parameters	Insitu Coal (I100); Ref pg 109 of GR	
	Min.	Max. Average
Moisture %	5.2	7.8 6.5
Ash %	38.9	51.7 45.3
VM %	21.6	24.8 23.2
Ash + Moisture	44.1	59.5 51.8
Grade as per norms	F	Ungraded G
UHV calculated kcal/kg		1751.3174

II. COAL QUALITY IMPROVEMENT DURING MINING

	Mining by Continuous Surface Miner (CSM)		Mining by Shovel (I100)	Total ROM (combined from CSM and shovel)
	Total (I20+dirt band (>20<100 cm))	Dirt band (>20<100 cm) Stone	(I20)	
Production in life, MT	105.61	15.26	90.35	125.03
Dirt Band %	14.45		14.45	
FC+VM+M (%)	54.7		54.7	
Ash %	45.3		45.3	41.06
Total ash (non coal), MT	47.84	0.8**X15.26	15.71	51.34
FC+VM+M, MT	57.77	0.2X15.26	18.97	73.69

10/11

	Mining by Continuous Surface Miner (CSM)		Mining by Shovel (100)	Total ROM (combined from CSM and shovel)
	Total (120+dirt band(>20<100 cm))	Dirt band(>20<100 cm) Stone		
III. COAL QUALITY IMPROVEMENT BY WASHERY				
Washery throughput, MT/yr				6
Input Ash % in feed to washery				41.06
Output Clean coal Ash% (Dictated by End Use Plant)				27
Clean coal yield %				50
Total ash in feed coal (MT)@41.06%				2.46
Weight of clean coal yield (MT) containing 27% ash				3
Total ash in clean coal (MT) @ 27%				0.81
Rejects, MT				3
Total ash in reject coal (MT)				1.65
Ash % in reject coal (av)				55.00

* 84% of the reserves lie in seam-IX

** Assuming dirt band contains 80% Ash

The insitu coal having average ash % of 45.3% will be improved by selective mining by continuous surface miner delivering ROM coal with 39.44% ash content. The washery will bring down the ash of clean coal to 27% at 50% yield. The clean coal yield of 50% can be obtained from reduction in ash by 14.06% (41.06%-27%) during washing.