



South Eastern Coalfields Limited

(A MINIRATNA PSU)

CIN: U10102CT1985GOI003161

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CORPORATE AFFAIRS DEPARTMENT

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Ref. No. SECL/BSP/CAD/604 FD/Extracts/16-17/ 442

Date: 14.12.2016

The enclosed subject was discussed in the 604th Meet of the Functional Directors held on 1st & 2nd Dec.2016 at CMD's Chamber vide Item No.604.21. The relevant minutes are quoted below:

QUOTE

Item No.604.21

Sub: Scheme for introduction of 2nd set Continuous Miner Package at Gayatri UG Mine of Bistrampur Area for production capacity of 0.36 MTY.

Ref: Nodal Officer (P&P)/GM(P&P)'s Noting No. 1894 Dt. 26.08.2016.

The Functional Directors discussed on the subject scheme in detail and GM(P&P)-HOD apprised the FDs that:

- Gayatri UG Mine is a completed project with production capacity of 0.30 MTY with approved EMP and the mine is presently incurring losses. However, the mine is having more potential to increase the production by the introduction of mass production technology and accordingly a Scheme for introduction of CM Package for additional production of 0.42 MTY was approved by SECL Board on 01.04.2016, which is in the process of Commissioning.
- There is a further scope to increase the production by introduction of 2nd set of CM package and CMPDIL, RI-V was requested for preparing the scheme. Accordingly, CMPDIL, RI-V prepared a new Scheme for introduction of CM Package at Gayatri UG for an additional production of 0.36 MTY with thickness range of +1.5m to 3.5m with a capital outlay of ₹22.89 Crore.
- The financial viability for the introduction of 2nd set of CM package has been done by CMPDIL, RI-V and according to the assessment made, the introduction of 2nd set of CM Package will yield a profit of ₹17.04 Crore with pay-back period of 4.6 years & 4.85 years on (100% and 85% capacity utilization) respectively on standalone basis thereby the overall loss of the mine will be reduced from (-)₹26.07 Core to (-) ₹6.25 Crore with sales price considered based on geological grade and the overall loss of the mine (-)₹26.07 Crore will be turned into profit (+)₹34.21 Crore, if actual sales price is considered based on actual sales realization of FY 2015-16.
- The Scheme as submitted by CMPDIL, RI-V was deliberated and recommended by the Planning Committee of SECL at its meeting held on 27.08.2016.

In view of the above appraisal, the Functional Directors after detailed deliberations agreed with the subject Scheme for introduction of 2nd set of Continuous Miner Package at Gayatri UG Mine of Bistrampur Area for incremental production of 0.36 MTY at a capital outlay of ₹22.89 Crore, as recommended by the Planning Committee, detailed and brought out in the Agenda.

UNQUOTE

Handwritten signature and date: 14/12/16

Accordingly, the above cited case file (s) is being forwarded herewith for kind perusal and for taking further needful action in the matter.

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COMPANY SECRETARY

✓ Director (Tech.) P&P. *[Handwritten signature]*

Encl: as above *GM P&P 2*

Copy for kind information to: Director (Fin.)/Director (Pers.)/Director (Tech.) Oprn

cc to: GM (P&P)/GM (CMC)/GM (Fin.)-HODs/GM, Bistrampur Area.

CE (EAM) P&P
Sh. Gaurav, no

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20/12/16

विदेशिक (सक.)
आयुक्त कार्यालय
विभाग
Genl. 550
19/12/2016
20/12/16



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Ref. No. SECL/BSP/CAD/244 BM EXT/16-17/ 14

Date: 11.04.2016

EXTRACT OF THE 244TH MEETING OF THE BOARD OF DIRECTORS OF SOUTH EASTERN COALFIELDS LIMITED HELD ON 01.04.2016 (FRIDAY) AT RAIPUR (CG)

ITEM NO.244:4:4

Sub: Scheme for Introduction of Continuous Miner Package on Hiring basis (for additional coal production of 0.42 MTY) at Gayatri UG Mine of Bistrampur Area, at an estimated capital investment of ₹105.57 Crore.

The Board discussed on the subject Scheme in detail and noted the deliberations and recommendation of FDs on the same given at their 579th FDs Meeting held on 15.03.2016 (Item No.579.02) and GM(P&P)-HOD apprised the Board that:

- The proposed Scheme has been formulated with an estimate capital expenditure of ₹105.57 Crore consisting of ₹86.795 Crore towards land acquisition for depillaring and the capital requirement for introduction of CM package has been envisaged as ₹18.77 Crore only.
- CMPDIL, RI-V reviewed the Scheme as per the new CIL guidelines and submitted that the overall IRR worked out to be 31.38% and 14.36% at 100% and 85% production capacity respectively.
- The payback period is 4.7 years and 5.02 years at 100% & 85% capacity utilization respectively for incremental production including land cost.
- The mine at present is incurring loss of ₹1112.08 per tonne with actual sales realization of ₹2945.97/tonne and if notified sale price of ₹1627.00/tonne at Gayatri UG (G6-Grade) is considered, then the mine would have incurred loss of ₹2430.64/tonne. With implementation of the subject scheme in totality, the losses may come down to ₹705.12 /tonne considering the notified price i.e. a huge reduction in loss per tonne. Further, the existing infrastructure/resources of Gayatri UG Mine will be better utilized with introduction of CM Package.

In view of the above appraisal, the Board after detailed deliberations approved the subject Scheme for introduction of Continuous Miner at Gayatri UG Mine, Bistrampur Area at an estimated capital expenditure of ₹105.57 Crore, for enhancement of underground production considering the commitment towards contributing to 01 (one) Billion Tonne coal roadmap of CIL, as reviewed by RD, RI-V, CMPDIL, and recommended by P&P Department as detailed and brought out in the agenda.

The Board further directed that in future such proposals should be brought before the Board with an exercise by comparison between deployment of CM Package on Risk & Gain Sharing Basis vis-a-vis on Hiring Basis, determining the net cash flow in both the methods and the most profitable and viable Scheme recommended.


COMPANY SECRETARY

Distribution for action:

1. GM(P&P)-HOD, SECL
2. GM, Bistrampur Area
3. GM(F)-HOD, SECL

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All Functional Directors.

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SCHEME
FOR
INTRODUCTION OF 2ND SET CONTINUOUS MINER
GAYATRI UNDERGROUND MINE

(Incremental Capacity - 0.36 Mty)
(Job No. - 512067)

BISRAMPUR AREA
SOUTH EASTERN COALFIELDS LIMITED



JULY, 2016
REGIONAL INSTITUTE-V
CENTRAL MINE PLANNING & DESIGN INSTITUTE
SECL COMPLEX, SEEPAT ROAD
BILASPUR (CHHATTISGARH)
PIN-495006

AN ISO 9001:2000 COMPANY
CERT.NO::C I/8656

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SCHEME FOR ADDITIONAL ONE SET CONTINUOUS MINER PACKAGE AT GAYATRI UNDERGROUND MINE OF BISHRAMPUR AREA, SECL, GAYATRI UG (ADDITIONAL CAPACITY- 0.36 Mty.)

1.0 Introduction:-

Gayatri underground mine is a running mine. The mine is a completed project. Date of completion is March, 2010. The date of last approval of Gayatri UG RPR is 8 April, 1999 with a production capacity of 0.30 Mty. Initially a project Report was formulated and approved on 09.12.1996 with a production capacity of 0.24 Mty. A scheme has been approved in 244th meeting of the board of Directors of SECL held on 01.04.2016 for coal production of 0.42 Mty by introduction of Continuous miner on hiring basis.

CHRONOLOGY OF PREVIOUS PROJECT REPORTS

Table 1.1: Chronology of Previous Approved Reports

Year of Preparation of PR/RPR/Scheme	Year of Approval	Technology adopted	Production Capacity (Mty)	Approved Capital (Rs. Crore)	Remarks
1	2	3	4	5	6
PR, March,1997	09.12.1996	SDL/LHD	0.24	19.585	Haulage transport of coal
RPR, July,1998	08.04.1999	SDL	0.30	21.814	Coal transport by Belt Conveyor
Scheme, May 2015	01.04.2016	CM	0.42 (Additional)	105.57	Cost of land is covered, including opening of Seam-I (Top)

Gayatri UG Mine is under administrative control of Rehar, Gayatri Ketki Sub Area of Bishrampur Area of SECL and is located in Surajpur District of Chhattisgarh. The mine has started coal production from the year 2003 and at present, only development is being done in the mine.

2.0 FORMULATION OF SCHEME FOR INTRODUCTION OF ADDITIONAL ONE SET CONTINUOUS MINER:-

Gayatri UG mine is incurring loss as per the cost sheet of the mine. A scheme has been approved on 01.04.2016 for introduction of CM package (0.42 Mty). The CM set is yet to be introduced. There is potential in the mine for further increase of production by putting another set of Continuous miner in seam I (Top) / Seam -I (Bottom).

In the recently approved scheme, working in seam I-Top and seam I-(Bottom) has been considered with existing semi- mechanized technology alongwith introduction of one set CM.

A letter has been received from SECL vide ref. No. SECL/BSP/P&P/254 Dated 18.04.2016 for introduction of CM package in Gayatri Underground mine. SECL desired to prepare and submit the scheme for introduction of CM/LHCM technology in Gayatri Mine. Accordingly, the job has been taken up at CMPDIL to formulate scheme for additional CM/LHCM as desired.

Mechanized coal cutting technology is to be introduced gradually and existing semi mechanized technology should be replaced with the same, wherever it is technically or techno-commercially viable, owing to its inherent property of safety, productivity and recovery of higher percentage of coal. The introduction of CM/LHCM technology will yield better productivity, more recovery of coal, incremental financial gain or overall financial results will decrease the loss compared to existing loss.

Underground production is gradually decreasing. In order to arrest negative trend of coal production from underground mine it is desired that new mechanised technology be introduced so that production, productivity and profitability of the mine could further be improved.

3.0 Marketability

Existing underground/Opencast mine of Bishrampur area are shrinking due to depletion of reserve. There is shortage of C/D, superior grade coal. By 2019-20 Coal production contribution from underground mine is 22.05 Mte from SECL command area against 1 billion te coal target of CIL. The current production level from UG mines of SECL is 15.5 Mte (2015-16).

4.0 Linkage

The project is not linked to any specific consumer. The most of the mines of CIC are kept for basket linkage. However this can be linked with sponge iron plant as the coal is suitable for the same (Ref: RPR). The coal from mine is also being transported to Bishrampur railway siding for onward transportation to miscellaneous consumers

5.0 LOCATION & ACCESSIBILITY

Gayatri underground mine is located in Rehar West block (Mani & Jogi Blocks). The block is located west of the Rehar river and is bounded by Latitudes 23°05'15" to 23°07'30"N and Longitudes 82°53'32" to 82°56'53" E. The area is covered under the Survey of India, topo-sheet No 64 I/16 (R.F. 1:50,000).

The block is located about 18.0 km south of Surajpur, district, state Chattishgarh. Surajpur is located about 40 km west of Ambikapur on the State Highway No- 14 to Manendragarh. A fair weather road which connects Surajpur to Dadgaon (a village on Bilaspur - Ambikapur, State Highway No 5), Passes just 3 km west of the block. The approach to the block is through a fair weather road connecting Sapkara, Village which bifurcates from Surajpur-Dandgaon road near Jobga village.

The nearest railway station is Bishrampur which is a terminus station for Manendragarh - Bishrampur section of South-Eastern Railway. Bishrampur railway station is about 30 km by road from the block Via Surajpur. However, the aerial distance of the railway station is just 10 km from the block. Administratively located in

Bishrampur area of SECL

6.1 Climate:-

The climate of the area is defined as tropical monsoon type. The area experiences three seasons during the year. The summer is from March to June when the day's temperature varies from 35.5⁰ C to 41.7⁰ C and at night it is between 8.5⁰ C to 22.8⁰C. Mid-June to September is the rainy season and from October the winter sets in and continues up to February. During the winter season the day temperature varies from 22.2⁰C to 39.1⁰C while the night temperature drops up to 2.9⁰C to 13.4⁰C. Generally May is the hottest month and December to January are the coldest months during the year. The wind flow during the winter season is gentle and it is generally has the speed of 5.4 to 7.7 Km per hour.

Rainfall:

Average rainfall in the area is 1100 mm.

Relative humidity

The average relative humidity experienced in morning and evening in the region is around 68% & 59% respectively.

6.2 Topography:

The topography of the mine is mostly flat, except at few places where it is gently undulating. The elevation of the ground within the proposed area varies between contour values of 562m and 536 m. the general slope of the ground is towards Rehar river.

Drainage

The south easterly flowing Jobga nalla (the tributary of Rehar river) and Rehar river are the main drainage system of the proposed project area. Apart from this, a few seasonal nallas/ gullies also join in Jobga nalla and Rehar river.

Hydrology

The area within project and around the block is manifested by some ponds and shallow dug wells. The ponds and wells are being used for domestic water supply and for agricultural purpose by villagers. All of them are rain fed only.

Human settlement:

Pondi village is situated towards the north within the Gayatri mine area. The village Getra the main village in Rehar west block (Gogi-Mani block) is situated just outside the eastern boundary of the project. The population is mostly engaged in agricultural work and in collection of Mohua flowers and Tendu leaves. The only industry in the area is coal mining.

6.3 HYDROGEOLOGICAL STUDIES

6.3.1 Surface Hydrology

The surface drainage of Gayatri UG is characterized by the occurrences of one major river named Rehar River and a nala called Jobga Nala. The Rehar River is flowing close to the eastern boundary of the block and flows from south to north and carries the main discharge of the area. The Jobga Nala flows from west to east within the block and finally meets with Rehar River.

6.3.2 Hydrogeology

6.3.2.1 Aquifer system:

The block area is covered by Barakar formation and comprises of soil cover and sandstone of different grain sizes with shale beds and coal seams. The Barakars comprising of medium to very coarse grained sandstone, are saturated and behave as aquifers. Whereas, the shale beds and coal seams behave as aquiclude. Due to stratification and with the presence of aquiclude (shale/coal), a multi-aquifer system developed. The various hydrogeological units developed in the Block area are furnished in Table 1.

TABLE 1: VARIOUS HYDROGEOLOGICAL UNITS DEVELOPED IN THE GAYATRI UG MINE, LAKHANPUR COALFIELD

Hydrogeological Unit	Formation	Thickness (m)
Phreatic aquifer A	<i>Alluvium, soil and sandy soil, poorly consolidated medium to coarse grained sandstone</i>	14.45 – 91.15
Aquiclude	Coal Seam – 4	1.50 – 3.50
Aquifer B	<i>Sandstone with shale bands</i>	7.68 – 17.16
Hydrogeological Unit	Formation	Thickness (m)
Aquiclude	Coal Seam – 3	0.46 – 2.56
Aquifer C	<i>Sandstone with shale bands</i>	16.00 – 66.00
Aquiclude	Coal seams – 2	0.9
Aquifer D	<i>Sandstone with shale bands</i>	60.00 – 90.00
Aquiclude	Coal seams – 1 Top	0.90 – 4.50
Aquifer E	<i>Shale with sandstone band</i>	15.00 – 20.00
Aquiclude	Coal seams – 1 Bottom	0.90 – 3.25

The thickness of unconfined aquifer zone present above Coal Seam 4, varying from 14.45 m to 91.15 m, behaves as phreatic and most potential aquifer. The lower aquifers due to compaction are usually less potential and the ground water flow dominates

through secondary porosity developed. The aquifer system exhibit a more or less uniform dip of 3° to 4° towards north.

6.3.2.2 General aquifer parameters:

CGWB carried out groundwater exploration in around 75 Nos. of wells with a depth range of 60 to 320 m below ground level at various places in the Surguja district and reported the transmissivity varying from 11 m²/day to 159 m²/day and storativity varies from 0.007 to 2.25x10⁻⁶. The discharge in the wells varies from 0.45 to 12 lps. This shows a vast variation in the aquifer potential in the area.

Detailed hydrogeological investigations were carried out by CMPDI in the adjacent Kalyani UG mine (situated around 30 Km north-east from the block boundary) of Bhatgoan Area. The aquifer parameters as evaluated at Kalyani UG are: Hydraulic Conductivity (K) =0.61 m/day and Storage coefficient (S) = 3.7x10⁻².

However, from the mine water discharge data, in Gayatri UG mine, the Hydraulic Conductivity value of the Aquifer D has been calculated, using the Darcy's equation. The hydraulic conductivity (K) of the confined aquifer (Aquifer D) above Coal Seam I Top is calculated as 0.32 m/day.

6.3.3 Ground water levels:

6.3.3.1 Groundwater levels in villages:

The water levels in the nearby villages of Gayatri UG namely Jobaga and Ketaka villages have been monitored during winter season (January 2016). The monitored water levels in the villages are furnished below.

TABLE 2: DETAILS OF WELL INVENTORY & GROUNDWATER LEVELS, GAYATRI UG BLOCK

Village	Well Owner	Well diameter (m)	Parapet Height (m)	Well Depth (m) (b.g.l.)	Water Level b.g.l Jan 2016 (m)	Remarks
Jobaga	Dharmu, S/o Ram Sai	1.95	0.1	11.2	8.8	Behind health center, rear side of school and adjacent to market, Road side.
Ketaka	Govt. Well	3.6	0.7	10	8.4	Behind Reliance tower, Adjacent to transformer and road side.

6.3.4 Mine Drainage

In sedimentary rocks, due to the stratification of formation & the horizontal permeability (KH) is usually many fold higher than the vertical permeability (KV). Thereby, the groundwater velocity/flow along the bedding plane is higher than across the plane. During mine development, the sandstone beds existing above the roof of the seam act as the major source for inflow into the mine. Thereby only aquifer lying in the immediate vicinity of mine workings is largely drained.

Only during depillaring activity (i.e. caving conditions), with the prominence of secondary porosity and increase in leakance, maximum inflow is anticipated. In such conditions, the aquifer in the mine area may get interconnected and drained for a limited period. With sufficient recharge, the aquifers get recouped immediately.

Various methods have been used to predict the mine water inflow during development as well as under depillaring condition. The controlling factors influencing the mine inflow rate are the mine and aquifer parameters. However, with the variation in the monsoon rainfall as well as connection to the surface water bodies, the inflow rates are to be adjusted accordingly. The estimation of water inflow rate in Gayatri UG during development and caving conditions is provided in following sections.

6.3.4.1 Present Mine Drainage

As per the project officials, the total water discharged from the mines on the surface during pre-monsoon season (April 2016) has been furnished in the following Table.

TABLE 3: Mine discharge from Gayatri UG and other operating mines nearby, Lakhanpur Coalfield

Sl. No.	Mine	Groundwater discharge from mine (Cum/day)	Groundwater discharge from mine (M. Cum/year)
1	Gayatri UG	1,962	0.43
2	Rehar UG	2,636	0.58

6.3.5 Probable water inflow during development condition:

The water inflow during development stage may be calculated using Darcy's Law with some minute modification. Here the formula will remain same, however the total exposed roof area which is considered as 30% of the total active mine workings. The other remaining parameters in the formula will remain same. According to Darcy's law, $Q = K.I.A$. Hence,

$$\text{Water Inflow within mine (Q)} = K \cdot I \cdot A \cdot 0.3$$

Where, K = Permeability or Hydraulic Conductivity, I = Hydraulic Gradient, A = Total area of active mine workings.

TABLE 4: CURRENT WATER INFLOW IN GAYATRI UG

Total mined out area, A, sq. m.	Hydraulic Conductivity, K, m/day	Hydraulic Gradient, I	$K \cdot I \cdot A \cdot 0.3$, cum/day
Seam I Top			
2285000	0.32	0.009	1974
Total Mine inflow, cum/day			1974
Total Mine inflow, GPM			302

In Gayatri UG mine, using the Darcy's equation, the hydraulic conductivity (K) of the confined aquifer above Coal Seam I Top is calculated as 0.32 m/day. Therefore, with increase in the developed area in future, by using the mentioned formula the future water inflow in mine may be calculated.

TABLE 5: PROBABLE WATER INFLOW IN THE MINE AFTER SEAM I TOP IS COMPLETELY DEVELOPED IN GAYATRI UG

Total area, A, sq. m.	Hydraulic Conductivity, K, m/day	Hydraulic Gradient, I	$K \cdot I \cdot A \cdot 0.3$, cum/day
Seam I Top			
5430000	0.32	0.009	4691
Total Mine inflow, cum/day			4691
Total mine inflow, GPM			717

The total water inflow in the mine at completion of development of coal Seam I Top is calculated as 4691 cum/day (717 GPM). However, deviation from the calculated value may occur in unlike situations in the future.

6.3.6 Probable water inflow during depillaring condition:

A. Model I:

This model is based on the rate of flow and mine expansion rate. The mine inflow takes place during depillaring in two phases.

- i. In the first part, after depillaring the water present in the collapsed aquifer part of the roof immediately drain out (Q1).
- ii. Then, in the second segment, water present adjacent to the collapsed aquifer part of the roof used to percolate continuously (Q2). The collapsed mass would act as a fully draining well.

Hence, during depillaring stage the total water inflow (Q) will be $Q = Q_1 + Q_2$. The Q1 and Q2 can be calculated using the following formulas.

$$Q_1 = SRH$$

$$Q_2 = 2\pi KH^2 / W(U_0)$$

S = Storativity/ Specific yield

R = Mine expansion rate, considered 100m²/day for Gayatri UG as practiced in different UG mines of SECL

K = Permeability (m/day)

H = Saturated thickness of aquifer, m

T = Transmissivity (m/day)

W(U₀) = Well function (obtained from Wenzel's Table)

TABLE 6: ESTIMATION OF GROUND WATER INFLOW IN GAYATRI UG DURING DEPILLARING STAGE BY MODEL I

H, m	R, sq. m	K, m/day	S	Uo	W(Uo)	Q1	Q2	Q, cum/day	GPM
Seam I Top									
116	100	1	0.0005	3.43E-05	9.683	6	8727	8733	1334
Seam I Bot									
134	100	1	0.0005	2.97E-05	9.837	7	11463	11470	1752

The above table illustrates that, while depillaring of the Seam I Top around 8,733 cum/day or 1,334 GPM water inflow may take place with mine. However, while depillaring of Seam I Bottom, the total water inflow in the mine would be around 11,470 cum/day or 1,752 GPM

During depillaring stage, the Permeability value is considered more than double of the indigenous permeability, because, while depillaring due to caving, a number of cracks and fractures generate in the aquifers lying in the roof of the working seam and that induces secondary porosity which leads to the increase in the permeability of the aquifers.

B. Model II:

In this model, the aquifer present above the mine is presumed to be punctured by fractures equivalent to various radii boreholes and the amount of groundwater to be encountered at various time.

$$\text{Inflow (Q)} = 2\pi TH / \ln(\text{Re}/\alpha)$$

H= Saturated thickness of aquifer, m

Re= Radius of Influence, m

$$\text{Re} = 2.08 \sqrt{(k.t)}$$

α = Radius of the fractures, m

T = Transmissivity in m²/day

k= Permeability (in Millidarcy)

t = Time in minutes

The water inflow prediction by this model is given in Table 7, Table 8 and in Fig.1 Fig. 2

TABLE 7: ESTIMATION OF GROUND WATER INFLOW IN GAYATRI UG DURING DEPILLARING STAGE OF SEAM I TOP BY MODEL II

Parameters		Value	Unit
Hydraulic Conductivity	K	1	m/d
Hydraulic Conductivity	k	1190	Milli Darcy
Saturated thickness of aquifer	H	116	m
Transmissivity	T	116	m ² /day

Sl. No	Radius of Fracture (m)	Time, min	Re	Q, (cum/day)	Q, (GPM)
1	0.1	1	72	12851	1963
2	0.1	60	556	9800	1497
3	0.1	300	1243	8963	1369
4	0.1	1440	2723	8275	1264
1	0.3	1	72	15428	2357
2	0.3	60	556	11231	1716
3	0.3	300	1243	10146	1550
4	0.3	1440	2723	9272	1416
1	0.5	1	72	17015	2599
2	0.5	60	556	12049	1841
3	0.5	300	1243	10809	1651
4	0.5	1440	2723	9823	1501
Sl. No	Radius of Fracture (m)	Time, min	Re	Q, (cum/day)	Q, (GPM)
1	0.75	1	72	18528	2830
2	0.75	60	556	12788	1953
3	0.75	300	1243	11400	1741
4	0.75	1440	2723	10309	1575
1	1	1	72	19775	3021
2	1	60	556	13370	2042
3	1	300	1243	11860	1812
4	1	1440	2723	10684	1632

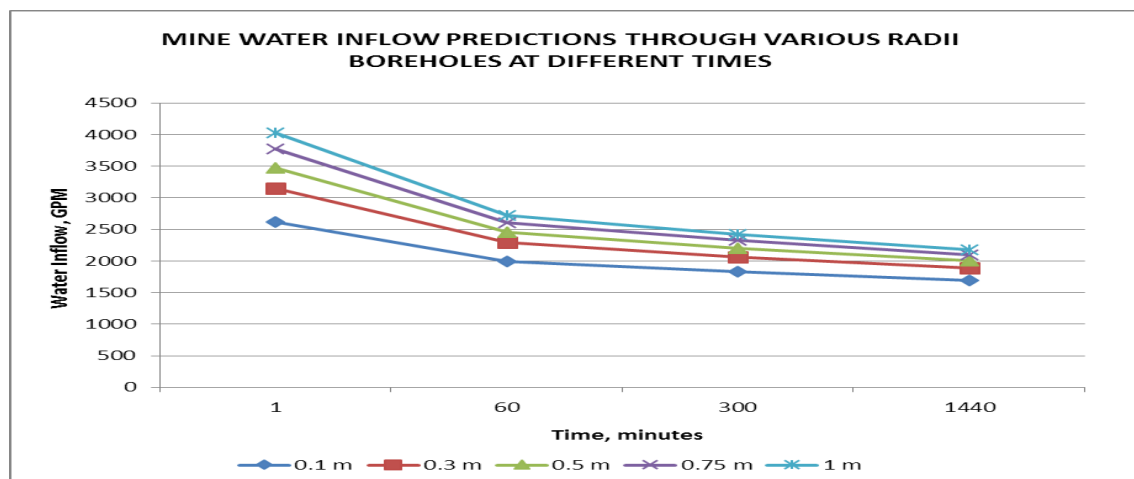


Fig. 1: Mine water inflow predictions (Seam I Top) through various radii boreholes at different times

If the groundwater inflow within the mines is presumed to be equivalent to the inflow of water through 0.1m to 1m radii boreholes, then the estimation in the Model II reveals that, in a single day the inflow of water in the mine will be varies from 8,275 cum/day (1,264 GPM) to 10,684 cum/day (1,632 GPM) which is close to the inflow value calculated in Model I.

Thus, Model I (Table 6) shows that the groundwater inflow within the mine during depillaring stage is 8,733 cum/day (1,334 GPM). Moreover, according to Model II (Table 7), the groundwater inflow within the mine during depillaring stage varies from 8,275 cum/day (1,264 GPM) to 10,684 cum/day (1,632 GPM).

Hence, the total groundwater inflow within the mine during depillaring stage of Seam I Top may be around 10,684 cum/day or 1,632 GPM. However, it is a general observation and deviation from this observation may also occur in unlike situations.

TABLE 8: ESTIMATION OF GROUND WATER INFLOW IN GAYATRI UG DURING DEPILLARING STAGE OF SEAM I BOTTOM BY MODEL II

Parameters		Value	Unit
Hydraulic Conductivity	K	1	m/d
Hydraulic Conductivity	k	1190	Milli Darcy
Saturated thickness of aquifer	H	134	m
Transmissivity	T	134	m ² /day

Sl. No	Radius of Fracture (m)	Time, min	Re	Q, (cum/day)	Q, (GPM)
1	0.1	1	72	17148	2620
2	0.1	60	556	13077	1998
3	0.1	300	1243	11961	1827
4	0.1	1440	2723	11042	1687
1	0.3	1	72	20588	3145
2	0.3	60	556	14986	2289
3	0.3	300	1243	13539	2068
4	0.3	1440	2723	12373	1890
1	0.5	1	72	22705	3468
2	0.5	60	556	16078	2456
3	0.5	300	1243	14423	2203
4	0.5	1440	2723	13108	2002

Sl. No	Radius of Fracture (m)	Time, min	Re	Q, (cum/day)	Q, (GPM)
1	0.75	1	72	24724	3777
2	0.75	60	556	17065	2607
3	0.75	300	1243	15212	2324
4	0.75	1440	2723	13757	2101
1	1	1	72	26388	4031
2	1	60	556	17841	2725
3	1	300	1243	15826	2418
4	1	1440	2723	14257	2178

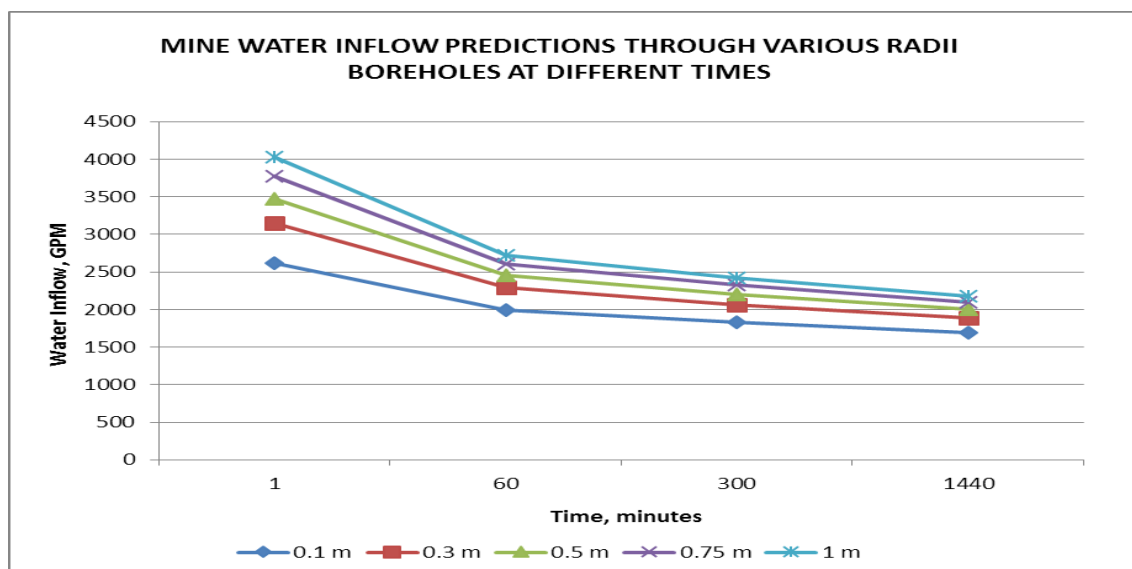


Fig. 2: Mine water inflow predictions (Seam I Bottom) through various radii boreholes at different times

Similarly, in case of Seam I Bottom, the estimation in the Model II reveals that, in a single day the inflow of water in the mine will be varies from 11,042 cum/day (1,687 GPM) to 14,257 cum/day (2,178 GPM) which is close to the inflow value calculated in Model I.

Thus, Model I (Table 6) shows that the groundwater inflow within the mine during depillaring stage is 11,470 cum/day (1,752 GPM). Moreover, according to Model II (Table 8), the groundwater inflow within the mine during depillaring stage varies from 11,042 cum/day (1,687 GPM) to 14,257 cum/day (2,178 GPM).

Hence, the total groundwater inflow within the mine during depillaring stage may be around 14,257 cum/day or 2,178 GPM. However, it is a general observation and deviation from this observation may also occur in unlike situations.

1.0 GEOLOGY

Gayatri UG mine is located in Rehar west block (Mani & Gogi blocks, combined area - 22 sq.km.), Lakhanpur coalfields of South Eastern Coalfields Ltd. The geological Block area for the Gayatri mine zone (located in Jogi Block) is around 8 sq. Km., whereas mine take area is about 6.435 sq. km. Out of five seams two seams namely I (Top) and I Bottom seam are techno-economically workable.

The Mineral Exploration Corporation Ltd., (MECL) explored the total block area about 22.0 sq.km. designated broadly as Rehar west block. However, in view of its large size, it was decided in the Co-ordination committee Meeting on 17.3.88 to divide it into two parts. The eastern part of the block was named as 'Mani block' and the western part as 'Jogi block'. However, the relevant plans viz., floor contours, seam folios etc. had been prepared and presented in the reports separately for the two blocks. Since the exploration in both the blocks had been completed simultaneously the geological report embodies the findings of the exploration carried out both in Mani & Jogi blocks.

The detailed scheme for exploration was prepared after considering the data of GSI boreholes. The work commenced in the area in August 87 and continued upto June 1989. The quantum of work carried out in these two blocks by MECL and GSI is as follows: Quantum of work carried out in Rehar west block (Mani and Jogi blocks)

A. Surveying

- i. Triangulation : 22.00 sq.km.
- ii. Surface contouring : 22.00 sq.km.
- iii. Borehole survey :-
 - a. MEC boreholes : 164-LRW series, 4-LRE series
 - b. GSI boreholes : 6 Nos. (LP-10, 25,27,29,39 & 48)

B. GEOLOGY

- i. Mapping : 22.00 sq.km.
- ii. Core logging : 16,642.20m (LRW boreholes) 573.00 (LRE boreholes)
- iii. Sampling : 701.58m (143 boreholes) 35.10m (4 boreholes)

Borehole density of the block:- 8 boreholes per sq.km.

The reduced level (RL) in the area has been carried from Survey of India Bench Mark (BM) No 4/10, located near Bishrampur Colliery Office, about 10 km away from the block. The reduced level of the BM 4/10 is 550.460 m. The RLs of the triangulation stations, boreholes and surface contours have been determined with this reference.

Recently, the coordinates of all boreholes of Rehar West block (Jogi and Mani Block) has been converted on coal grid based on World geographic system, WGS-84 system, accordingly, the coordinates of boreholes and grid has been changed. The reference point/Bench mark and other features on the surface may be changed for record. The coordinates on WGS -84 system is presented in **Annexure-I** of this report.

BLOCK BOUNDARY

The area of Mani & Jogi blocks (Rehar west) is about 22.00 sq.km and is located on the western part of the Rehar river. The approximate geographical limits, as decided for block are as follows:

- North : Jobga and Sapakara villages and Talchir/ Metamorphic contact.
 East : Rehar River (and Rehar East Block)
 South : Jobga nala, Khutiya, Mahangai and Potka village.
 West : Jobga nala, and P.W.D. road from Surajpur

MINE BOUNDARY

Considering the various parameters, boundaries of the minetake area has been defined as follows:-

- North** : Boundary fault F1-F1.
South : 1.2 m thickness line of seam –I (combined and bottom).
East : Arbitrary line, act as common boundary with Rehar UG mine
West : Jobga nala.

2.0 Geo-Mining Characteristic:-

- 2.1 **Mining Area** (approved RPR) 6.435 Sq. Km
 (Seam thickness >1.2m)
- 2.2. No. of boreholes 62 approx. (within the mining area)
- 2.3. Borehole density in
 Proposed mining area: 9.76 borehole/Sq. Km. (approx.)

2.4. **Dip & Strike:** - The amount of dip of the coal seams in the northern part is 3° (gradient 1 in 29) while the northern part decreases to 1° to 2° with northerly dips. In general, strike is toward NW-SE.

2.4.1 Roof and floor

a) **Immediate roof:-** Dominant being medium to Coarse grained sandstone and sub-ordinated by Carb shale and fine grained sandstone.

b) **In 3 m column:-** Dominant is fine to medium grained sandstone and sub-ordinated by Coarse grained sandstone and grey shale.

a) **Immediate floor:-** Dominant is fine grained sandstone, grey shale, intercalations and carb. Shale. Whereas it is sub-ordinated by medium to coarse grained sandstone.

b) **In 1 m column:-** Dominant is fine to medium grained sandstone and and intercalations.

Soil/ Alluvium:-

Thickness range of soil and alluvium is from 0.5 to 12 m. The soil is mostly composed of sandy clays. The zone of weathering varies from 5m to 32m below soil cover of the Barakar strata.

2.4.2 Dirt bands: The coal seam is almost free of dirt bands.

2.5. Intrusion: - No Intrusions in the form of Sill or dyke is noticed during exploration in the block.

2.6. Faults: - Only 6 faults named as F1, F7, F8, F9, F10 & F11 are deciphered within the considered mining area of Gayatri Project as per GR. Out of these 6 faults, F1 & F7 are boundary faults of this Project. Except F1 & F7, the throw of other faults vary in between minimum 2m to maximum 35m. However, Recently GR for PR has been made in Minex software. The fault has not been interpreted in most of the two third of southern part except in northern part where question mark has been put in absence of detailed exploration.

2.7. Forest Area: - The Project area is partly covered by forest. The forest area is 3.03 Sq. Km considering the mining area of >1.2m seam thickness. The above area was measured by Plannimeter (as per RPR, & Ref geological plan).

2.8. Seams available in the Mining Area: - Total five seams are available within the proposed area. In recent study in Minex model the seam correlation has been changed. The seam I and seam "O" has been referred as Seam I Top and seam I Bottom respectively which are as follows:-

Seam-IV:-This is the topmost coal seam and occurs in the northern part of the mining area. The depth of the seam from surface varies from 7.8m to 91.15m. In area of >15m hard cover line, it is workable in small patch varying seam thickness 1.2m to 3m. In this area, the grade of coal is mainly "E/F" grade. So, it has not been considered for extraction by underground mining (Ref. Approved RPR).

Seam-III :- It occurs 8.45 to 17.16m below Seam-IV it is generally thin seam and the seam thickness hardly crosses 1.5m in proposed mining area. The average seam thickness is 1.2m. The grade of coal is D to E. Due to low seam thickness and occurring in patch, this seam is also not considered for extraction.

Seam-II:- It occurs 16.69m to 24.27m below Seam-III and depth varies from minimum 11.23m to maximum 129.5m. In most of the area, the seam exhibits <0.9m thickness. Due to low thickness, it is an un-workable seam and it does not have any economic importance.

Seam-I TOP:- It is the most potential seam and occurs 60 to 90m below Seam-II and depth from surface ranges in between 16.15m (LRW-113) to maximum 206.99m (LRW-34) within the block. This seam has developed in the entire block and it is a composite seam within the proposed mining area except in area near borehole LP-48, LRW-36, LRW-9 and near borehole LRW-5, where this seam has splitted in top and bottom section. However, in this part, only the bottom section has workable seam thickness except borehole LP-48. In this splitted area, the grade of coal is "E/F/G". In rest of the proposed mining area, it occurs as a composite seam and thickness varies from 1.2 to 3.9 m (LRW-69). The average grade of coal is "C to D" with longflame

characteristics. The immediate dominant roof of Seam-I combined is medium to coarse grained sandstone whereas floor is fine grained sandstone, grey shale, intercalations and carb. shale.

Seam-I Bottom:- This seam is occurring below Seam-I top with parting of 15 to 20 m (approx.) and it is the lowest workable seam in the proposed mining area. The depth of occurrence of the seam varies from 32.20 m (LRW-113) to 185.62m (LRW-29). The dominant lithology of parting is fine to coarse grained sandstone. It has developed its workable thickness >1.2m in central part of the proposed mining area of Gayatri Project. In eastern and western part, the seam is not developed. The seam thickness varies from 1.2 to 4.0m (LP-27). In most of the mining area of this seam, the prevalent thickness range is in between 2 to 3m. The grade of coal is “C to D.” This seam is proposed for extraction. The immediate dominant roof of Seam-I Bottom is grey shale, intercalations of shale and sandstone whereas floor is shale and intercalations of shale and sandstone.

Out of these above five (5) coal seams, only Seam-I & Seam-“O” (i.e. **Seam-I Bottom**) were considered workable under Revised Project report of Gayatri UG (0.30 Mty).

In this scheme also the same seams are proposed to be worked. The Geological Report was formulated and submitted by MECL in November 1990 showing 14 faults. In 2014-15 GR for Project Report has been formulated by using Minex software by the exploration department of CMPDIL. In the fresh study correlation of the seam has been re-established. Accordingly, the nomenclature of seam I and Seam O has been changed as Seam I (Top) and Seam I (Bottom) respectively. As per recent assessment and co-relation of seams fault has not been found except the northern most boundary where sufficient data was not available to establish the fault. Hence question mark has been put by the geologist. Accordingly, seam –me (comb.) and Seam-O is being referred as Seam- I Top and Seam -I bottom respectively in this particular scheme.

Coal seams with parting as per PR and Minex model)

Seam / Parting	Seam/Parting Thickness (m)	Prevalent thickness in (m)
Seam IV	0.9 to 4.42	Not considered in PR by UG method
Parting	7.68 to 17.16	
Seam III	0.46 to 2.53	Not considered workable in PR
Parting	16.69 to 24.23	
Seam II	0.03 to 1.53	Not considered workable in PR
Parting	55.58 to 119.6	
Seam I (Top)	0.29 to 4.94	2.0-4.0
Parting	9.95 to 30.41	15 to 20 m
Seam I (Bottom)	0.03 to 4.0m	2.0 to 3.0

2.9 PHYSICO-MECHANICAL PROPERTIES

The bore hole LRW- 96 located in north eastern part of the block (in Mani block, above Mani Basti) was selected for Physico –mechanical tests to study the behavior of various litho –units while mining. The physico mechanical properties are presented in Table-1.

Table_1 PHYSICOMECHANICAL PROPERTIES OF B. H. LRW-96						
The partig-wise physico-mechanical properties of the strata below the weathered zone are summarised as follows:						
DEPTH (m) FROM - TO		Compressive Strength Kg/Sq.cm.	Tensile Strength Kg/Sq.cm.	Shear Strength Kg/Sq.cm.	Porosity %	Density gm/cc
16.00-25.00	Mini	95.16	4.38	11.53	14.5	2.07
	Maxi	184.5	5.54	18.2	17.14	2.34
	AV	125.84	4.94	14.95	15.58	2.13
	SD	31.83	0.52	2.87	0.87	0.19
25.00-31.52m	Mini	54.6	6.92	12.23	16.88	1.95
	Maxi	93.43	9.92	16.15	25.42	2.57
	AV	77.93	8.62	14.44	20.22	2.18
	SD	15.77	1.04	1.68	3.8	0.24
Seam III 31.52-33.53m	Mini	Nil	Nil	Nil	11.6	1.06
	Maxi	Nil	Nil	Nil	14	1.63
	AV	Nil	Nil	Nil	12.82	1.42
	SD	Nil	Nil	Nil	0.97	0.2
33.53-37.10m	Mini	92.27	3.69	8.07	15	2.04
	Maxi	128.03	8.3	11.53	21.43	2.88
	AV	102.31	5.26	9.46	17.43	2.34
	SD	13.29	1.88	1.35	2.2	0.3
37.10-50.07m	Mini	101.5	8.07	13.84	13.33	1.83
	Maxi	122.26	11.07	18.45	20.83	2.59
	AV	113.38	9.87	16.84	15.77	2.14
	SD	7.61	1.04	1.72	3.02	0.35
50.07-53.50	Mini	96.08	8.07	13.79	14.44	1.62
	Maxi	196.08	11.53	21.91	17.71	2.24
	AV	179.12	9.64	18.81	15.8	2.01
	SD	14.47	1.15	3.28	1.32	0.23
53.50-54.45 Seam-II	Mini	Nil	Nil	Nil	13.84	0.99
	Maxi	Nil	Nil	Nil	18.55	1.15
	AV	Nil	Nil	Nil	16.78	1.12
	SD	Nil	Nil	Nil	1.73	0.07
54.45-57.00	Mini	100.34	5.07	5.53	13.77	1.91
	Maxi	137.25	8.99	21.68	15.87	2.25
	AV	123.04	7.47	13.6	14.96	2.07
	SD	15.13	1.3	6.59	0.76	0.11
57.00-66.03	Mini	92.27	6.46	10.14	14.8	1.91
	Maxi	139.85	9.22	15.45	16.5	2.18
	AV	112.16	8.06	13.46	15.32	2.06
	SD	20.39	0.92	1.97	0.74	0.09
66.03-75.60	Mini	102.07	5.76	10.14	6	1.93
	Maxi	222.6	14.07	24.68	16.96	2.18
	AV	140.71	8.71	19.74	13.33	2.05
	SD	42.61	3.76	5.33	3.79	0.08

Table_1 PHYSICOMECHANICAL PROPERTIES OF B. H. LRW-96						
The partig-wise physico-mechanical properties of the strata below the weathered zone are summarised as follows:						
DEPTH (m) FROM - TO		Compressive Strength Kg/Sq.cm.	Tensile Strength Kg/Sq.cm.	Shear Strength Kg/Sq.cm.	Porosity %	Density gm/cc
75.6-84.75	Mini	80.73	5.3	4.84	13.37	1.82
	Maxi	177.04	12.45	20.06	15.9	2.32
	AV	141.3	9.26	11.66	14.02	2.08
	SD	34.9	2.68	5.3	0.95	0.16
84.75-94.35m	Mini	94	4.38	7.15	13.59	2
	Maxi	134.9	11.99	17.53	15.6	2.25
	AV	112.67	7.49	11.18	14.79	2.09
	SD	15.69	3.03	3.84	0.67	0.09
94.35-106.55m	Mini	92.2	5.89	11.53	14.3	2.05
	Maxi	131.4	9.66	16.37	15.3	2.23
	AV	100.5	7.35	14.45	14.6	2.14
	SD	19.9	1.48	2.57	0.7	0.07
106.55-117.50m	Mini	68	4.24	11.53	14.3	2.05
	Maxi	160.2	8.01	16.37	15.3	2.23
	AV	113.9	5.75	12.17	14.6	2.14
	SD	35.1	1.38	3.28	0.7	0.07
117.50-126.00m	Mini	137.2	9.42	16.37	13.1	2.03
	Maxi	220.2	12.25	21.67	14.7	2.45
	AV	186.9	10.22	19.23	13.7	2.23
	SD	38.1	1.9	2.07	0.7	0.19
126.00-137.34m	Mini	150.4	6.83	21.21	8.7	1.98
	Maxi	260.5	16.49	27.44	11.2	2.26
	AV	200.6	12.53	23.17	10.6	2.12
	SD	46.1	3.51	2.87	1.1	0.12
137.34-142.74m Seam I	Mini	Nil	Nil	Nil	15.6	1.14
	Maxi	Nil	Nil	Nil	18.6	1.36
	AV	Nil	Nil	Nil	17.1	1.22
	SD	Nil	Nil	Nil	1.3	0.04
142.74-147.5m	Mini	153.3	9.66	19.14	8.2	2.22
	Maxi	345.8	24.03	28.36	10.4	2.49
	AV	210.7	17.76	24.02	9.7	2.35
	SD	78	5.29	3.53	0.9	0.1
		AV - Average	SD- Standard Deviation			

3.0 RESERVE AND LIFE OF THE MINE

Total balance extractable reserve in seam I (Top.) and seam I Bottom has been estimated as 10.889 and 4.595 Mte respectively. The balance extractable reserve of seam I Top has been calculated as on 01.04.2016 Based on the mine working plan No. GAYATRI/SUR/20.:Dated 18.03.2016 of Gayatri mine. The summary of estimated Geological, mineable and extractable reserve is given intable-1.

Table 1: Summary of Estimated Geological reserve, as assessed (2015, Minex Model)

SEAM↓	GRADE→	SEAMWISE GRADEWISE RESERVE IN GAYATRI MINE (JOGI BLOCK)															
	G2	G3	G4	G5	G6	G7	G8	G9	G10	G11	G12	G13	G14	G15	G16	G17	Grand Total
IBOT		0.0022	0.2049	0.6495	2.1621	4.3389	0.7683	0.1984	0.1301	0.101	0.0865	0.067	0.0555	0.0418	0.035	0.0309	8.8721
ITOP	0.051	0.3304	0.6227	1.1678	9.7318	10.7558	3.0018	1.0715	0.2773	0.1974	0.1446	0.1166	0.0669				27.5356
SEAM2	0.0139	0.0054	0.1382	0.6635	0.2398	0.0177	0.0117	0.0072	0.0008	0.0008							1.099
SEAM3							0.2528	0.8225	0.8014	0.3368	0.2294	0.1574	0.1132	0.0606	0.0438	0.0261	2.844
SEAM4		0.1267	0.221	0.1572	0.1432	0.1677	0.2298	0.7106	1.6259	1.0966	1.1733	1.035	0.3387	0.2131	0.1481	0.0913	7.4782
Grand Total	0.0649	0.4647	1.1868	2.638	12.277	15.2801	4.2644	2.8102	2.8355	1.7326	1.6338	1.376	0.5743	0.3155	0.2269	0.1483	47.8289

SEAM↓	GRADE→	SEAMWISE, THICKNESS WISE GRADEWISE RESERVE IN GAYATRI MINE (GOGI BLOCK)															
THICKNESSWISE	G2	G3	G4	G5	G6	G7	G8	G9	G10	G11	G12	G13	G14	G15	G16	G17	Grand Total
IBOT		0.0022	0.2049	0.6495	2.1621	4.3389	0.7683	0.1984	0.1301	0.101	0.0865	0.067	0.0555	0.0418	0.035	0.0309	8.8721
0.90-1.20				0.0008	0.0907	0.0477	0.0309	0.0238	0.0212	0.0248	0.0212	0.015	0.0103	0.0108	0.0108	0.0115	0.3195
1.20-1.50					0.1026	0.0663	0.0602	0.0474	0.0276	0.0101	0.0141	0.0199	0.0245	0.0186	0.015	0.0194	0.4257
1.50-2.00				0.1404	0.2587	0.3006	0.1269	0.0924	0.0651	0.0609	0.0512	0.0321	0.0207	0.0124	0.0092		1.1706
2.00-2.50			0.0332	0.3052	0.905	1.1425	0.3539	0.0348	0.0162	0.0052							2.796
2.50-3.00		0.0022	0.1717	0.2031	0.7975	2.0135	0.1565										3.3445
3.00-3.50					0.0076	0.6285	0.0306					0.0076					0.6667
3.50-4.00						0.1364	0.0093										0.1457
4.00-4.50						0.0034											0.0034
ITOP	0.051	0.3304	0.6227	1.1678	9.7318	10.7558	3.0018	1.0715	0.2773	0.1974	0.1446	0.1166	0.0669				27.5356
0.90-1.20					0.0266	0.3589	0.5512	0.0987	0.0095	0.0079							1.0528
1.20-1.50					0.1295	0.4796	0.3975	0.0285	0.0112	0.0112	0.0091						1.0666
1.50-2.00				0.0159	0.4424	0.645	0.4005	0.0527	0.0258	0.0228	0.0196	0.0231					1.6478
2.00-2.50				0.024	0.8061	0.7218	0.0852	0.0551	0.0451	0.0377	0.0468	0.0527	0.0645				1.939
2.50-3.00	0.0419	0.0337	0.0093	0.1547	2.2227	1.6662	0.1864	0.1175	0.0708	0.0584	0.0604	0.0408	0.0024				4.6652
3.00-3.50	0.0091	0.2199	0.3599	0.4857	2.5246	1.8254	0.1577	0.0891	0.0714	0.0594	0.0087						5.8109
3.50-4.00		0.0314	0.1545	0.4528	2.1595	2.3774	0.1942	0.1272	0.0435								5.5405
4.00-4.50		0.0454	0.099	0.0347	1.0286	1.5528	0.5812	0.2261									3.5678
4.50-5.00					0.3918	1.0904	0.2608	0.2766									2.0196
5.00-5.50						0.0383	0.1726										0.2109
5.50-6.00							0.0145										0.0145

Technology wise Extractable coal Reserve has been assessed (As on 1.04. 2016)

Seam	Technology	Development Reserve	Depillaring Reserve	Total (Million Te)	Remarks
Seam I TOP	CM/LHCM	5.070	4.234	9.304	Partly developed and rest virgin Seam extent 6.435 Sq.km
	CM reserve +2.5 m				
	LHD/SDL	0.731	0.864	1.595	
	Total	5.801	5.098	10.899	
Seam I BOTTOM/ (Seam O)	LHD/SDL/LHCM	2.403	2.192	4.595	Virgin seam, Seam extent 3.03 Sq.km (Ref. approved RPR)

Grade of Coal: - The grade of coal as per above assessment varies mostly in G6 to G7. (Earlier C to D as per PR), the weighted average of coal in mining area is G-6 grade. The declared grade of coal is G-6.

Life of the Mine

Life of the mine had been estimated as 47 years as per approved project report, however 36 years with current rate of production and life may further reduce if coal

production is resumed by introduction of two sets of CM Package. Life of mine will be 21 years. However, the life of mine will depend on the number of CM packages and year of deployment CM for which contract is to be executed.

ACCESS TO THE MINE

The brief description of mine entries, underground drivage and other drivage / strata bunkers as per project report is given in Table -2.

Opening of Deposits:-

Location of Mine Entries:-

The inclines of Gayatri UG Project are existing inclines and located near boreholes no. LRW-18 & LRW-102 in tenancy land. Sinking of the return airshaft is completed and installed with Main Mechanical ventilator.

Mode of Mine Entries:-

Entries in seam I Top

Total two number of Inclines and one airshaft have been driven for ventilation as well as transport system for the mine. The size of the existing inclines are 4.8m x 3.0m. The length of incline is given in table-6.1. At coal touch point in the Seam-I (Top) near borehole no.GPS-1 the height of gallery is about 1.5m however after 10-20 m the height become 1.8m. It gradually increases up to 2.5 m (+) after about 1200 m. From this coal touch point, two dip drivages, each of about 252 m are already made in thin seam.

Continuous Miner equipment package will be transported from surface to working panels through the gallery. For smooth transport of continuous miner package up to working panels, height of transport gallery (One gallery) will be about 3.0 m. Therefore, about a length of about 1200 m heightening of existing gallery is required in trunk heading from coal touch point. To meet the statutory ventilation requirement one additional incline is proposed for ventilation, transport of material or man riding system.

Entries in seam I Bottom

To approach the workings of Seam-I Bottom, two (2) numbers of drift drivages in stone and one staple pit (i.e. in parting between the seams, about 20m) will be made from Seam-I(Top) workings from LHD -2 panel or at suitable location identified by the mine authority due to constraints to drive drift from LHD panel-2, if any.

Table-2 : Details of Existing Inclines/Mine entries

Sl. No	Incline / Shaft	Purpose	Dimension (width, height, gradient & depth)	Total length driven	Status
1.	Incline No.1	Material transport & intake airways	4.8mx3.0m 1 in 4.5	495	Existing
2.	Incline No.2	Coal transport, traveling & intake airways	4.8mx3.0m 1 in 4.5	495	Existing
3.	Air Shaft (6.6m dia)	Main Return airway		37m	Existing
PROPOSED DRIVAGES TO APPROACH SEAM-I-BOTTOM AND ONE ADDITION INCLINE					
4.	Stone drift no.1 and 2	Material and belt Transport	100mx2 No. 1 in 4.5	100m	Proposed (Covered in approved scheme)
5.	Staple Pit	Return airways	5.0m X 20m Deep (Appx.)	20m	Proposed (Covered in approved scheme.) (If inconvenience in staple pit drivage two additional stone drift may be driven in ug),
6.	Incline	Intake air ways	4.8mx3.0m, Gradient 1 in 5	550m	(Proposed) Flatter gradient is proposed for manriding system/ or in future for transport of CM or other bulky material
7.	Strata Bunker	Seam-I Bottom- (1 No)	Capacity 300 Te 1 no's		2 No in seam I top approved in scheme and one number for seam 1 Bottom at suitable location (proposed)

Since continuous miner is to be introduced, the early completion of proposed additional incline drivage and other developmental work is required (Viz. tendering to completion of job of incline and other drivage) before introduction of CM i.e. within 2 years period after approval of scheme. The discussion held during review meeting in presence of CMD, SECL for speedy completion of incline drivage by adopting mechanized drivage technique. This will yield early completion of work in addition to smooth and undisturbed roof strata of incline due to mechanized cutting and avoiding blasting operation. It is preferred to go for mechanized drivage of incline to maintain the proper time schedule of CM deployment.

BRIEF DESCRIPTION OF THE MINE

Surface Constraints:-

Gayatri UG mine area is located in the western side of the Rehar West block. The major surface features above the proposed mining area are Pondi Village and small hamlets, PWD road, nalla and Forest. The extraction of the workable seams have been planned in approved RPR and scheme in such a way that village and roads are not damaged due to mining operation. To protect the above surface features, only development of panels by Bord & Pillar system of mining has been proposed during assessment of reserve. No depillaring operation in panel is proposed below and around 60m from this surface features. However, depillaring beneath the structure may be considered if suitable technology by then is available with stowing etc., without shifting the village. It is also proposed that a 60m barrier (solid coal) will be left between the Jobga nalla and mine underground workings. If DGMS permits, then only development of panels near/below this area may be carried out. A fresh survey for determination of HFL may be carried out before depillaring. Other constraints are:-

- a. Mine is watery, water oozes out from drilled roof hole and sometimes from floor
- b. Undulating floor
- c. Cracks in roof

Selection of Mining Methods:-

Underground Mining:-

Seam-I (Top) and Seam-I (Bottom) are identified as potential seam for extraction by underground mining method within the Gayatri Project area. Within mining area, both seams are having seam thickness >1.5m in large area with adequate balance extractable reserves of 11.344 Mt (Seam –I). Due to good seam thickness in large area and “C/D” grade coal, these seams are proposed for extraction by underground mining. During mine it shall be kept in mind that the property of Seam-I (Top) will be extracted first and after completion of extraction of Seam-I (Top), the property of Seam-I Bottom will be extracted by the same equipment package or low height CM (LHCM) package or Semi- mechanized technology or simultaneous working may be done after initial seam development.

Bord & Pillar System of Mining:-

The seam thickness in Seam-I (Top) and Seam-I (Bottom) is in between 1.5 to 4.5 m and 1.5 to 3.0 m respectively, hence both the seams are suitable for development of its panel by Bord & Pillar system of mining. Gayatri UG Project were approved by SECL Board for extraction of the property by deploying SDLs/LHDs. In Gayatri mine area, geological disturbances (like faults) are less in comparison to the property of Rehar UG and floor contour of Seams are dipping from Rehar mine side to Gayatri mine side. Considering this, panels are proposed from Gayatri Project main dip to have rise panels and to make the panel self-draining.

The mine is suitable for introduction of additional Continuous Miner technology based on seam thickness and balance reserve.

However, this technology has some production restriction if the mine is a watery mine because operation of tyre mounted shuttle cars will create operational difficulty and

hamper the production. Recently, manufacturer claims that technology is available with soft and watery floor. The mine is under development stage and development in coal seam is under progress. In Seam-I (Top) of Gayatri mine, make of water is about 500 GPM. So, before introduction of continuous miner package equipment in Gayatri mine, hydro-geological study in the area & assessment of water percolation in underground, may be carried out.

Seam-I (Top):

Proposed Mine Development Strategy:

Initially, five numbers of dip headings (named as Maindip-2 {Part of it } and Maindip-3), commencing from existing developed area, will be developed towards dip up to the mine boundary of Seam-I (Top). The length of this Maindip about 500 m starting from already developed area is to be developed, at seam gradient upto the dip side mine boundary. (Average gradient in seam is 1 in 20 to 1 in 30).

The number of headings, in this cross dip, will be five numbers and size of the coal pillar would be 34.5m x 34.5m where depth is more than 150 m.

The panel projection has been shown in Plate-III. The panel marked as CMP-1 to CMP-26 has been identified for deployment of continuous miner, whereas panel LHD-1 to LHD-10 are identified for deployment of semi mechanized technology/LHCM at places. (Deployment for standard height CM in seam thickness +2.5m to 4.5m and for LHCM seam thickness +2.0m to 3.5m, may preferably be considered, whereas for LHD panels thickness <2.0m and other small and difficult area not suitable for deployment of CM) .

Large area of the eastern and western side property of this trunk headings is having seam thickness more than 2.5 m. The layout of the panels are proposed in in both sides of trunk headings & isochore (thickness) line of 2.5m. Thus, optimum number of panels for extraction by Continuous Miner equipment are available in area having more than 2.5 m seam thickness. These panels are laid in such a way that they are self-draining type. Main sump is proposed below Pondi village or at dip most part developed. As stated earlier that Pondi village is situated over dip most part of the considered mining property and only development of panels are proposed in this area. Considering this surface constraints, the panels below this village are proposed as a main sump for this seam. Deployment of CM and LHCM shall be done based on the thickness of seam and status of working at the time of actual deployment. Two strata bunkers has been provisioned in seam Top the capital is provisioned for the same in relevant table.

Seam- I (Bottom)

The workings of Seam-I Bottom will be approached by driving drifts at a gradient of 1 in 4.5 from the workings of Seam-I (Top) i.e. from Panel LHD-2 (refer Plate-III). From the coal touch point of Seam-I Bottom, Main dip-1 & 2 with five number of headings, having pillar size of 25.5m x 25.5m & gallery width of 4.8m, will be driven in such a way that thickness of this seam, having 2m or more falls on the eastern side of this cross dip and thus maximum panels are available in this seam for extraction by Low height Continuous Miner package/LHD or SDL as decision will be taken in due course of time at SECL. One of the gallery should be heightened up to 2.6 to facilitate the transport of

LHCM package. The Cross dip will be developed upto dip side boundary of the mine i.e. upto fault. The size of the coal pillars in this main dip-2 would be 34.5m x 34.5m where depth is more than 150m.

The length of cross dip-4 & 5 of this seam are 1500 m and 750 m respectively. The main sump for this seam is also located in panels below Pondi village and the layout of all the panels are laid in such a way that water will be accumulated by gravity in this main sump.

Near coal touch point of Seam-I bottom, drifts, will be used as main intake airways and staple pit would be used as main return airways for the workings of Seam-I Bottom. These intake and return drifts will be connected with the main intake and return airways of Main dip-1 of Seam-I (Top). These returns will be connected with the airshaft where main fan is installed.

In both seams, where thickness is in between 1.5 to 2.0 or at places up to 2.5m, panels will be worked by extra low height SDLs/LHD in combination with belt conveyors.

Provision of underground bunkers in maindip/crossdip are required to be made for uninterrupted mining operation, reducing idle running of conveyor belts and to increase total bunkering capacity in the mine. As per mine working plan received from the mine, a strata bunker is proposed at 58L/dip.

HFL lines survey (mainly for Jobga nalla), hydro-geological study etc. should be carried out before depillaring operation. Additional boreholes should be drilled, if required, over few panels considered for Continuous Miner operation to confirm the thickness as well as to have better idea about the lithology of the immediate roof and alignment of drift to Seam-I Bottom. Few boreholes lithology should be sent for testing of various parameter / data (like Porosity, compressive strength, tensile strength, shear strength and Young's modulus etc.) & physico - mechanical properties of the strata if required by scientific agency. Detail physico – mechanical properties of one borehole as per GR record is presented in the report.

FUTURE DEVELOPMENT OF SEAM-I (BOTTOM)

All arrangement should be made in advance to open the underlying seam, viz- drivage of drift, staple pit, necessary development at coal touch point, statutory permissions etc. Provision of capital has been made for making necessary drivages and installation of belt structure for establishing the mine layout for coal production in previous approved scheme and this scheme.

A bunker proposed may be constructed at the coal touch point during incline drivage only so that bunker and trunk belt are aligned from the beginning.

METHOD OF MINING

General :-

Both seams will be developed by Bord & Pillar system of mining. Seam-I (Top) will be extracted first and after extraction of this seam, the coal property of Seam-I (Bottom) will be extracted. Initially, existing LHD/SDL panels one Continuous Miner Panel medium range CM and one LHCM panels will be working in Seam-I (Top) and when LHD/SDLs are spared in this seam, it will be deployed in underlying Seam-(Bottom) or may be replaced with the low height continuous miner package after obtaining administrative and statutory approval required for operating the seam. A decision regarding deployment of LHCM/LHD/SDL may be taken later on after completion of drivages and opening of seam and observing mining conditions. The zone, eastern side of trunk headings has generally seam thickness about 2m to 3.0 m in I Bottom seam.

It is desirable that the panels in Eastern side in I top shall be liquidated on priority basis so that underlying seam I Bottom could be freed and be ready for extraction.

Main dip Development :-

The main dip of Seam-I (Top) is almost completed. Abbot 450 m development is yet to done, will be developed LHD/SDL. This main dip occur from a depth of 60m to 165m. In the area where seam height is less than 3 m , one gallery is to be heightened up to 3.0m, for transporting Continuous miner from surface to dip side workings. The size of pillar in this main dip is considered as 25.5m x 25.5m (center to center) and 34.5 mX34.5 m where depth of cover is more than 150m. The gradient of the seam is mild i.e. nearly 1 in 20m to 30m.

Proposed System of Panel development / depillaring:-

Development of a LHD/SDL Panel:-

Each LHD/SDL panels will be developed by five/six number of headings. The size of the pillars in a panel is considered according to the depth of occurrence from surface i.e. as per CMR, 1957 guidelines. The width of the gallery is kept as 4.8m whereas height of the gallery is height of the seam and maximum upto 3m. Where the thickness of seam is less than 1.5m, this area is not proposed for extraction due to technological constraints. However if there is technological advancement by then the seam thickness less than 1.5 m may be extracted , if possible.

Depillaring of LHD/SDL Panel:-

During depillaring operation each developed pillar would be divided into two equal rectangular halves by driving a split gallery, having width 4.8m, along the strike direction of the panel. The splitted half pillar on dip side of the panel would be extracted fast from this split gallery by slicing method, whereas, the rise side half pillar would be extracted from original gallery of the panel. In each half of split pillar, slices would be made and number of slices would vary with pillar size in the panel. In general, panels occurring at a depth of 90-150m from surface, the size of the pillars are 25.5m x 25.5m (center x center), the number of slices are three (3), each of 4.5m wide by leaving rib pillar of 1.8m thickness against goaf. While retreating this rib pillars

would be judicially reduced leaving less exposed coal in goaf area to avoid danger from spontaneous heating. However, the methodology may change based on the result of scientific study, statutory permission and site specific condition.

Where seam thickness is >3m, extraction height during development of panel would be upto 3m along the floor of the seam. During depillaring of panel, extraction height would be the seam would be upto the seam height.

Coal & Material transport in LHD/SDL Panel:-

In a LHD/SDL panel, blasted coal at face would be loaded by extra low height SDLs/LHDs and unload the coal onto pony belt conveyors which are installed in development heading of panel to reduce the flitting time of loading machine. These pony belts would discharge coal onto gate belt conveyor installed in one of the intake galleries of the panel. For material transport, endless haulage has been provided within the panel to make availability of materials near the face.

Ventilation system in LHD/SDL Panel:-

Out of Five/six headings, dip -side four headings (in case of six heading) would act as intake airways and rise side two headings would act as return airways. At face, auxiliary fans are provided to supply fresh air to face and to clear the dust, noxious gases, etc. If the panel is five headings panel, then instead of four headings, three headings would act as intake airways for the panel.

Development of Continuous Miner (CM) Panel:-

The panels occurring at a depth of 60m to 90m and 90m to 150m from surface, the size of the pillars would be 21m x 21m (center to center) and 25.5m x 25.5m (center to center) respectively. In more than 150m depth i.e. below Pondi village, the size of the pillars in the panel is considered as 34.5m x 34.5m (center to center)(Reg-99,CMR-1957)

All the Continuous Miner panels are proposed >2.5m seam thickness in seam I Top seam. Considering the seam thickness, the proposed Continuous Miner and its ancillary equipment like Shuttle Car, Roof bolter should capable of operating in 2.5m to maximum 4.5m thickness range. General seam thickness in seam I (Bottom) is 2.0m to 3.0 m

The Continuous Miner Panels are proposed to be developed by five number of headings. The width of each heading would be 6.0 m and the height of extraction during development would be maximum height upto 3m. If DGMS permits then only the extraction height during development can be made upto maximum height of the seam i.e. 4.5 m.

Depillaring of Continuous Miner Panel (CM) -

Once the Continuous Miner panel is developed upto the end of the panel, pillar extraction would commence from the panel boundary and gradually retreats towards maindip trunk roadways. The equipment which are proposed to be used in development of panel, the same set would also be used for extraction of pillars.

Since the size of pillars varies from 21m to 34.5m depending on depth of occurrence, the width of slice will vary accordingly.

A Continuous Miner package is presently working at Kurja Pinoura and Kapildhara mine of , SECL and producing more than 1700 TPD on day basis and average 0.42 Mty . In the above mines, the seam thickness ranges in between 2.0m to 4.5m and the seam gradient is almost flat. In the above mine, DGMS has given special permission for extraction of pillars maintaining straight line of extraction instead of diagonal line of extraction which was suggested by the equipment supplier. Permission has also given for widening of gallery / slice width more than 4.8m.

Coal & Material transport in Continuous Miner Panel -

The Continuous Miner would cut and simultaneously load the coal by its in-built stage conveyor into Shuttle car. The loaded shuttle car would discharge coal onto feeder hopper. From feeder hopper, coal would be discharged uniformly onto gate belt conveyor which is installed in central gallery of the panel. This gate belt conveyor will in turn discharge the coal on the trunk belt conveyor. The gate belt would be installed in the central gallery to ensure equal loading distances and cable length on each side of the loading point. Material will be transported by endless haulages upto the face. For transport of material within the panel, LHD may be used for quick transport in between faces where haulages are not provided.

Ventilation system in Continuous miner panel:-

In a five headings panel, three galleries on the dip side galleries of the panel to be used as intake airways and two galleries on the rise side to be used as return airways. The faces would be ventilated by auxiliary fan using ventilation ducting. The Continuous Miner should be inbuilt with automatic inter-locking water spraying arrangement i.e. before start of coal cutting operation water should spray on the coal face and thus, air borne dust will be suppressed at the face along with methane sensors.

The main advantages of using the proposed Continuous Miner Technology:-

- * The basic mining layout are similar to those already in use at CIL mines.
- * Training requirement will be reduced and much easier to understanding of new techniques.
- * Improvement in safety
- * Relatively low capital cost for high production (about 1000 to 1600 tpd) and productivity when compared to imported longwall package considering the present economic scenario.
- * Significant reduction in manpower and hence impact of higher wages would be reduced in a big way.
- * The technology being highly flexible and it can be adopted in maximum extraction, partial extraction and development as a final extraction with an aim to achieve. The recovery of coal is more compared to conventional semi mechanized technology.
- * At Continuous Miner face, coal is given shear cut and not blasted. The pillar sides are however far stronger as no shattering effect due to blasting is occurred. This may permit to increase the gallery width keeping the same pillar size.

BRIEF DESCRIPTION OF TECHNOLOGY AND PRODUCTION

Present Technology and Production :- Presently Gayatri UG mine is being worked by Bord and Pillar method of mining with SDL/LHD technology.

Existing production level.

Gayatri UG mine started in the year 2003. The mine is completed mine. Production contribution from Existing mine is 0.30 Mty i.e. 1000 tpd as per approved Revised Project Report. The actual production in the financial year 2015-16 was 0.226 Mte.

Productions during last few financial years are as follows:

YEAR	PRODUCTION IN (MTE)
2010-11	0.0282
2011-12	0.245
2012-13	0.229
2013-14	0.227
2014-15	0.219
2015-16	0.226

Mine has achieved production up to 94% of the targeted production i.e. very close to target. Total coal produced since inception of the mine is 2096158 te (2.096 Mte). The proposed production from the mine is presented in table-8.1.

		CM PRODUCTIVITY LOW HEIGHT RANGE				0.36 MTY				MINING PLAN								Table-8.1						
		CM PRODUCTIVITY 1 SET (STD HEIGHT TYPE.)				0.42 MTY				Gayatri UG														
		PRODUCTION-YEARWISE								JOB NO 512067														
PRODUCTION PROGRAMME FOR GAYATRI UG MINE (WITH MECHANISATION)																								
Production district	Total Reserve	2016-17	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14	Y15	Y16	Y17	Y18	Y19	Y20	Y21	TOTAL prod.
Seam-I Top & IB																								Expected
SDL/LHD/	1.595	0.226	0.226	0.226	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.017									1.595
CM SET1	9.304			0.21	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.000
LHCM SET 2	4.595				0.29	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.08	7.770
TOTAL	15.494																							6.129
Annual prod.		0.23	0.23	0.44	0.81	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.80	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.50	15.49
CM set		1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	

The proposed liquidation plan for the entire reserve is mentioned above. It is expected that CM set –I will be introduced after 2 and half year of approval and Second set will be introduced 1 year later than first. However both can be introduced simultaneously if requisite infrastructures are ready to contribute the desired production.

The year-wise production may vary depending on the date of actual implementation of CM packages and as per Annual Planned Production (APP) agreement made for deployment of CM .

After exhaustion of reserve identified for semi mechanized technology the equipment may be shifted to underlying seam or LHCM may be deployed in underlying seam for initial development complying all administrative and statutory obligations.

RESERVE, SEAM IDENTIFIED FOR CONTINUOUS MINER AND PRODUCTION FROM PANELS

Total reserve having thickness +2.5 m is about 9.304 Mte out of which 5.07 mte is development and 4.234 Mte is depillaring reserve and about 1.59 Mte reserve is having seam thickness in between +1.5 m to 2.5 m in seam I top. Seam -I (B) is virgin and LHCM/LHD/SDL can be deployed. Preferably after initial development by SDL/LHD LHCM should be deployed.

THE PROPOSED PRODUCTION FROM THE MINE (NORMATIVE PRODUCTION AFTER APPROVAL OF 2 ND SET CM)

Production from CM /panels

Introduction of first set continuous miner (standard height +2.5 m to 4.6 m range) will contribute additional 0.42 Mty from seam-I top and Proposed second set CM of low height continuous miner (LHCM, +1.5 to 3.5m range) will contribute 0.36 Mty from the mine. Proposed 2nd set LHCM may be introduced in I top or in I Bottom seam depending upon working condition / situation of the mine at the time of actual implementation and installation.

Production from semi- mechanized panel (thickness - 1.5 to 2.0m):-

The existing production from conventional district will reduce from 0.30 Mty after introduction of CMs and is expected by one semi- mechanized district with production contribution about 0.1 Mty (Three SDLs/ Two LHD). Production from development of main dip and also cross dips in Seam- I top/Bottom, are proposed as 300 TPD, because the seam thickness are less i.e in between 1.5m to 2.0m.

Total normative production assessed is 0.88 Mty, when all three districts are under operation. The production from each district is given in table below:

Sl. No.	Panel to be worked by	No. of Operating Panels	Prodn. from panels (TPD)	Total Additional Production (MTY)	Remarks
a	Continuous Miner panel	1	1400	0.42	Approved in scheme.
b.	Continuous mine (Low height range)	1	1200	0.36	Proposed LHCM
c.	Semi-mechanized Technology	1	330	0.10	Existing production Machine
Total		1	2930	0.88	

Available working days in a year has been considered as 300 days. It has been proposed to carry out major overhaul of Continuous miner after 48 months (approx.) and the period of overhauling is considered as 50 days. During this period, there will not be production from Continuous Miner Panel. Arrangement/and effort should be made to compensate the yearly production within the year itself with the rehabilitated trouble free machine.

LIQUIDATION SEQUENCE OF MINE FOR ENTIRE LIFE

The coal reserve will be initially liquidated by deploying standard height CM and low height range CM in seam I Top. Preferably the North- Eastern part of the seam-I Top should be liquidated on priority basis. This will free the reserve of underlying seam I-Bottom. And after initial development LHCM could be deployed for development and depillaring simultaneously. The year-wise expected production from the mine is presented in Table-8.1.

Physico Mechanical properties

The estimated RMR value of the immediate roof is 44.02 and it comes under the “fair category” of roof. RMR for each district /seam may be determined. Details of one borehole is mentioned above in tabular form.

EMP

EMP approved for this project is 0.30 Mty. The introduction of CM will enhance the production of the mine. A fresh EMP for increased production is required to be obtained. An additional approval of 1.0 Mty EMP will suffice the need of Peak production (Peak Production, $0.88 \times (1+35\%) = 1.188$ Mte). Existing EMP, (0.30 Mty) + 0.90 Mty additional EMP, say 1.0 Mty). In this scheme the area considered is same as that has been considered in the approved revised project report. There is no change in mining area.

VENTILATION

Gayatri U/G mine is a completed project with approved production capacity 0.30 Mty and additional production 0.42 Mty from first set of CM. The mine has started coal production from the year 2003 and at present, only development is being done in the mine by semi-mechanized technology. As per mine official, the said installed fan was brought from Jainagar U/G mine and not delivering desired quantity of air. Contribution of production 0.78 Mty is expected from two sets of CM panels. Total production expected is 0.88 Mty.

PRESENT VENTILATION SYSTEM AND VENTILATION REQUIREMENT

Main Mechanical Ventilator installed at Gayatri Underground Mine in air shaft, has been shifted from Jainagar reverse incline which is very old. As per mine authority, due to the existing physical condition of the MMV it is difficult to increase its capacity further. Presently the main fan is delivering 3168 cum/m. The Specification of existing MMV is given hereunder in table-3 (As per record of mine).

It is expected that existing fan will not serve the statutory requirement of air. A new fan is required to cater the need of air quantity requirement. Tentative assessment is being done below. However since it is an existing mine a complete air quantity and pressure survey shall be carried out to know the efficacy of existing ventilation system. The Capital provision for the new fan has been made in appendix A-8.1 and appendix A-2.0.

Table-3: Existing Main Mechanical Ventilator

Mine	Detail/Particular	Description	Remarks
Gaytri UG	MMV/Type	Axial flow fan	Existing fan is to be replaced.
	Make	Andrew Yule	
	Model No.	MXS 2794	
	Fan Diameter	2794	
	Shaft dia	240mm	
	Fan speed	360 rpm	
	NO. of blades	18	
	wg	28	
	Capacity (Rated)	Not written	
	Actual discharge	3168 Cum/m	
	Capacity of fan	6000 cum/m	
	Water gauge	100 mm	
	Motor rating	110 kw	
	Motor rpm	740	

Requirement of air quantity

A tentative requirement based on statutory provision is being done for estimation of MMV and capital provisioning in table given below.

S.N.	Panel -1	Size	Air requirement	Air quantity (Based on production) cum/min	Remarks
1	CM district	0.42 Mty= 1400 tpd	30 cum/s	3500	As per international requirement 25-30 cum /s air is required at LVC of CM faces
2	CM district 2	0.36 Mty= 1200 tpd	25 cum/s	3000	
3	LHD /SDL	320 tpd	10 cum/s	800	
4	Pumping /sump	5 cum/s	5 cum/s	300	
5	Miscellaneous old working	5 cum	5 cum/s	300	
	Total	2720 TPD	75 cum/s	7900	=7900/0.65 =12150 cum/min

Hence high capacity fan of capacity say, 12000 cum/min i.e. 200 cum/s is required to cater the ventilation requirement of the mine. However it is suggested that the complete ventilation survey may be carried out for assessment of ventilation requirement at the earliest.

Details of mine entries

S.N.	Particulars	Size	Gradient	Existing Length/ Depth	Purpose
1	Incline no. 1	4.8m x 3.0m	1 in 4.5	495	Material transport, Intake airway
2	Incline No. 2	4.8m x 3.0m	1 in 4.5	495	Coal transport, travelling roadway intake airway
3	Air Shaft	6.0m	-	37m	Return ventilation

Note:- Data as per annual Safety Fortnight report 2013

Since there are three openings two inclines and one air shaft. The inclines having dimension 4.8x3.0 m=14.4 m sq. each, one is being used for belt conveyor and other with haulage and serves as intake airways. It is required that one additional drivage shall be made for transport of equipment, man riding system and maintain the speed of air current within statutory limit as pre CMR- 1957. An Incline with dimension 4.8x 3.0 m be constructed with gradient 1 in 5. Capital provision has been made in Appendix- 8.1and 8.3

UNDERGROUND TRANSPORT SYSTEM

General:-

The coal produced at coal faces in the underground need to be transported effectively, economically to surface for dispatching to customers. Similarly required material have to be transported from surface to the place of usage in underground. The equipment which needs repairing have to be transported from underground to surface. New equipment and repaired equipment have to be transported from surface to underground. For performing the above jobs an efficient u/g transport system is also required. Initially transport arrangement will be provided in Seam I Top and the same will be used in Seam-I Bottom in panels after their utility in Seam-I Top.

Basic Data :-

The basic data considered for planning of underground transport system is as follows:-

i)	Av. target production (Incremental)	(Mty)	0.36
ii)	Number of workable Seams	(nos.)	Two seams
iii)	Number of SDL/LHD working panels	(nos.)-	1
iv)	Number of CM working panels	(nos)	1
vi)	Peak production from CM panel	(tpd)	1200
vii)	Working hours per day	(hrs.)	15
viii)	No.of headings trunk roadways	(nos.)	5
	- CM Panel	(nos.)	5
	- SDL Panel	(nos.)	5/6
vii)	Number of entries	(nos.)	2 inclines (intake)+1 proposed 1 Air Shaft (Return)
viii)	Details of entries, trunk roads		As given in table 10.1etc.
ix)	Life of the mine (balance)	(years)	38/21

STATEMENT OF EXISTING P&M ITEMS in Gayatri UG

SL.NO.	PARTICULARS	QTY
A	EQUIPMENT FOR UNDER GROUND TRANSPORT	
1	Main incline belt conveyor TB1 (1X110kW) W-1000 mm, L-670m,drive Horizontal loop take-up electricals suitable for 3.3 kV NFLP electricals a) Drive Head & structurals, etc. (sets) b) Idlers, Loading points, etc. (sets) c) Conveyor Gantry and drive house on surface (Civil and structural cost)	1 set 1 1 LS
2	Trunk belt conveyor TB2 (1X90kW) W-1000 mm, L-800m,drive Horizontal loop take-up electricals suitable for 550 V FLP electricals a) Drive Head & structurals, etc. (sets)	1 sets 1

	b) Idlers, Loading points, etc. (sets)	1
3	Trunk belt conveyer TB3 (1X90kW) W-1000 mm, L-650m,drive Horizontal loop take-up electricals suitable for 550 V FLP electricals a) Drive Head & structurals, etc. (sets) b) Idlers, Loading points, etc. (sets)	1 sets 1 1
4	Trunk belt conveyer TB4 (1X55kW) W-1000 mm, L-175m,drive Horizontal loop take-up electricals suitable for 550 V FLP electricals a) Drive Head & structurals, etc. (sets) b) Idlers, Loading points, etc. (sets)	1 sets 1 1
5	Gate belt conveyer 69 L (1X 41 kW) W-1000 mm, L-100m,drive Horizontal loop take-up electricals suitable for 550 V FLP electricals a) Drive Head & structurals, etc. (sets) b) Idlers, Loading points, etc. (sets)	1 sets 1 1
6	Gate belt conveyer 33LE (1X 90 kW) W-800 mm, L-825m,drive Horizontal loop take-up electricals suitable for 550 V FLP electricals a) Drive Head & structurals, etc. (sets) b) Idlers, Loading points, etc. (sets)	1 sets 1 1
7	Gate belt conveyer 33LE (Tandum) (1X 41 kW) W-800 mm, L-500m,drive Horizontal loop take-up electricals suitable for 550 V FLP electricals a) Drive Head & structurals, etc. (sets) b) Idlers, Loading points, etc. (sets)	1 sets 1 1
8	Pony belt conveyer 43LE (1X 22 kW) W-800 mm, L-100m,electricals suitable for 550 V FLP electricals a) Drive Head & structurals, etc. (sets) b) Idlers, Loading points, etc. (sets)	1 sets 1 1
9	Pony belt conveyer 8 dip (1X 22 kW) W-800 mm, L-100m,electricals suitable for 550 V FLP electricals a) Drive Head & structurals, etc. (sets) b) Idlers, Loading points, etc. (sets)	1 sets 1 1
10	Direct Haulage (at surface) (37kW) with 550V NFLP Electricals	1
11	Endless Haulage (41 kW) with 550 V FLP Electricals	1
12	Rails, 15kg/m (in tonnes)	105
13	Track Materials (Sleeper Dognails etc.)	LS
14	Haulage Rope (6x7 construction, 22mm dia.) (in km.)	4.00

B	UNDER GROUND PUMPING	
a	Pumps	
1	Pump-motor set, centrifugal, multistage, 80 lps. Capacity, 120m head, 135 kW motor, D.O.L starter, FLP electricals suitable for 550V, 3 phase, 50 Hz. Supply, complete with accessories (such as base plate, required valves, pressure gauge,flow meter etc.)	4
2	Pump-motor set, centrifugal, multistage, 80 lps. Capacity, 150m head, 150 kW motor, D.O.L starter, FLP electricals suitable for 3.3 kV, 3 phase, 50 Hz. Supply, complete with accessories (such as base plate, required valves, pressure gauge,flow meter etc.)	1
3	Pump-motor set, centrifugal, multistage, 80 lps. Capacity, 60m head, 90 kW motor, D.O.L starter, FLP electricals suitable for 550V, 3 phase, 50 Hz. Supply, complete with accessories (such as base plate, required valves, pressure gauge,flow meter etc.)	3
4	Pump-motor set, centrifugal, multistage, 38 lps. Capacity, 80m head, 125 kW motor, D.O.L starter, FLP electricals suitable for 550V, 3 phase, 50 Hz. Supply, complete with accessories (such as base plate, required valves, pressure gauge,flow meter etc.)	2
b	Pipes	
1	G.I. PIPE, medium duty, 150 mm diameter in Km.	5.6
	G.I. PIPE, medium duty, 100 mm diameter in Km.	3.52
C	WORKSHOP	
1	Light duty centre lathe, CH=200mm, DBC=1000mm	2
2	Pillar drill, cap. In steel = 38mm	1
3	Bench drill cap. In steel 13 mm	1
4	Shaping Machine, 630 mm stroke	1
5	Transformer welding set, 400 A	5
6	Oxyacetylene gas cutting and brazing set	4
	EXISTING P & M ITEMS	

Underground Strata Bunker:-

One number strata bunker (ST1) of 1x100 t capacity has been proposed at the intersection point of main dip and cross dip-1 (58L/2Dip). Trunk belt conveyor TC3 will discharge coal in the bunker. A second bunker (ST2) of 2x100t capacity will be provided between belt conveyor TC3 and TC4 in cross dip 1. Conveyor TC 4 will discharge coal in the bunker ST 2. Or at suitable location depending on, then site based mine condition. Third strata bunker has been proposed at the coal touch point of seam- I Bottom having capacity 300 te. Capital provision has been made in Appendix- 8.1

Coal from below the bunkers will be reclaimed with the help of reciprocating feeders fitted below it and load on to trunk conveyors TC2, TC3 and TC4 as the case may be. Proper communication will be provided with strata bunker operation point and various other operating points of trunk belt conveyors for better operation of the system.

Men Transport:-

Workmen will travel down the incline from man riding system which is to be installed. As the trunk roads are of mild gradient, man riding haulage with suitable design shall be provided. The capital provision has been made for man riding system in appendix 8.1

POWER SUPPLY & ILLUMINATION FOR THE PROPOSED CONTINUOUS MINER & OTHER PROPOSED LOADS:

This project is already receiving power at 33 kV from CSEB and having transformers to cater the different existing loads at main surface substation.

Proposed Stage:

For catering the power supply for the proposed loads of Continuous Miner with underground face equipments, pumping, transport & additional underground lighting loads one additional transformer of capacity **2 MVA, 33/3.3 kV**, outdoor type is proposed which will be installed near the already existing surface substation. This additional transformer will also receive power from the same 33 kV line through existing bus section at main substation.

The major functional components for this transformer are as follows:

(i) Outdoor Installations

- a) 33 kV isolators
- b) Lightning arresters for 33 kv system
- c) 33/3.3 kV 1x2 MVA transformer (vector Group-Dy11)
- d) 33 kV current transformers & potential transformer
- e) 3.3 kV FLP vacuum circuit breaker

(ii) Indoor Installations

The following switch board panel will be installed:

- a) 3.3 kv switch board, indoor type, 9 panel comprising 9 numbers of VCBs for the following functions:

Incoming feeder control	1 no.
Pumps feeder control	2 nos.
Capacitor bank control	1 no.
CM panel	2 nos.
Transport & haulage	2 nos.
Reserve feeder	1 nos.
Total	9 nos.

b) 3.3 kv, 700 kVAR capacitor bank

Apart from the above accessories the following major components will be there:

- a) 315 kVA 3.3/550 v TSU
- b) 400 Amp, 3.3 kv FLP VCBs for TSU
- c) 200/100 a, 550 V FLP ACBs

Proposed Connected Load & Maximum Demand:

The total connected load & maximum demand for the proposed loads has been assessed as 2072 kW and 1031 kVA with a corrected power factor of 0.98 (lagging) respectively.

- For **power factor improvement** two sets of 350kVAr capacity power bank is provided to maintain the pf at 0.98(lagging) even during maximum demand hours.
- Sufficient number of earth pits will be provided. The neutral of 2 MVA transformer will be earthed conforming to IS: 3043.
- Power Balance & Energy Consumption: Power balance & specific energy consumption for different options: Existing with proposed (Table-15.1), Only Proposed loads (table-15.2) and only CM option (Table 15.3) has been shown.

Salient electrical features & Cost estimate: The total capital investment of electrical P&M for the proposed loads has been estimated and shown at appendix A.3.2.1 which is Rs. 294.96 Lakhs.

Table:15.3												
POWER BALANCE OF SCHEME OF GAYATRI UNDERGROUND MINE (CM only)-Proposed												
Sl. No	EQUIPMENT	Qty.	UNIT	TOTAL	DEMAND	POWER	TAN (PHI)	ACTIVE	REACTIVE	APPARENT	ANNUAL	ANNUAL
			LOAD	LOAD	FACTOR	FACTOR		POWER	POWER	POWER	WORKING	UNITS
			(kW)	(kW)		COS(PHI)		(kW)	(kVAR)	(kVA)	HRS.	kWh
UNDERGROUND FACE EQUIPMENT (CM), Additional												
1	Continuous miner	1	585.0	585.0	0.60	0.70	1.02	351	358	501	1800	631800
2	LHD	1	37.0	37.0	0.60	0.70	1.02	22	23	32	1500	33300
3	Coal Haulers/Shuttle Cars	2	207.0	414.0	0.60	0.70	1.02	248	253	355	2100	521640
4	Feeder Breaker	1	112.0	112.0	0.70	0.80	0.75	78	58.8	98	2700	211680
5	Quad roof bolter	1	112.0	112.0	0.70	0.80	0.75	78	58.8	98	4500	352800
6	Auxiliary fan	2	15.0	30.0	0.60	0.70	1.02	18	18	26	1800	32400
Total				1290.0		0.72		796.4	770.1	1108		1783620.0
Add distribution losses at 3.0%											Add 3.0% Loss	53508.6
PROJECT TOTAL												1837128.6
											Specific Energy Consumption, kWh/Te	2.087646

MANPOWER

Total existing manpower as on 01.04.2016 in the mine is 641. OMS - 1.47 and EMS is Rs. 3140.47. As per scheme submitted by mine authority the man power is sufficient to take up the above job without additional manpower.

Exact manpower requirement for introduction of CM depends on mode operation. A study for introduction of CM has been done on two methods Risk and Gain Vs Hiring option. Presently hiring option is relatively cheaper than Risk and gain (in study of Sheetaladhara –Kurja Vs Hadibari UG project, hiring option has been found more economical). In this mine it is to be decided at SECL regarding mode of operation. In hiring option only statutory manpower is required to supervise the panel i.e. 15 numbers in LHCM district with production contribution from CM faces will be 0.36 Mty.

LAND REQUIREMENT

General:-

As per approved project report total revised mining area under the Project (project area) is 6.435 Sq. Km. except residential out of which 3.06 sq km falls under forest land. The capital required for acquisition of land has been approved in scheme for introduction of CM in 2016. The acquisition of land shall be carried out as per prevailing R&R policy of SECL/CIL.

Existing Status:-

Mining right -Mining right for Rehar & Gayatri UG Project has been marked and obtained permission for mining operation as per information by project officials. The proposed Gayatri Project Mining area falls within this mining right area except a small area in north-west direction.

Surface right- As per data obtained from Area authority, an area of about 31.268 Ha of land had been acquired as on 31.03.03, for construction of various service buildings & infra-structure development. Out of which, 6.191 Ha is of tenancy type and 21.077 Ha is of Govt. type land.

20.0 MINE CLOSURE

20.1 Mine Closure Activities

Mine Closure activities with time frame and cost shall be detailed in the revised Mine Closure Plan. As per guidelines of the MoC, the cost of mine closure is to be computed on the basis of the area involved in the project. For Gayatri U/G Mine the Progressive Mine Closure Plan has already been approved. With the introduction of Continuous miner the life of mine will reduce due to increase in production. Accordingly the amount to be deposited be reviewed time to time for payment. A calculation based on present scenario is presented in table 1 below.

MINE CLOSURE CALCULATION FOR GAYATRI UG MINE						
Total Amount of Corpus is: 533.861 Lakhs as on 31.03.2010					Yearly amount deposited	
					2010-11	11.864
Total amount already paid (assumed to be) as on 20.06.2016 is: 80.696 Lakhs					2011-12	12.457
					2012-13	13.08
Total amount to be paid for rest of mine life is: 453.165 Lakhs					2013-14	13.734
					2014-15	14.42
Now as the mine life decreased with increased production i.e 21 years					2015-16	15.141
we should distribute 453.165 Lakhs (i.e current value of corpus) for this 21 years					TOTAL Deposited	80.696
1sy year annual corpus is: 21.579						
		Year	Yearly amount in Rs in lakhs	Reimbursable amount		
		Y1	21.579			
		Y2	22.658			
		Y3	23.791			
		Y4	24.981			
		Y5	26.230			
	PHASE-1		119.239	95.391		
		Y6	27.541			
		Y7	28.918			
		Y8	30.364			
		Y9	31.882			
		Y10	33.477			
	PHASE-2		152.183	121.746		
		Y11	35.150			
		Y12	36.908			
		Y13	38.753			
		Y14	40.691			
		Y15	42.726			
	PHASE-3		194.228	155.382		
		Y16	44.862			
		Y17	47.105			
		Y18	49.460			
		Y19	51.933			
		Y20	54.530			
	PHASE-4		247.890	198.312		
		Y21	57.256			
	PHASE-5			770.796		
	TOTAL CORPUS PAID		770.796			

FINANCIAL EVALUATION

GENERAL

Gayatri underground mine is a completed project. The mine is presently being operated by deploying Semi mechanised technology (LHD/SDL). As per the data of mine for the financial year 2015-16, the mine has incurred a loss (-1126.27 Rs./te). One set continuous miner has been approved for the capacity of 0.42 Mty. However a new seam has been opened up where there is potential to introduced 2nd set Low height range CM (LHCM) for a capacity of 0.36 Mty.

Capital Investment in the mine

Following table shows the approved Capital Expenditure against Gayatri U/G Mine :

S. No.	Item	Amount in Rs. crores
1.	Capital as per approved RPR	21.814
2.	Capital Expenditure as on 31/03/2016	
	Gross Block	31.6834
	Net Block	13.6498
3.	Scheme approved for introduction of CM (Land cost included)	105.5566

Proposed capital investment for 2nd set of CM package.

SCHEME FOR INTRODUCTION OF CM GAYATRI UG MINE		APPENDIX -A	
(RISK & GAIN METHOD)		(Rs. Lakhs)	
		OPTION-I	OPTION-II
SI .No.	PARTICULARS	SCHEME, 2016 RISK &GAIN	PARTIAL HIRING
		SCHEME JUNE,16	SCHEME JUNE,16
		ADDITIONAL CAPITAL	ADDITIONAL CAPITAL
1	LAND (Appendix A.1)		
2	BUILDINGS		
	a) Service Buildings (Appendix A.2.1)	23.95	23.95
	b) Residential Buildings (Appendix A.2.2)		
	Sub Total (2)	23.95	23.95
3	PLANT & MACHINERY (Appendix A.3)	10369.10	1073.39
4	FURNITURE & FITTINGS (Appendix A.4)		
5	RAILWAY SIDING (Appendix A.5)		
6	VEHICLES (Appendix A.6)		
7	PROSPECTING AND BORING (Appendix A.7)		
8	DEVELOPMENT		
8.1	Capital Outlay in Mines (Appendix A.8.1)& other	8663.27	1145.00
8.2	Road & Culverts (Appendix A.8.2)		
8.3	Water Supply for CM equipment (Appendix A.8.3)	46.39	46.39
8.4	EMP capital (data generation) (Appendix A.8.4)		
8.5	Research & Development (Appendix A.8.5)		
8.6	PR preparation Cost (including EMP prep.)		
	Sub Total (8.1 to 8.6)	8709.659	1191.387
	TOTAL (1 to 8)	19102.705	2288.728
9	REVENUE EXPENDITURE CAPITALISED DURING DEVELOPMENT PERIOD (Appendix A.9)		
	TOTAL (1 to 9)	19102.705	2288.728
10	LESS DEPRECIATION CAPITALISED DURING DEVELOPMENT		
	GRAND TOTAL	19102.705	2288.728
	Job No. 512067		
	Note -Capital provision indicated in appendix is not for indenting purpose		

ECONOMICS

CAPITAL REQUIREMENT FOR THE SCHEME

Total capital requirement for the Gayatri UG for second set CM has been assessed and presented in various Appendices .The details of additional capital investment are shown in Appendix – A,, A.2, A.2.1, A.2.3, A.3, A.3.1.1, A.3.3, A.8.1, A.8.3. The above tabulated investment is for catering to the needs of incremental production of 0.36 Mty. For both risk and Gain and Partial Hiring option. The financial exercise has been carried out for both risk and gain vis- Partial Hiring mode provision in order to study the financial viability in both mode of CM operation.

However, a study has been done to compare the risk and Gain and Partial Hiring option based on actual terms and conditions of the contract of Sheetal Dhara/Kurja and Haldibari UG . The Net present value of cash outflow and Inflow has been calculated and LRMC has been finally calculated. It is observed that LRMC for Partial Hiring method is Lower compared to Risk and gain method. Which indicates at this stage and conditions Hiring mode is relatively cheaper.

Major investment is being incurred against P&M items, main mechanical ventilator, an additional incline drivage, strata bunkers modernization of mine in respect of communication and monitoring heads. Total Activity wise capital provision is presented in Appendix-A. The table above shows the additional capital investment being proposed in this Scheme for introducing LHCM in Gayatri U/G Mine in Risk and Gain Sharing and Partial Hiring mode. The capital will be approved for approve mode of operation of CM.

INTRODUCTION (MODE OF CM OPERATION)

Continuous Miner technology is in operation in number of mines in SECL command area since 2002. In all these mines, the mode of operation is out-sourcing. Out-sourcing of the continuous miner district is being done in two modes:

- (i) Risk and Gain Sharing
- (ii) Hiring

In **Risk and Gain Sharing** mode, the continuous miner package equipment is procured by the company departmentally (SECL). The equipment supplier or his sub-assignee operates and maintains the equipment and also produces coal as per the guaranteed production committed in the agreement. The company pays to the equipment supplier the cost of maintenance spares on per tonne basis. The company also pays to the equipment supplier the service cost on per tonne basis for the manpower involved in the operation and maintenance of continuous miner package. The scope of work also involves scientific investigations for support design during development and extraction stage, installation and commissioning of equipment, pre-production planning and site preparation, training, etc. For all these services, company pays separately to the equipment supplier or his sub-assignee. Face ventilation and pumping is in SECL's scope of work. The expenditure on revenue items such as roof bolt assembly, drill rods and drill bits, consumables and lubricants for the continuous miner package has to be borne by the company.

In **Hiring** mode SECL pays to the contractor a single out-sourcing cost on per tonne basis against an annual production guarantee. This cost is expected to include the

various costs involved in the Risk and Gain sharing mode besides the ancillary costs being borne by company.

As per the directives of SECL Board, the economics of this Scheme has been worked out in both modes.

In order to compare the economics of both modes on an equitable platform, capital and operating cost figures have been taken from the following contracts:

- (a) Contract between SECL and JMML, UK for supply of equipment, initial spares, consumables, maintenance spares, provision of services and scientific site investigation for introduction of continuous miner technology at Sheetaladhara-Kurja U/G Mine, Hasdeo Area (Base date August 2007)
- (b) Contract between SECL and JMS Pvt. Ltd. for introduction of continuous miner package on hiring basis at Haldibari U/G Mine, Hasdeo Area (Base date September 2014)

The reason for taking the data from these two contracts is that in both contracts the average annual production is 0.42 Mty and both contracts are being implemented in mines of Hasdeo Area in Seam 4A under comparable mining conditions.

Cost of continuous miner package has been taken from the Standard Price List of Mining Equipment, June 2015 (escalated up to February 2016) circulated by the Specialist Cell of CMPDI, Ranchi.

Capital cost of other services forming part of Sheetaladhara-Kurja Contract are tabulated as under:

S. No.	Activity	As per Sheetaladhara-Kurja Contract (Base date Aug 2007)	Considered in Scheme (February 2016)
		Cost in US \$	Cost in US \$
1.	Pre-production Planning & Site Preparation	609342.45	649164.6226
2.	Assembly, Installation, Training & Commissioning	412061.93	438991.2885
3.	Training Abroad	122294.10	130286.3493
4.	Mobilisation Cost	52234.00 + Rs. 12300000.00	55647.63278 + Rs.18460603.45
5.	Scientific Site Investigation & Monitoring Phase 3 & 4	796368.63	848413.4679

The above capital costs have been escalated considering the Labour Index of UK (Unit Wage Cost –whole economy third quarter 2007 – 96.4, Unit Wage Cost –whole economy third quarter 2007 – 102.7). Mobilisation cost payable in INR has been escalated considering WPI (all commodities) (WPI in August 2007 – 116.0, WPI in March 2016 – 174.8)

The operating cost parameters recorded in Sheetaladhara - Kurja Contract are tabulated as under:

As per Sheetaldhara-Kurja Contract (Base date August 2007)				Considered in Scheme	
Annual Production Period	Production (t)	Supervision Services (US \$/t)	Maintenance Spare Parts FOB (US \$/t)	Supervision Services (US \$/t)	Maintenance Spare Parts FOB (US \$/t)
1 st	360000	8.72	1.50	9.29	1.89
2 nd	460000	4.95	4.37	5.27	5.49
3 rd	420000	4.82	4.37	5.14	5.49
4 th	460000	4.95	4.37	5.27	5.49
5 th	400000	4.87	3.29	5.19	4.14
Total / Wt. Avg.	420000	5.56	3.67	5.92	4.62

The Maintenance Spares cost/t has been escalated considering the Retail Price Index of UK (RPI in August 2007 – 207.3, RPI in December 2015 – 260.6). For arriving at the landed cost of maintenance spares, conversion factor considered is 1.44545. This factor has been obtained from Hasdeo Area. Exchange rate considered is 1 US\$ = Rs. 68.616 as on 29/02/2016 as displayed on Reserve Bank of India website.

The Supervision Services cost/t has been escalated considering the Labour Index of UK (Unit Wage Cost –whole economy third quarter 2007 – 96.4, Unit Wage Cost – whole economy third quarter 2007 – 102.7).

In addition the quantity and last purchase price of revenue items such as roof bolt assembly, drill rods and drill bits, consumables and lubricants for the continuous miner package falling under the scope of work of SECL and supplied by SECL against Sheetaldhara-Kurja Contract since inception upto March 2016 has been obtained from Hasdeo Area. This cost works out to Rs. 97.75/t of actual production upto 31/03/2016. Miscellaneous expenditure has been considered as per norm.

Hiring Rate

Hiring rate considered in this Scheme for calculating the economics in Hiring Mode is the rate awarded by SECL for continuous miner deployment on hiring basis at Haldibari U/G Mine of Hasdeo Area after escalation as per the price variation clause in Haldibari NIT. The calculation of hiring rate is tabulated as under:

S. No.	Particulars	Value
1.	Hiring Rate as per Haldibari U/G LOI excluding 12.36% service tax (Rs./t)	1318.00
2.	Base WPI for Haldibari Contract (September 2014)	185.0
3.	WPI in March 2016 (obtained from website www.eaindustry.nic.in)	174.8
4.	Escalation formula as per Haldibari NIT	
5.	Modified hiring rate in March 2016 considering escalation formula as per Haldibari NIT (Rs./t)	1285.30

Sale Price of Coal

As per the borehole data, the weighted average GCV of I Top & I Bottom seam for remaining coal works out to 5526 kCal/kg which corresponds to GCV band G6. Effective grade for Gayatri U/G Mine for 2016-17 is G6.

Therefore in this Scheme incremental economics and its impact on overall profitability of the mine has been worked out in 2 options, viz.

- **OPTION –I** :Risk and Gain
- **OPTION- II-** :Partial Hiring

Considering notified sale price of G6 coal for power sector (Rs. 1900/t and sizing charge Rs. 79/ te.) economics has been worked out.

Cost of Production

The incremental cost of production at 100% capacity utilization level is tabulated as under for Risk and gain sharing basis (Option-I) and Partial hiring Mode (Option-II).

S. No.	Item	Unit	Option 1	Option 2
			RISK& GAIN SHARING BASIS	PARTIAL HIRING BASIS
1.	Production	Lakh t	3.60	3.60
2.	Salaries and Wages	Rs./t	206.44	39.60
3.	Stores	Rs./t	534.37	15.25
4.	Power	Rs./t	16.38	7.57
5.	Miscellaneous	Rs./t	32.44	13.77
6.	Mine Closure	Rs./t	8.10	8.10
7.	Interest on Working Capital	Rs./t	38.56	4.07
8.	Depreciation	Rs./t	593.55	74.60
9.	Supervision Services Cost	Rs./t	432.32	0
10.	Interest on Working Capital	Rs./t	20.90	62.12
11.	Incremental Cost(100%)	Rs./t	1883.05	1510.38
12.	Sales Realization	Rs./t	1950.50	1950.50
13.	Incremental Profit / Loss	Rs./t	67.45	440.12
14.	Incremental Profit / Loss	Rs. Crs.	2.43	15.84
15.	Incremental IRR(100%)		2.34%	113.33%
	Incremental IRR(85%)		-3.80%	89.50%
16.	Payback period (100%)		11 years	3.42 YR
	Payback period (85%)		>11 years	3.72 YR
	BEP (In Mte)		0.34	0.09

Detail of all appendices and cash flow for both options are annexed with this report.

CONCLUSION

Gayatri underground mine is a completed project. The mine is presently being operated by deploying Semi mechanised technology (LHD/SDL). As per financial data of mine for the financial year 2015-16, the mine has incurred a loss (-1126.27 Rs./te). One set continuous miner has been approved for the capacity of 0.42 Mty. However a new seam has been opened up where there is potential to introduced 2nd set Low height range CM (LHCM) for a capacity of 0.36 Mty.for which Competent Approval is necessary.

A fresh approval of EMP for an additional capacity 1.0 Mty will be needed. However there is no change in approved RPR boundary.

As on 01/04/2016, the balance extractable reserves in Gayatri U/G Mine is 15.49 Mt in Seam-I Top and I -Bottom. With proposed technology and maximum achievable capacity of 0.88 Mty, the balance life of the mine as per production schedule will be 21 years.

The incremental economics and its impact on the overall profitability of Mine has been worked out considering the notified sale price of coal for GCV bands G6 in this Scheme.

In Gayatri UG mine, the grade of coal is C/D (Geological & declared weighted average grade GCV-6).The IRR at 100% and 85% production level worked out to be 113.33% and 89.50%, and payback period 3.42 years in Partial Hiring mode and 2.34% and -3.80% with payback period 11 years in case of Risk and gain Sharing basis. Detail are presented in Appendix-C3 of both mode of operation

In Risk & Gain Sharing Mode, the payback period is 11 years at 100% production capacity and the mine earns an overall profit of Rs. 2.43 crores due to the additional investment and incremental production proposed in this Scheme considering the notified sale price of avg. weighted geological grade (G6) of coal.

In Hiring Mode, the payback period is 3.42 years and the mine earns an overall profit of Rs. 15.84 crores due to the additional investment and incremental production proposed in this Scheme considering the notified sale price of avg. weighted geological grade (G6) of coal.

Hence this Scheme for Introducing LHCM (0.36 Mty) in Gayatri U/G Mine may be considered for approval on incremental economics.

Table-5: Cost Sheet of the mine for financial year 2015-16

PARTICULARS	GAYTRI
Total Production (LT)	2.27
Manpower (No.)(31.03.2016)	641
OMS (Te)	1.47
EMS (₹.)	3140.47

CPT AS PER COST SHEET OF 2015-16, GAYATRI MINE , BISHRAMPUR AREA		
EXPENDITURE	₹. LACS	CPT (₹.)
SALARY & WAGES	4833.18	2133.85
ADMN EXPENSES	430.54	190.08
STORES (Expl, Timber, Other store)	628.22	277.36
POWER(INCL.G.SET)	860.74	380.02
Miscellaneous(Other contractor, Purchase repair, Welfare exp, Other Miss exp. Transport)	1146.52	506.2
INTEREST	0.13	0.06
DEPRECIATION	160.53	70.87
TOTAL COST	8059.85	3558.44
NET S.VALUE OF RAW COAL	5459.09	2410.19
PROFIT/LOSS ON COAL	2600.76	1148.24
Total loss in (Lakhs)	-2600.76	

Impact on overall economics with introduction of CM (0.36 Mty) for both option Risk and Gain and Partial Hiring has been presented in Table-6 below.

GAYATRI CM SCHEME UG [TOTAL 0.88 Mty] (G6)							
Statement Showing Unit Cost Estimate.							
OPTION -HIRING							
Sl.No	Particulars		Existing Cost Sheet (2015-16) (Rs./t)	Apportioned Total Cost (2015-16) (Rs./t)	Approved Scheme (Incremental) Cost (Rs./t)	Incremental Cost (Rs./t)	Overall Cost (Rs./t)
A	Production (Mty)		0.227	0.10	0.42	0.36	0.88
1	Salaries,Wages & Benefits		2133.85	2420.15	19.05	39.60	300.31
2	Stores		277.36	417.83	21.42	15.25	63.94
3	Power		380.02	688.84	41.10	7.57	100.99
4	Misc. exp.		696.28	1070.60	3.82	13.77	129.12
5	M.Closure		0	0.00	0.00	8.10	3.31
6	Depreciation		70.87	160.87	33.04	74.60	64.57
7	Int. on wkg. cap @	14.50%	6.00%	0.14	4.13	4.07	3.65
8	Int. on loan cap @ *	11.50%	0.00%	0.00	0.00	0.00	0.00
			3558.44	4758.42	122.55	162.96	665.89
9	MARC		0.00	0.00	1318.00	1285.30	1154.85
10	Int. on wkg. cap @	14.50%	0.00	0.00	63.70	62.12	55.82
B	All Inclusive Cost		3558.44	4758.42	1504.25	1510.38	1876.55
C	Sales Price (G6 Power Sector)	(Rs./t)	2410.19	1950.50	1950.50	1950.50	1950.50
D	Profit & Loss (C-B)	(Rs./t)	-1148.25	-2807.92	446.25	440.12	73.95
E	Gorss P/L	(Rs Crs)	-26.07	-28.08	18.74	15.84	6.51
Note:	Manpower as on 31.03.2016 is 641 (as per cost sheet). The above overall exercise has been done considering required manpower 350 . After implementation of scheme There will be surplus Manpower that will require its proper utilisation.						

ANNEXURE-I				
CORDINATES OF ALL BORE HOLES OF REHAR WEST BLOCK (COVERING JOGI ANG MANI BLOCK), BOREHOLES FALLING IN COMMAND AREA OF GAYATRI AND REHAR UG BASED ON WGS-84 SYSTEM				
BORID	DEP	LAT	RL	FINAL DEPTH(m)
LP010	2891224.861	1013025.418	542	300.5
LP022	2892127.383	1012397.181	538	1000
LP025	2887713.212	1013143.162	568	275.3
LP027	2889035.633	1012369.686	560	259.6
LP029	2887296.584	1012186.822	555	204.45
LP039	2890326.378	1011759.604	558	216.65
LP048	2887941.802	1014023.063	576	318.45
LRE001	2892830.483	1012684.626	544.08	183
LRE002	2892404.603	1011853.085	541.37	140
LRE003	2892872.062	1011072.810	551.58	162.5
LRE004	2893256.558	1011886.188	553.02	187.5
LRW001	2891187.996	1013418.301	552.06	175.5
LRW002	2890417.742	1013387.388	555.55	176.3
LRW003	2890046.949	1012596.675	556.91	112.7
LRW004	2889624.107	1013442.447	559.9	138.85
LRW005	2891260.779	1012597.191	540.94	157.85
LRW006	2889192.890	1012721.011	564.54	115.6
LRW007	2888853.666	1013459.009	566.07	140.05
LRW008	2888350.154	1012765.762	567.71	154.2
LRW009	2888027.222	1013565.079	574.45	135.5
LRW010	2889268.955	1014272.093	563.19	183.5
LRW011	2887551.420	1012782.778	562.9	105.15
LRW012	2889674.884	1011782.480	557.86	96.75
LRW013	2891264.422	1011832.131	552.44	151.6
LRW014	2892061.045	1011835.048	540.72	145.35
LRW015	2890912.279	1011017.646	549.16	156.65
LRW016	2890092.746	1010980.347	552.48	75
LRW017	2888870.448	1011754.804	560.3	133.6
LRW018	2888068.053	1011749.920	555.33	84.2
LRW019	2889294.811	1010953.958	549.07	61.1
LRW020	2890010.300	1014248.354	563.1	181.65
LRW021	2891697.355	1011028.490	543.04	112.85
LRW022	2887225.862	1013592.628	563.77	115.6
LRW023	2887649.353	1014343.881	578.36	160
LRW024	2892013.411	1013458.128	548.51	212.05
LRW025	2892824.162	1013493.862	543.61	56.3
LRW026	2891197.033	1013824.524	557.29	187.1
LRW027	2890814.959	1013846.230	558.92	184.5
LRW028	2889583.677	1014157.729	563.03	161.35
LRW029	2892008.826	1013053.884	540.09	190.3

ANNEXURE-I				
CORDINATES OF ALL BORE HOLES OF REHAR WEST BLOCK (COVERING JOGI ANG MANI BLOCK), BOREHOLES FALLING IN COMMAND AREA OF GAYATRI AND REHAR UG BASED ON WGS-84 SYSTEM				
BORID	DEP	LAT	RL	FINAL DEPTH(m)
LRW030	2891634.229	1013442.629	546.5	172.4
LRW031	2890000.837	1013787.165	561.64	146.7
LRW032	2891308.166	1010230.305	540.94	69.6
LRW033	2890386.955	1013815.763	563.13	147.7
LRW034	2892411.671	1013467.158	546.13	215
LRW035	2890853.297	1012211.503	552.45	135.2
LRW036	2890000.522	1013404.411	552.06	144.6
LRW037	2889200.237	1013752.056	568.15	154
LRW038	2891261.651	1012226.698	546.68	155
LRW039	2888791.198	1014142.508	569.98	171.65
LRW040	2890453.263	1012195.984	551.64	132
LRW041	2891666.965	1012241.345	542.89	158
LRW042	2888775.355	1014535.161	566.89	186.6
LRW043	2889218.822	1013341.220	565.8	138.7
LRW044	2890865.726	1011811.441	553.85	119
LRW045	2890877.326	1011414.319	554.95	86
LRW046	2888374.496	1014508.971	571.93	182.4
LRW047	2891275.871	1011432.939	553.48	95
LRW048	2891665.987	1011829.958	546.09	143.5
LRW049	2888388.625	1014129.591	573.52	161.25
LRW050	2890829.264	1013002.036	551.11	136
LRW051	2889976.329	1014587.739	573.6	132
LRW052	2891694.476	1012694.054	534.13	164
LRW053	2892597.637	1013164.603	539.51	204.25
LRW054	2890000.773	1012990.813	551.01	120
LRW055	2889627.146	1012960.500	554.41	116.1
LRW056	2888360.613	1013321.681	573.32	132
LRW057	2891595.715	1013857.426	551.71	212.1
LRW058	2888403.113	1013726.277	571.08	136.7
LRW059	2890462.955	1012988.300	543.97	119
LRW060	2888758.036	1013793.904	566.84	152.5
LRW061	2887210.239	1014191.045	567.62	121
LRW062	2887193.700	1014489.988	570.96	133.5
LRW063	2887602.818	1013722.302	568.6	127.85
LRW064	2892070.768	1013771.077	553.95	198.9
LRW065	2890385.227	1014215.070	559.45	171
LRW066	2887613.200	1013307.929	567.62	117.6
LRW067	2889661.178	1012167.372	564.04	112
LRW068	2887516.412	1014020.278	572.96	142.8
LRW069	2889656.571	1012549.298	561.74	116.6
LRW070	2889269.353	1011752.202	556.82	85.55

ANNEXURE-I				
CORDINATES OF ALL BORE HOLES OF REHAR WEST BLOCK (COVERING JOGI ANG MANI BLOCK), BOREHOLES FALLING IN COMMAND AREA OF GAYATRI AND REHAR UG BASED ON WGS-84 SYSTEM				
BORID	DEP	LAT	RL	FINAL DEPTH(m)
LRW071	2890137.855	1011799.020	560.67	98
LRW072	2889299.268	1011362.163	552.4	72.6
LRW073	2890040.879	1012162.318	560.47	106.7
LRW074	2892081.790	1011465.405	541.73	142.5
LRW075	2889701.812	1011377.841	555.49	71.25
LRW076	2890058.840	1011390.810	558.27	70
LRW077	2892090.533	1011137.093	537	115
LRW078	2890489.025	1011401.335	551.04	86.75
LRW079	2890506.096	1011005.081	552.07	62.25
LRW080	2889739.375	1010958.374	554.18	52.9
LRW081	2890956.145	1010665.685	541.95	67.15
LRW082	2891313.044	1011055.868	548.57	80.5
LRW083	2891726.603	1010684.746	539.25	66
LRW084	2891330.456	1010661.714	539.63	55.5
LRW085	2890120.250	1010586.718	548.32	59
LRW086	2890946.073	1010229.359	542.6	57.25
LRW087	2889717.485	1010569.140	546.86	95.6
LRW088	2892339.700	1013751.675	551.39	80
LRW089	2892955.564	1013260.142	534.97	231.6
LRW090	2891378.418	1009866.089	549.34	65
LRW091	2887248.054	1012490.320	559.97	140
LRW092	2889259.045	1012154.274	561.03	98.65
LRW093	2888040.905	1012530.003	564.84	101
LRW094	2887695.130	1012456.641	558.49	101.6
LRW095	2888895.985	1011347.825	554.59	62
LRW096	2890810.573	1013420.053	558.8	147.5
LRW097	2888857.293	1012142.406	562.52	98
LRW098	2890369.479	1014598.091	553.41	28
LRW099	2891188.813	1014220.723	556.57	28.5
LRW100	2887319.497	1012833.016	562.83	90.1
LRW101	2890785.671	1014209.766	561.52	183.75
LRW102	2888041.791	1012126.676	557.31	110.1
LRW103	2887956.377	1013240.366	570.61	108.2
LRW104	2887639.378	1012113.598	551.91	74
LRW105	2888024.129	1012917.096	567.47	106
LRW106	2889576.910	1014561.259	558.23	24.5
LRW107	2888597.429	1012466.748	564.9	148
LRW108	2887300.822	1013282.566	562.08	85.25
LRW109	2888720.457	1012869.475	565.05	113
LRW110	2888458.410	1012127.996	563.7	94
LRW111	2889178.985	1014563.140	560.56	24

ANNEXURE-I				
CORDINATES OF ALL BORE HOLES OF REHAR WEST BLOCK (COVERING JOGI ANG MANI BLOCK), BOREHOLES FALLING IN COMMAND AREA OF GAYATRI AND REHAR UG BASED ON WGS-84 SYSTEM				
BORID	DEP	LAT	RL	FINAL DEPTH(m)
LRW112	2888459.736	1011725.409	559.5	60
LRW113	2888488.039	1011329.359	553.36	46
LRW114	2890383.035	1012549.118	551.71	106
LRW115	2891323.470	1013268.189	551.2	31
LRW116	2891474.432	1013028.678	548.97	26
LRW117	2890529.853	1013693.560	560.54	31
LRW118	2890721.593	1013586.275	556.42	26
LRW119	2890911.791	1013473.691	551.26	26
LRW120	2890203.228	1013803.910	563.54	37.5
LRW121	2889788.462	1013558.791	555.64	47
LRW122	2889793.489	1013883.636	562.24	40
LRW123	2886898.046	1014613.034	571.07	20
LRW124	2888969.425	1013886.443	566.12	26
LRW125	2887364.262	1014410.636	572.62	24
LRW126	2888594.536	1014060.784	573.23	37.25
LRW127	2888139.319	1014176.086	575.11	28.2
LRW128	2887300.114	1013889.467	568.51	23
LRW129	2888635.297	1013533.423	570.03	46.9
LRW130	2887091.135	1013984.689	565.39	16.5
LRW131	2887701.433	1013853.820	572.33	28.5
LRW132	2888876.955	1013575.712	569.47	26
LRW133	2889094.098	1013591.839	567.75	29
LRW134	2889364.269	1013592.079	564.3	28
LRW135	2888198.655	1013842.119	576.01	32
LRW136	2887968.828	1013842.520	575.31	29
LRW137	2889588.517	1013636.886	559.48	29
LRW138	2888383.459	1013038.767	570.73	117.6
LRW139	2890221.859	1013302.483	550.33	33
LRW140	2888837.775	1013212.279	566.6	127.9
LRW141	2890636.282	1013209.643	554.31	23
LRW142	2888912.451	1012624.165	564.67	110.85
LRW143	2891054.340	1012835.448	544.66	17
LRW144	2888939.458	1011052.360	549.44	109.5
LRW145	2891460.687	1012418.934	541.77	20
LRW146	2891897.526	1012021.098	539.72	16
LRW147	2889311.329	1010570.605	546.31	83
LRW148	2889851.175	1010225.936	546	65
LRW149	2890529.606	1010625.725	546.47	74
LRW150	2890562.803	1010259.197	541.12	68
LRW151	2887783.476	1014193.319	577.99	29
LRW152	2887526.124	1014230.558	576.03	24.5

ANNEXURE-I				
CORDINATES OF ALL BORE HOLES OF REHAR WEST BLOCK (COVERING JOGI ANG MANI BLOCK), BOREHOLES FALLING IN COMMAND AREA OF GAYATRI AND REHAR UG BASED ON WGS-84 SYSTEM				
BORID	DEP	LAT	RL	FINAL DEPTH(m)
LRW153	2886768.861	1015069.909	573.23	147
LRW154	2887460.279	1014630.946	579.4	165.65
LRW155	2887148.021	1015042.243	577.64	98.75
LRW156	2887976.023	1014204.118	572.02	63
LRW157	2890494.033	1009776.834	546.39	65
LRW158	2890897.931	1009779.290	552.87	66.1
LRW159	2890128.008	1009977.504	548.76	89.5
LRW160	2891712.769	1009434.408	545.27	134
LRW161	2891676.670	1009796.978	543.32	64.5
LRW162	2891123.002	1009603.332	554.42	68
LRW163	2890692.198	1011275.452	549.79	80
LRW164	2887572.721	1014899.402	577.59	154
MLK007	2886579.847	1013299.415	565.85	82
MLK012	2886413.348	1014797.439	586.17	149.2
MLK027	2886421.394	1012998.937	562.14	113.5
MLK028	2886832.430	1012872.745	560.97	141.3
MLK031	2886953.277	1013189.093	565.12	82.25
MLK032	2886813.512	1013732.163	570.1	105.3
MLK034	2886622.053	1014257.776	571.84	122.5
MLK037	2886788.689	1014625.968	573.1	134
MLK042	2887160.665	1014797.729	578.1	147.65
MLK091	2886522.513	1015133.655	581.05	173
MLK097	2886795.101	1011968.698	565.48	53.5
MLK100	2886954.693	1014096.247	566.94	116
MLK103	2887158.735	1011764.619	563.04	74
MLK104	2886876.293	1011059.894	559.03	34.1
MLK105	2887507.272	1011571.889	558.72	53
MLK107	2887855.615	1011390.201	554.6	83
NOTE:- BOREHOLE NO. IN BOLD IS FALLING IN AND AROUND GAYATRI UG COMMAND AREA				

Capital Expenditure (GROSS –BLOCK)

Table –C-1 indicates Capital Expenditure below:-

TABLE- C-1**(Figures in Rs. lakhs)**

Sl. No.	Particulars	Approved RPR Provision, April, 1999	Existing Capital Expenditure as on 31/03/2016
			As per Gross Block (15-16)
1	LAND	41.60	74.80
2.	BUILDING		
	Residential	333.06	285.60
	Non -residential	54.91	49.15
	Welfare		17.54
3	PLANT & MACHINERY	1171.79	1343.88
4	Furniture & Fixtures	5.77	2.50
5	Railway Siding	0.00	0.00
6	Vehicles	30.23	0.00
7	Prospecting and Boring	48.98	61.75
8	DEVELOPMENT		
8.1	Roads & Culverts (Others)	61.41	207.89
	WATER SUPPLY		
8.2	Building & P&M	95.50	28.35
8.3	OTHERS (Capital Outlay in Mines)	182.75	1096.88
	TOTAL DEVELOPMENT		1333.12
8.4	EMP Capital	12	
8.5	Research & development	5	
8.6	PR preparation cost	12.21	
	GROSS BLOCK	2054.70	3168.34
9	Revenue Expenditure capitalized during development period - Net	201.83	
10	Provision for Depreciation progressive	75.54	1803.36
	Total Capital	2181.40	1364.98 (Net Block)

ANNEXURE-II

**STUDY REPORT FOR FINANCIAL VIABILITY OF CM OPERATION
BY RISK AND GAIN SHARING BASIS Vs PARTIAL HIRING MODE**

SUB: A COMPARATIVE STUDY FOR DEPLOYMENT OF CONTINUOUS MINER PACKAGE ON RISK AND GAIN SHARING BASIS VS PARTIAL HIRING OPTION AT GAYATRI UG MINE IN SECL COMMAND AREA.

SECL vide letter no. SECL/BSP/P&P/2016/254 dated 18.04.2016 advised CMPDIL, RI-V to prepare and submit a scheme regarding introduction of CM/ LHCM Technology in the Gayatri UG mine, Bishrampur area of SECL as it discussed during review meeting with area in presence of CMD it was decided to explore possibility to introduce CM technology in above mine. Accordingly job has been taken up at this institute.

As per the extract of the 244th meeting of the Board of Directors of South Eastern Coalfields Limited held on 01.04.2016 vide item No. 244:4:4 , subject: the scheme for introduction of Continuous miner Package on Hiring basis at Gayatri UG , the board directed that in future such proposal should be placed before board with an exercise by comparison between deployment of CM package on Risk and Gain sharing Basis Vis-à-vis on Hiring basis, Determining the net cash flow in both the methods and the most profitable and viable Scheme recommended.

Subject study

Presently two modes of operations for operating continuous miner package are prevalent across Coal India Limited and SCCL for underground coal mining. They are Risk and gain sharing basis (MARC-Maintenance and repair contract) and Partial hiring mode.

RISK AND GAIN SHARING BASIS

Initially Risk and gain sharing basis was introduced for introduction and operation of CM package in mines of SECL/ CIL. The indigenous CM equipment and expertise to operate the CM package was not available. The company purchased the CM equipment from OEM and Maintenance and repair contract (MARC) was executed.

The company executes the contract by offering global bidding for the scientific site investigation (including support requirement and design of layout), Supply of equipment, initial spares, consumables and Maintenance spares and provision of services contract for guaranteed production and availability and proper utilization of equipment for achieving a Guaranteed production in each Annual production period (APP).

NCPH, Chirimiri area, was the first mine in SECL, where such contract was executed and the production started in 2002 followed by Sheetaladhara and Churcha mine.

THE SCOPE OF WORK (EXPENDITURE) IN RISK AND GAIN MODE ARE AS FOLLOWS:

In risk and gain sharing basis, the manufacturer/ contractor not only supply the CM package but operate it for 5 to 9 years and is responsible for minimum guaranteed production on annual basis. Payments to bidders are made generally on following account:

- i. Scientific site investigation and study.
- ii. Supply of CM package and initial spares on FOB basis.
- iii. Supply of maintenance spares for its 9 years operation (contract period) on per tonne coal production basis.
- iv. Assistance service cost which includes pre-production planning and site preparation, assembly, installation, training and commissioning, training abroad, mobilization cost and strata monitoring cost for contract period operation.
- v. Supervision charge on per tonne coal production basis.
- vi. SECL has to bear the cost of importation beyond FOB like freight, insurance, custom duty, inland transportation, electricity, diesel, mining and machine consumables, manpower etc.
- vii. The contract envisage bonus and penalty clause.

PARTIAL HIRING

At later stage to achieve guaranteed production in each Annual production period (APP) by offloading the import of equipments, scientific site investigation (including support requirement and design of layout), Supply of equipment, initial spares, consumables and Maintenance spares and provision of services to qualified bidders itself and the contract was executed on rate per tonne basis, which was called as partial hiring mode.

In case of Partial hiring contract, the contractor is paid at a rate on per tonne coal production basis in the district. The rate includes the cost of scientific site investigation, CM package, mining and machine consumables, electricity/diesel, manpower, pre-production planning, site preparation, assembly, installation, training, commissioning, mobilization expenses and strata monitoring cost.

Pinoura was the first mine where such contract was executed in 2009 in SECL command area.

COMPARATIVE STUDY

The comparative study has been done between Risk and Gain Sharing Basis and Partial Hiring mode of continuous miner operation being practiced at Sheetaladhara –Kurja mine, and Haldibari mine of Hasdeo area, SECL, respectively. Both mines have been considered for studying the comparative financial viability and profitability between two modes of operations. The mining and working environmental conditions is almost same for both the mines because they are located in the same coalfield, area, seam and situated nearby. Similar comparative study had been done earlier also in SECL for assessing better financial viability out of two mode of operations in case of deployment of CM on partial hiring method at Haldibari UG.

Assumption made for comparative study are as follows:

The year of CM operation has been considered for 9 years. The operating life of face equipment, CM is 9 years.

For risk and gain method, The equipment and spares cost for CM has been taken from Standard Price list of CMPDI for mining Equipment, June -2015 and escalated as per guideline in relevant chapter.

The rates for MARC i.e. Provision of services, spares, maintenance has been considered based on the present rate of payment being made against various heads to party/bidder at Sheetal- Dhara –Kurja Mine.

The store cost (average consumption of last five years of Kurja mine with present awarded rate has been considered.

The number of Manpower for Risk and Gain mode has been considered as per contract and company norm and in case of Partial hiring mode only statutory man power has been considered.

Electricity cost has been estimated based on total equipment deployed at face and power used in package and rate of electricity as prevailing in Bishrampur area for risk and gain mode, whereas power cost is inclusive in partial hiring rate on per tonne coal production.

The EMS has been considered from Cost sheet of financial year 15-16 of Gayatri Mine. It has been considered same for both mode of operations.

Partial Hiring (i.e. rate on per tonne coal production) of Haldibari Mine has been considered and escalated based on the executed contract with WPI as on March, 2016.

Cash outflow calculated for risk and gain mode is based on the actual payment made, quarter wise/ year-wise against various heads to the bidder as per executed contract as indicated in Table-1.1

Cash outflow calculated for Partial hiring mode is based on the actual payment to be made, on per tonne coal production basis (quarter wise/ year-wise) as per executed contract in each APP and salary and wages of statutory man power. Cash outflow is indicated in Table-2.

Cash inflow has been calculated based on the proposed production in the respective APP and the sale price of coal of Gayatri mine. (For year-wise cash inflow for both method is same as coal production in each APP and sale price of coal is same for both mode of mining operations).

The Net present value, Present Value of the net cash inflow and present value of net cash out flow and has been calculated considering discounting Factor @ 12% per annum along with LRMC (Long range Marginal Cost).

Considering the cost/rate of above two contracts duly updated, an exercise has been done to compare the Present Value of the net cash inflow in case of introduction of CM package on hiring basis vis-à-vis on risk and gain basis at Gayatri UG having 1st to year guaranteed production 0.36 Mt. The production figure is presented in Table-3. The result is as below:

Risk & Gain

Present value of total cash outflow = Rs. 3,374,070,758=00

Present value of total cash inflow = Rs. 3,695,405,227=00

LRMC - 0.9130

PV of total cash outflow	3,374,070,758
PV of total cash inflow	3,695,405,227
LRMC	0.9130

Partial Hiring

Present value of total cash outflow = Rs. 2,400,248,832=00
Present value of total cash inflow = Rs. 3,695,405,227=00
LRMC - 0.64952

PV of Total Cash outflow	2,400,248,832
PV of Total Cash inflow	3,695,405,227
LRMC	0.64952

NET PRESENT VALUE IN CASE OF PARTIAL HIRING MODE = Rs.1, 295,156,395

NET PRESENT VALUE IN CASE OF RISK &GAIN MODE = Rs. 321,334,469

Difference between both Partial hiring and R&G mode (NPV) = Rs. 973,821,927=00

As per the above analysis, as on date, hiring of CM package is relatively cheaper than Risk & Gain mode of CM operation and more financially viable in comparison to risk and gain sharing basis.

The above evaluation of Risk and Gain sharing basis Vis-à-vis Partial Hiring mode holds good for the present hiring rate and the productivity considered.

Note: The detailed calculation is enclosed below:

Details of Risk and Gain Sharing Basis and Partial hiring basis:

Risk and Gain Sharing Basis is under operation at Sheetaladhara –Kurja UG mine. Contract has been executed for five years with guaranteed production of 2.0 Mte i.e. (avg. 0.42 mty) . The same production has been considered for comparing Partial hiring and Risk and Gain UG for 9 years. Partial hiring basis is under operation at Haldibari UG. Production for 9 years given below in Table-3

TABLE-3 : PRODUCTION FOR COMPARISON R&G Vs HIRING			
Sl.No	Item	Unit	Production as per CM Contract on Hiring & RISK AND GAIN
1	Production		
a	1st. Year	MT	360,000.00
b	2nd. Year	MT	460,000.00
c	3rd. Year	MT	420,000.00
d	4th. Year	MT	460,000.00
e	5th Year	MT	400,000.00
f	6th Year	MT	420,000.00
g	7th Year	MT	420,000.00
h	8th Year	MT	420,000.00
i	9th Year	MT	420,000.00
	Total		3,780,000.00

TABLE-1: SHOWING YEARWISE CASH OUTFLOW IN RISK AND GAIN MODE AS PER CONTRACT

		RISK AND GAIN MODE OF CONTINUOUS MINER OPERATION										
		CASH OUT FLOW					CASH OUT FLOW					
Sl. No	Year	Scientific Study & DGMS Approval Phase 1 and 2	Freight Insurance Custom Duty	Site Assistance Service Cost+ Mobilisation cost	FOB Equipment Cost	Yearly Strata Monitoring Cost	Electricity Cost	SECL's Spare Part/ Consumable Cost	SECL's Manpower Cost	Supervision Service Cost	Maint. Spare Cost	Total Cash Out Flow per Year.
1	Y1	18,066,333	0	0	0	0	0	0	0	0	0	18,066,333
2	Y2	0	142,115,917	103,884,567	0	0	12,274,841	19,395,550	53,639,228	114,738,138	34,731,558	480,779,800
3	Y3	0	0	0	949,243,137	8,029,681	24,549,682	44,178,754	107,278,455	197,962,762	163,198,587	1,494,441,057
4	Y4	0	0	0	0	8,029,681	24,549,682	47,411,345	107,278,455	157,216,688	240,177,489	584,663,340
5	Y5	0	0	0	0	8,029,681	24,549,682	47,411,345	107,278,455	157,216,688	245,763,012	590,248,863
6	Y6	0	0	0	0	8,029,681	24,549,682	46,333,815	107,278,455	154,424,258	212,870,163	553,486,054
7	Y7	0	0	0	167,340,774	8,029,681	18,412,261	32,864,683	80,458,841	138,130,215	104,663,209	549,899,664
8	Y8	0	0	0	0	8,029,681	24,549,682	45,256,284	107,278,455	238,785,591	100,674,528	524,574,221
9	Y9	0	0	0	0	8,029,681	24,549,682	45,256,284	107,278,455	150,977,582	158,753,205	494,844,890
10	Y10	0	0	0	0	8,029,681	24,549,682	45,256,284	107,278,455	148,367,903	175,858,896	509,340,901
11	Y11	0	0	0	0	0	18,412,261	33,942,213	80,458,841	112,139,424	175,943,975	420,896,715
												6,221,241,839

TABLE1.1: YEARWISE CASH FLOWS (NET PRESENT VALUE) IN RISK AND GAIN MODE OF OPERATION**TABLE-1.1: RISK AND GAIN MODE OF CONTINUOUS MINER OPERATION**

		RISK AND GAIN MODE OF CONTINUOUS MINER OPERATION								
		CASH OUT FLOW			CASH IN FLOW			Rs in ()		
Sl. No	Year	Total Cash Out Flow per Year.	Discounting Factor @ 12% per annum	Total PV of outflow	Coal (Te.)	INFLOW (Rs.)	Net Flow	Discounting Factor @ 12% per annum	Total PV of inflow	Total NPV
1	Y1	18,066,333	0.892857	16,130,655	0	0	-18,066,333	0.892857	0.00	-16,130,655
2	Y2	480,779,800	0.797194	383,274,713	180,000	356,220,000	-124,559,800	0.797194	283,976,403	-99,298,310
3	Y3	1,494,441,057	0.711780	1,063,713,626	410,000	811,390,000	-683,051,057	0.711780	577,531,375	-486,182,251
4	Y4	584,663,340	0.635518	371,564,122	440,000	870,760,000	286,096,660	0.635518	553,383,722	181,819,600
5	Y5	590,248,863	0.567427	334,923,056	440,000	870,760,000	280,511,137	0.567427	494,092,609	159,169,552
6	Y6	553,486,054	0.506631	280,413,260	430,000	850,970,000	297,483,946	0.506631	431,127,885	150,714,625
7	Y7	549,899,664	0.452349	248,746,682	305,000	603,595,000	53,695,336	0.452349	273,035,725	24,289,043
8	Y8	524,574,221	0.403883	211,866,730	420,000	831,180,000	306,605,779	0.403883	335,699,661	123,832,932
9	Y9	494,844,890	0.360610	178,446,028	420,000	831,180,000	336,335,110	0.360610	299,731,841	121,285,813
10	Y10	509,340,901	0.321973	163,994,139	420,000	831,180,000	321,839,099	0.321973	267,617,715	103,623,576
11	Y11	420,896,715	0.287476	120,997,748	315,000	623,385,000	202,488,285	0.287476	179,208,291	58,210,543
		6,221,241,839		3,374,070,758	3,780,000	7,480,620,000	1,259,378,161		3,695,405,227	321,334,469

LRMC CALCULATION BASED ON CASH FLOW IN RISK & GAIN METHOD

PV of total cash outflow	3,374,070,758
PV of total cash inflow	3,695,405,227
LRMC	0.9130

TABLE-2: YEARWISE CASH FLOW (NET PRESENT VALUE) IN PARTIAL HIRING MODE OF OPERATION

		PARTIAL HIRING OPTION							
		CASH OUT FLOW			CASH INFLOW				
Sl.No	Year	Total Cash Out Flow per Year.	Discounting Factor @ 12% per annum	Total PV of outflow	Coal (Te.)	Inflow (Rs.)	Total PV of inflow	Discounting Factor @ 12% per annum	TOTAL NPV
1	Y1	0	0.892857	0	0	0	0	0.892857	0
2	Y2	231,372,904	0.797194	184,449,062	180,000	356,220,000	283,976,403	0.797194	99,527,341
3	Y3	527,016,059	0.711780	375,119,621	410,000	811,390,000	577,531,375	0.711780	202,411,754
4	Y4	565,578,210	0.635518	359,435,177	440,000	870,760,000	553,383,722	0.635518	193,948,545
5	Y5	565,578,210	0.567427	320,924,265	440,000	870,760,000	494,092,609	0.567427	173,168,344
6	Y6	552,724,160	0.506631	280,027,261	430,000	850,970,000	431,127,885	0.506631	151,100,625
7	Y7	392,048,532	0.452349	177,342,846	305,000	603,595,000	273,035,725	0.452349	95,692,879
8	Y8	539,870,109	0.403883	218,044,482	420,000	831,180,000	335,699,661	0.403883	117,655,179
9	Y9	539,870,109	0.360610	194,682,574	420,000	831,180,000	299,731,841	0.360610	105,049,267
10	Y10	539,870,109	0.321973	173,823,726	420,000	831,180,000	267,617,715	0.321973	93,793,988
11	Y11	404,902,582	0.287476	116,399,817	315,000	623,385,000	179,208,291	0.287476	62,808,474
		4,858,830,984		2,400,248,832	3,780,000	7,480,620,000	3,695,405,227		1,295,156,395

LRMC CALCULATION BASED ON CASH FLOW IN PARTIAL HIRING METHOD

PV of Total Cash Out flow	2,400,248,832
PV of Total Cash In Flow	3,695,405,227
LRMC	0.64952

