Coal India Limited

Enterprise Risk Management

Final Report (June 2018)

Abbreviations

ADRM	Additional Dispute Resolution Mechanism
AMP	Abandonment Mine Plan
BCCL	Bharat Coking Coal Limited
BG	Bank Guarantee
BH	Bench Height
CBM	Condition Based Monitoring
CCL	Central Coalfields Limited
CEA	Central Electricity Authority
CHP	Coal handling Plant
CIL	Coal India Limited
CISF	Central industrial Security Forces
CMPDIL	Central Mine, Planning & Design Institute Limited
CRR	Capital Redemption Reserve
DFC	Dedicated Freight Corridor
DGMS	Directorate General of Mines Safety
ECL	Eastern Coalfields Limited
ERM	Enterprise Risk Management
FRL	Finished Road Level
FSA	Fuel Supply Agreement
H	High
Ha	Hectares
HEMM	Heavy Earth Moving Machineries
HFL	High Flood Level
IT	Information Technology
IWAI	Inland Waterways Authority of India
L	Low
LHD	Load Haul Dumpers
M	Medium
MCL	Mahanadi Coalfields Limited
MGR	Merry Go Round
MOC	Ministry of Coal
R&R	Relocation & Resettlement
RMC	Risk Management Team
RMR	Rock Mass Rating
RQD	Rock Quality Description
RTM	Risk that Matter
SDL	Side Discharge Loaders
SECL	South Eastern Coalfields Limited
SSR	Systematic Support Rules
TDS	Truck Dispatch System
UCG	Underground Coal Gasification
UG	Underground
VH	Very High
WCL	Western Coalfields Limited
LHD	Load Haul Dumpers
M	Medium
MCL	Mahanadi Coalfields Limited
MGR	Merry Go Round
MOC	Ministry of Coal
MOP	Ministry of Power
MTPA	Million Tonne per Annum
NCL	Northern Coalfields Limited
NEERI	National Environmental Engineering Research Institute
NTPCL	National Thermal Power Corporation Limited
NW	National Waterways
OB	Overburden
OC	Opencast
OEM	Original equipment Manufacturer
OITDS	Operator Independent Dispatch system
PPP	Public Private Partnership
PPV	Peak Particle Velocity
PSU	Public Sector Unit

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WCL	Western Coalfields Limited

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Section 1:

Executive Summary

Organizations need to improve their approach to managing risks to meet the demands of an evolving business environment and to meet expectations of various stakeholders. A pre-requisite is therefore to develop, implement and sustain a framework of risk management, which would enhance executive strategy setting and decision-making processes. Such a risk management framework would support the organization to meet objectives, including the following:

1. Providing insights in strategic decision making
2. Enhancing alignment between organizational objectives, strategy, performance and outcomes
3. Providing mechanisms for effective risk-managed governance and oversight on performance
4. Enhancing greater transparency for stakeholders

The Committee of Sponsoring Organizations of the Treadway Commission (COSO) in its publication 'Enterprise Risk Management – Integrating with Strategy and Performance' (June 2017), has expressed a view that organizations that integrate risk management throughout the entity can realize many benefits, including, but not limited to:

1. Increasing positive outcomes and advantages while reducing negative surprises
2. Increasing the range of opportunities
3. Identifying and managing risk entity-wide
4. Reducing performance variability
5. Improving resource deployment, and
6. Enhancing enterprise resilience

In India, from a regulatory perspective, the SEBI (Listing Obligations & Disclosure Requirements) Regulations, 2015, inter alia, requires the listed entity to lay down procedures to inform members of Board of Directors about risk management and minimization procedures [Regulation 17 (9) (a)]. The Board of Directors shall be responsible for framing, implementing and monitoring the risk management plan for the listed entity [Regulation 17 (9) (b)]. Per Regulation 21 (4), the Board shall define the roles and responsibility of the Risk Management Committee and may delegate monitoring and reviewing of the risk management plan to the Committee, and such other functions as it may deem fit.

The Companies Act, 2013, requires the Boards of Directors to present a statement indicating development and implementation of a risk management policy for the company, including identification therein of elements of risk, if any, which in the opinion of the Board may threaten the existence of the company [vide section 134 (3) (n)]. Further, the Audit Committee is also required, inter alia, to evaluate the risk management systems of the Company [vide section 177 (4) (vii)].

Keeping in view the core value proposition of business benefits arising out of enhanced risk managed operations, as well as with a view to ensure Regulatory compliance, Coal India Limited (CIL) had embarked to formalize Enterprise Risk Management (ERM) program and the mechanisms that will

sustain the program in CIL and its Subsidiaries. With this view, CIL has commissioned implementation of the governance process designed in the Risk Management Framework at Coal India Limited and all of its Subsidiary Companies. As part of a first wave of implementation, CIL had developed a framework for risk management across CIL & all its Subsidiary Companies. In Sep 2016, CIL embarked on the second wave of initiatives with the following objectives:

1. Developing an appropriate approach for monitoring of enterprise-level risks, including developing a Risk Management Calendar to identify the desired frequencies for such monitoring activities at different levels of management of CIL & Subsidiaries.
2. Identifying any relevant risks for incorporation in the existing Risk Registers, arising out of changes in business environment, policy changes, etc.
3. Update key risks ('Risks That Matter') which are of relevance for the Risk Management Committee (RMC) of CIL and the Board of Directors
4. For the key risks, working with the risk management team of CIL & Subsidiaries to initiate workshops for finalization of the mitigation plans.

As part of this current initiative of CIL, the risk management framework has been refreshed across CIL & all its Subsidiary Companies. This report highlights the updated Risk Register for CIL including Risks That Matter (list of key risks), detailed risk management plans (Mitigation Plans) for the key risks (Risks That Matter), and a Risk Management Calendar, which charts out the key risk management activity timelines for management, Risk Management Committee, the Audit Committee and the Board of Directors of CIL.

Some of the key themes which have been prioritized in the current business context of CIL include the following:

1. Credit risk of receivables (disputed & undisputed receivables) from public sector undertakings
2. Default risk by specific subsidiary companies in relation to redeemable preference shares
3. Evacuation challenges for coal off-take across subsidiaries
4. Operational safety risks arising out of mining operations
5. Technology upgradation and equipment utilization
6. Impact from unviable underground mining operations
7. Competition Risk from Commercial Mining & Alternate energy sources (renewables)

The risk management plans for these key themes have been deliberated by the management view a view to arrive at precise action plans to reasonably de-risk operations, and / or reduce the risk exposures to acceptable thresholds. Further, guidelines / indicative standard operating procedures for implementing the mitigation action plans have also been appended on directions of the Board of CIL for a focused implementation of the plans.

Needless to say, risk management for Coal India Limited is a continuous journey, and as applies to any other progressive organization, the risk profile of CIL and the corresponding risk management plans would also continually evolve, as a response to the dynamic business environment and socio-political environment in which CIL operates.

Section 2:

Risk Register of Coal India Limited (including Risks that Matter)

2.1 Risk Register: Risks that Matter (RTM) for Coal India Limited

<table>
<tr><th>#</th><th>Risk Category</th><th>Risk Event</th><th>Summary of Risk and contributing factors</th></tr>
<tr><td>1</td><td>Financial</td><td>Credit Risk from receivables of Public Sector Undertakings (disputed and undisputed receivables)</td><td>

Aggregate receivables (across Subsidiaries) amount to ~ INR 10,467 Crore (as of 31 Mar 2018), of which INR 8,373 Cr. (~80%) is pending from the SEBs/CPSUs and Power units. BCCL, CCL and SECL contribute to ~60% of the total receivables. Refer Table below:

INR Crore
<table>
<tr><th>Sector</th><th>Disputed receivables</th><th>Undisputed receivables</th><th>Total</th></tr>
<tr><td>State Power Units</td><td>574.97</td><td>3,576.09</td><td>4,151.06</td></tr>
<tr><td>Central Power Units</td><td>933.74</td><td>3,288.09</td><td>4,221.83</td></tr>
<tr><td>Private Power Units</td><td>44.00</td><td>116.31</td><td>160.31</td></tr>
<tr><td>Steel</td><td>439.77</td><td>1,203.09</td><td>1,642.86</td></tr>
<tr><td>Loco</td><td>0.44</td><td></td><td>0.44</td></tr>
<tr><td>Government</td><td>10.00</td><td>61.04</td><td>71.04</td></tr>
<tr><td>Others</td><td>11.08</td><td>208.91</td><td>219.99</td></tr>
<tr><td>Total</td><td>2,014.00</td><td>8,453.53</td><td>10,467.53</td></tr>
</table>

On comparing the receivables positions as of Dec 31, 2017 with that of Mar 31, 2018, a decrease of INR 111.09 Cr. was observed in the undisputed dues. In addition, approximately 30% of total receivables were over 1 year old (INR 1,194.84 Cr. of disputed receivables and INR 1,969.92 Cr. of undisputed receivables) as of Mar 31, 2018. As of Mar 31, 2018, CIL has provisioned for doubtful receivables to the tune of INR 1,778.37 Cr.
Recoverability of disputed receivables, and timeliness of realization for the remaining balance (particularly from PSUs) would impact the cash flows adversely.

</td></tr>
</table>

<table>
<tr><th>#</th><th>Risk Category</th><th>Risk Event</th><th>Summary of Risk and contributing factors</th></tr>
<tr><td>2</td><td>Financial</td><td>Default risk by Subsidiaries for Redeemable Preference Shares</td><td>
Coal India Limited has investments in BCCL and ECL in the form of 5% Redeemable Preference Shares. As per terms, the redemption becomes due in FY 2018-19. However, a possible default by these subsidiaries in generating sufficient Capital Redemption Reserves (CRR) for redemption of preference shares may result in CIL rolling-over the investment/ internalizing the resultant exposure, to the tune of ~ INR 6,118 Crore (Refer table below)
<table>
<tr><th>Particulars</th><th>BCCL (INR Crore)</th><th>ECL (INR Crore)</th></tr>
<tr><td>Investment in Equity Shares</td><td>2,118</td><td>2,218</td></tr>
<tr><td>Investment in Preference Shares (Equity Component)</td><td>1,058</td><td>856</td></tr>
<tr><td>Investment in Preference Shares (Debt Component)</td><td>1,728</td><td>1,220</td></tr>
<tr><td>Total investment</td><td>4,904</td><td>4,294</td></tr>
<tr><td>Net Worth</td><td>1,913</td><td>1,166</td></tr>
<tr><td>Exposure to CIL</td><td>2,990</td><td>3,128</td></tr>
</table>
</td></tr>
<tr><td>3</td><td>Financial</td><td>Operation of loss making mines</td><td>
A total of 252 cost centres related to Underground Mines under the various subsidiaries have been identified by CIL as unprofitable / unviable (as of April 1, 2017). Data computed by CIL for the period 2016-2017 showed an aggregate loss of ~ INR 12,836 Crore arising out of these UG mines' cost centres, across 7 Subsidiary companies. Four Subsidiaries account for ~ 88% of these losses [ECL ~30%, BCCL ~24%, SECL ~19% and WCL ~15%].
</td></tr>
</table>

#	Risk Category	Risk Event	Summary of Risk and contributing factors
4	Operations	Safety risks associated with mining operations	• Safety in mining operations (underground and open cast mining) continues to be a top priority for CIL & its Subsidiaries. While significant accidents and fatalities have come down in FY 2017-18 as compared to earlier periods, adoption of improved techniques for safety in mining operations continues to be an important agenda for CIL. • There have been a history of several significant accidents / disasters (and fatalities) in recent past (Rajmahal OC Expansion Project, Jharkhand, 18 fatalities). The associated investigation reports of major disasters in Chasnala (375 deaths, inundation), Dhori (268 deaths, coal dust explosion), Chinakuri (175 deaths, explosion of fire damp), Gaslitand (64 deaths, inundation), etc. indicate that inundation, failure of OC bench, coal dust explosion, roof fall, explosion of fire damp, fire & gas suffocation are the top reasons for disasters (& fatalities) in CIL mines. As many as 1447 fatalities have been reported across CIL mines between 1952 and 2005.

#	Risk Category	Risk Event	Summary of Risk and contributing factors
5	Operations	Need for further Technology Upgradation and need for improved Equipment / HEMM Utilization across Subsidiary Companies	• CIL has undertaken various initiatives for technology development, including introduction of high capacity equipment, operator independent truck dispatch systems, vehicle tracking system using GPS / GPRS, CHP & Silos for faster loading and monitoring using laser scanners. CIL has also introduced Continuous Miner technology and Long Wall technology at selected places. Man riding systems in major mines and use of tele -monitoring techniques continue to receive priority to increase production from underground mines. • Overall system capacity utilization fell by ~ 15.36% from 99.87% in 2015-2016 to 84.51% in 2016–2017. This was mainly due to low overall system capacity utilization in ECL, BCCL, NCL, and WCL & MCL. Some of the contributing factors for low overall system capacity utilization across subsidiaries are presented below: 1. Physical environment not conducive for operation of mining equipment 2. Operating environment of the mine is dynamic and many exigencies can affect the equipment utilization drastically. 3. Mining involves interrelated operations, so the utilization of one equipment is dependent on other. 4. Shortage of skilled manpower to operate the equipment 5. Due to survey-off at NCL and MCL in 2016-2017, the population of 5 draglines was reduced to 35 as on 31st Mar, 2017. Further, 6 technologically upgraded Dragline are being procured for NCL. 6. Performance of HEC Dragline at NCL supplied 10 Cu. Mtr. Shovels at MCL are not satisfactory. 7. Dragline of Sonepur Bazari Project, ECL, was under breakdown since June 2016 due to non – supply of imported spares. Equipment was recommissioned on 21 Dec 2017. 8. Heavy Rainfall in NCL & MCL, land and R&R problems in BCCL, MCL & SECL resulted in less utilization of the heavy earth moving machines (HEMM).

<table>
<tr><th>#</th><th>Risk Category</th><th>Risk Event</th><th>Summary of Risk and contributing factors</th></tr>
<tr><td>6</td><td>Operations</td><td>Evacuation risk for coal-offtake (Dependence on railways)</td><td>

CIL is highly dependent on Railways for providing wagons for transportation of coal. However, due to paucity of wagons provided by railways, CIL currently is unable to meet the projected target of despatching 288 rakes per day for FY 2018-19. The FY 2017-18 position (targeted vs. actual till Feb 2018) is presented below:
<table>
<tr><th>Name of Subsidiary</th><th>Wagon Loading Target 2017-18 (Rakes per day)</th><th>Actual Wagon loading till Feb 2018 (Rakes per day)</th></tr>
<tr><td>ECL</td><td>23.1</td><td>22.8</td></tr>
<tr><td>BCCL</td><td>25</td><td>19.5</td></tr>
<tr><td>CCL</td><td>35.5</td><td>31.1</td></tr>
<tr><td>WCL</td><td>22.9</td><td>25</td></tr>
<tr><td>SECL</td><td>23.8</td><td>24.9</td></tr>
<tr><td>MCL</td><td>44.5</td><td>38.1</td></tr>
<tr><td>NCL</td><td>69.4</td><td>64.4</td></tr>
<tr><td>NEC</td><td>0.4</td><td>0.5</td></tr>
</table>

Lack of infrastructure especially rail connectivity remains one the biggest challenges in increasing CIL’s productivity. Only 56% of the total coal produced is evacuated using the rail. The construction of two Dedicated Freight Corridors (DFCs) – Eastern DFC (Ludhiana-Dankuni, 1856 km*) & Western DFC (Dadri-JNPT, 1504 Km**) are scheduled to be completed by Dec 2019, however any further delays in commissioning shall add to the evacuation challenges in the face of a growing demand for coal supplies.

* http://dfccil.gov.in/dfccil_app/Eastern_Corridor /
**http://www.dfccil.gov.in/dfccil_app/Western_Corridor
</td></tr>
</table>

2.2 Risk Register: Other Risks for Coal India Limited

#	Risk Category	Risk Event	Summary of Risk and contributing factors
7	Strategic	Competition Risk from Commercial Mining & Alternate energy sources (renewables)	• Allocation of coal blocks to private sectors for commercial mining is likely to impact CIL's profitability in the medium to long term. There will be no end-use restriction as far as output of the auctioned mines are concerned. Under private commercial mining modalities approved by the Cabinet, coal blocks will be allocated by "ascending forward auction" in which the winner will be determined by the price per tonne of coal offered to the state government where the mine is located. However ancillary risks such as attrition of mining talent / experienced personnel, shall arise even before commercial production in private sector begins. The impact on profitability of CIL is yet to be determined, as the quantity and size of blocks being offered for commercialization is currently being determined by the Government. • Coal India Limited faces threats from the growing market share of renewable energy sources. Estimates indicate a clear shift away from coal power towards clean renewables & alternate energy. Studies indicate that alternate energy would comprise 49% of India's power generation by 2040. • The government is planning India's energy future based on the goal of 175 gigawatts of renewable energy capacity by 2022. They also plan on allocating 15 percent of its energy needs to natural gas, from 6.5 percent currently, as a cleaner fuel for power plants and transport. According to the draft National Electricity Plan released late last year, we will have a capacity of 275 GW of renewable energy by 2027. • NITI Aayog's National Energy Policy aims to curb imports by increasing production of renewable energy in the country five-fold to 300 billion units by 2019. It is estimated that renewables will account for 10-17 percent of India's energy demand in 2047, up from about 4 percent now.

<table>
<tr><th>#</th><th>Risk Category</th><th>Risk Event</th><th>Summary of Risk and contributing factors</th></tr>
<tr><td>8</td><td>Financial</td><td>Steady decline in Retained Earnings over long term may limit capacity to fund capex, and internalize defaults / losses of Subsidiaries</td><td>

Net worth of CIL has declined by 49% over FY 2012-13 (INR 48,461 Cr.) to FY 2016-17 (INR 24,507 Cr.). Comparatively, Retained Earnings declined by 68% over the same period INR 11,455 Cr. in FY 2012 - 13 vis-à-vis negative INR 3,618 Cr. in FY 2016 - 17)

<table>
<tr><th>Year</th><th>2013</th><th>2014</th><th>2015</th><th>2016</th><th>2017</th></tr>
<tr><td>Profit (In INR Crore)</td><td>17,356</td><td>15,111</td><td>13,726</td><td>14,267</td><td>9,267</td></tr>
<tr><td>Equity (In INR Crore.)</td><td>6,316</td><td>6,316</td><td>6,316</td><td>6,316</td><td>6,207</td></tr>
<tr><td>No. Of Shares (In ‘000)</td><td>631.6</td><td>631.6</td><td>631.6</td><td>631.6</td><td>620.7</td></tr>
<tr><td>EPS</td><td>27</td><td>24</td><td>22</td><td>23</td><td>15</td></tr>
<tr><td>DPS</td><td>14</td><td>29</td><td>21</td><td>27</td><td>20</td></tr>
<tr><td>DPS as % of EPS</td><td>51%</td><td>121%</td><td>95%</td><td>121%</td><td>133%</td></tr>
</table>

The Earning per Share (EPS) has declined by 44% over a period of 5 years, but the Dividend per Share (DPS) as a percentage of earnings has increased from 51% in FY 2012-2013 to 133% in FY 2016-2017. This has impacted CIL’s net worth over the period.
An optimum policy for retained earnings and dividend distribution may be planned to address future planned project outlays, projected increase in establishment costs (salaries & wages) and eroding net-worth of specific subsidiaries.

<table>
<tr><th>Subsidiary</th><th>Net Worth in FY 2015 - 2016</th><th>Net Worth in FY 2016 - 2017</th><th>Reduction</th><th>% decline in Net Worth</th></tr>
<tr><td>NCL</td><td>4,254</td><td>2,795</td><td>1,459</td><td>34%</td></tr>
<tr><td>SECL</td><td>5,304</td><td>3,352</td><td>1,952</td><td>37%</td></tr>
<tr><td>WCL</td><td>3,321</td><td>2,557</td><td>764</td><td>23%</td></tr>
</table>
</td></tr>
</table>

#	Risk Category	Risk Event	Summary of Risk and contributing factors
9	Operations	Absence of succession planning resulting in skills shortage	• The total manpower strength of CIL & Subsidiaries as of March 31, 2017 was 310,016, of which Executive Manpower was 17,730. Compared to FY 2015-16, there was a reduction in Executive Manpower strength by 437, largely due to superannuation. Given the specific age profile of the Executive Manpower across CIL & Subsidiaries, approximately 30% of the Executive Manpower will superannuate over the next 5 years (~ 1000 per year). • The HR Vision 2020 for Coal India Limited identifies the following two aspects (inter-alia), as key challenges: i. Knowledge management due to high rate of superannuation: A high rate of superannuation (~750 per year) from the middle management and senior management positions was identified as a serious threat to the tacit knowledge base of the organization. The Vision document also recommends that CIL needs to put in place effective mechanisms to address the challenges of knowledge erosion. ii. Succession Planning & Successor Development: The Vision document has identified that the manpower distribution across the grade levels is uneven. There is a skills shortage / manpower shortage in middle management positions which affects the continuous supply of talents for all levels. There is therefore a need to identify successors for all levels across the value chain and develop them to occupy leadership positions.

#	Risk Category	Risk Event	Summary of Risk and contributing factors
10	Strategic	Non-adherence to MoEF's stipulation for coal ash content	• As per Ministry of Environment and Forest (MoEF) stipulation, coal based thermal power plants (situated beyond 500 km from the pit-head) are to be supplied with, and shall use, raw or blended or beneficiated coal with ash content not exceeding thirty-four percent, on average basis every quarter. Coal Companies are supplying coal to their customers maintaining ash percentage below 34% on an average basis quarterly, however, it is getting difficult to compete with imported coal. CIL needs to supply ~129 million tonnes of coal with average ash content below 34% to 99 power plants lying beyond 500 kms of its pitheads. Coal produced by CIL generally contains 25% - 45% ash as compared to imported coal which contains 10% - 20% ash on an average.
11	Compliance	Statutory and Regulatory Compliance reporting framework	• CIL and its Subsidiaries need to formulate a framework to ensure that all applicable Statutory and Regulatory compliances are adhered to. In the context of changing regulations, the comprehensiveness of compliance requirements currently being tracked, needs to be reviewed. Implications of non-compliances extend beyond financial penalties and include exposures such as imprisonment of key managerial personnel (including Directors of CIL & Subsidiary Companies). • There is no IT enablement currently in place to i. Track critical non-compliances on due dates, and ii. Generate Compliance Certificates along with list of specific non-compliances for quarterly reporting to the respective Boards.

<table>
<tr><th>#</th><th>Risk Category</th><th>Risk Event</th><th>Summary of Risk and contributing factors</th></tr>
<tr><td>12</td><td>Projects</td><td>Delayed projects due to FC clearance, Land acquisition and R&R issues</td><td>

Currently CIL has 114 ongoing projects funded by a total sanctioned capital of ~ INR 63,480 Crore. Of these 114 projects, 59 projects have been delayed as of March 31, 2018 (194 MTY capacity / sanctioned capital of INR 13,718 Cr. / capex since inception INR 7550 Cr). The delays in these projects are mainly due to the following reasons:

Delay in land acquisition
Delay in FC
Rehabilitation & Resettlement, and Contractual issues

<table>
<tr><th>Category</th><th>No</th><th>Capacity (MTY)</th><th>Capital (INR Cr.)</th><th>On Schedule</th><th>Delayed</th></tr>
<tr><td>INR 500 Cr. and / or 3 MTY (QPR Projects)</td><td>47</td><td>477</td><td>52,010</td><td>27</td><td>20</td></tr>
<tr><td>INR 150 Cr. and above (MOSPI)</td><td>69</td><td>487</td><td>59,148</td><td>45</td><td>24</td></tr>
<tr><td>INR 100 Cr and above</td><td>89</td><td>508</td><td>61,759</td><td>53</td><td>36</td></tr>
<tr><td>INR 20 Cr and above</td><td>114</td><td>548</td><td>63,480</td><td>55</td><td>59</td></tr>
</table>

Of the 59 projects that have been delayed due to external factors (such as delayed FC, etc.), 3 Subsidiaries (MCL, CCL & SECL) have been impacted the most (163 MTY / 84% of delayed capacity).

<table>
<tr><th>Subsidiary</th><th>Project Capacity (MTY)</th><th>Sanctioned Capital (INR Cr.)</th></tr>
<tr><td>MCL</td><td>100.</td><td>4,002</td></tr>
<tr><td>CCL</td><td>44</td><td>2,703.</td></tr>
<tr><td>SECL</td><td>19</td><td>2,243</td></tr>
</table>
</td></tr>
</table>

#	Risk Category	Risk Event	Summary of Risk and contributing factors
13	Support	Absence of ERP system	• In the absence of an effective ERP system in place across CIL and Subsidiaries, speed of decision making shall get impacted due to want of timely and accurate information. Absence of robust IT policy and procedure, multiple standalone applications for various functions, and reliance on manual workflow instead of system based workflow shall potentially impact efficiency and productivity across CIL & Subsidiaries.
14	Support	Cyber Security Risk	• CIL needs to have a comprehensive Cyber Security framework to prevent malicious changes to CIL's operational Information System technologies. Such an event (i.e. remote exploitation by an external attacker or the accidental introduction of malware by site personnel) may result in compromised IT systems, breach of confidential information, etc. Typical causes resulting in cyber security threats arise from unauthorized physical access to IT systems, IT asset vulnerability, non-secure networks, unresponsiveness to IT incidents, lack of employee awareness, etc.

Section 3:

Mitigation Plans for key risks (Risks That Matter)

3.1 Mitigation Plan for Credit Risk from receivables of Public Sector Undertakings (disputed and undisputed receivables)

Mitigation approaches to reduce the risk of non-realization of dues shall include the following:

3.1.1 Disputed Receivables

1. Approximately 77% of the disputed receivables relate to the power sector, majority of which are due from State Gencos / State power corporations. A pro-active reference of each specific case of dispute shall be made by each Subsidiary to the ADRM (Additional Dispute Resolution Mechanism). Orders of the ADRM shall closely be monitored for implementation within the stipulated time frame and any non-compliance on part of the counter-party shall be referred back to ADRM on a quarterly basis for further directions. Quantification of the disputed value referred to ADRM shall be done in all cases.

   The present system of joint reconciliation with power utilities shall be made more structured and uniform across subsidiaries. The template for joint reconciliation shall be standardized prepared monthly. The joint monthly reconciliation must capture head wise claims and counterclaims, clearly bifurcating into disputed and undisputed amounts under different heads, so that unresolved disputed amounts can be unambiguously identified as jointly determined by both the sides for mutual settlement and / or by reference to ADRM quarterly, if required.

   A cross-functional empowered team comprising of GM (Sales), GM (Quality Control) and GM (Finance) from each Subsidiary shall be formed, which shall meet with each customer to evaluate & decide:

   i. Whether the reasons for the disputed receivables from the State Gencos / State power corporations have been identified and deliberated upon. They shall determine whether or not the dispute will be resolved bilaterally between the subsidiary and the customer;
   ii. Where a resolution is unlikely to be achieved directly with the customer, an acceptable time frame needs to be formulated for applying to ADRM for each specific dispute;
   iii. Monitoring shall be strengthened to ensure that no disputed cases are left unattended by any Subsidiary. This is particularly important where the customers have filed a claim but no rejoinder / counter claim has been filed by CIL / Subsidiaries;
   iv. Orders passed by ADRM shall be monitored closely for implementation within the stipulated time frame indicated in the order;

v. Periodical reporting shall be made by the proposed empowered cross-functional team to functional Directors and the Risk Management Committee/ Board of Subsidiaries on progress made in reducing the disputed receivables.

2. For Steel sector, case files for each and every disputed case should be prepared and pursued for resolution by the empowered cross-functional team within a targeted time frame. Monitoring shall be strengthened to identify cases where reasons for the disputes have not been investigated / evaluated for accepting or rejecting such customer claims, either in part of in full. Where a bilateral resolution is unlikely, based on the facts of each specific case, advice of CIL's Legal counsel shall be sought to evaluate merits of referring such cases to the appropriate Court of Law and a likely recovery value of such disputed receivables in such cases.

3. For all other customers (including Governments, Loco and Others), monitoring shall be strengthened to address the reasons for such disputes and recover / settle the disputed receivables within a targeted timeframe.

For each of the categories of disputed receivables, the monitoring activities need to arrive at a common set of guidelines for the Subsidiaries to follow, such that receivables with similar root causes / reasons for disputes are not repeatedly disputed by customers. A common template for reconciliation with customers shall be notified by CIL for mandatory prospective use by all Subsidiary companies.

3.1.2 Undisputed Receivables

1. As per direction of Hon'ble Minister of State (I/C), Power & NRE, Govt. of India, Ministry of Power (MOP) shall consult Ministry of Coal (MOC) to frame a policy, including in regard to regulating coal supply to the State/ Central Gencos corresponding to their current payment, if undisputed outstanding dues are more than 90 days equivalent coal values [vide Minutes of Meeting dated Jan 25, 2018, File No. 19/3/2018 – OM(E)-Part(1)]. A monitoring group shall be set up to track the progress of collections of aged receivables once such a policy has been notified by the relevant Ministry.

2. Subsidiaries shall institute / enhance a direct follow-up mechanism for expediting collection of aged undisputed dues from the customers. A periodical report for such follow-ups and collections realized shall be

circulated to the relevant functional Directors and / or Board for their information and further direction.

Further, as decided by the Board of CIL,

1. That huge undisputed sums are overdue for more than 6 months but upto one year amounting to Rs 2029.62 Crores, more than 1 year but upto 2 years amounting to Rs. 1133.87 crores, More than 2 years upto 3 years amounting to Rs. 699.36 crores and more than 3 years amounting 474.33 crores, Hence the total outstanding undisputed debtors of more than 6 months amounting to Rs. 4337.18 crores as on 31st December'2017 to be minimized up to a zero level.

2. All debtors are to be analyzed bill wise and notice is to be sent to customers advising them to make payment within 30th April'2018. If the dues outstanding for 6 months or more are not settled, dispatch of coal should be regulated.

3. A statement of up-to-date accounts indicating the interest due thereon be sent to all the parties as on 28th February 2018 and thereafter every month. CIL should also try and recover even previous interest

4. Due to difference of opinion regarding the reasonable certainty for recognizing interest income, an opinion from Expert Advisory Committee (EAC) of The Institute of Chartered Accountants of India (ICAI) should be obtained regarding recognition of interest income on delayed payments for the period till 31st March'18 and from 1st April'18 in view of the revised instruction about the procedure of recovery.

5. FSA mandates to collect payment in advance and delivery order is to be given after that. CIL management should decide on Cash & Carry on all despatches.

6. Due to delayed payment by the Customer the company is incurring loss and interest charged from the Customer is towards compensation for the loss.

7. Audit Committee recommended that in respect of dues which are even less than 6 months but more than 15 days, interest should be charged for

all sales with effect from 1st April'2018 and recovered from the Customer.

8. Quarterly Review to be made by FDs & Audit Committee for ascertaining doubtful & bad debts

The Board advised that as already decided, for any delayed payment interest is to be charged mandatorily. Further Board also advised that Company should prepare a time bound program for bill wise reconciliation. In order to expedite the bill wise reconciliation, Company might consider appointment of a chartered firm to conduct bill wise reconciliation and their fee shall be decided by the Audit Committee.

Action: Director (Sales & Marketing) / GM (Sales & Marketing)

Timeline: 31 March, 2019

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3.2 Mitigation Plan for default risk by Subsidiaries for Redeemable Preference Shares

Company (CIL) has investments in BCCL and ECL in the form of 5% redeemable preference shares. As per terms, the preference shares are due for maturity in FY 2018 -19. However, BCCL has losses in the current year and ECL has a marginal profit. The net worth of both subsidiaries is below the total investment resulting in an exposure of ~INR 2,990 and ~INR 3,128 for BCCL and ECL respectively. Considering the weak financial position of the subsidiaries, a possible default in generating sufficient Capital Redemption Reserves for the redemption of the preference shares is likely.

Broad mitigation approaches under consideration includes accepting a roll-over of the investments. An evaluation based on cash flow analysis shall be made for issuing fresh Redeemable Preference Share Capital, which represents the value of the existing investments and any accrued interest / dividend thereon, for such period as shall be deemed appropriate. Such an option shall provide a window of opportunity to ECL & BCCL to generate operational surpluses over the renewal period and allows them to be in a position to redeem the preference shares when it falls due next.

Intrinsically, ability to generate redemption reserves are linked to profitable and efficient operations by these subsidiaries. To that extent, measures to improve operational efficiencies and to reduce operational losses particularly from underground mining operations, as elucidated in subsequent mitigation plans, would also hold relevance.

The Board of Directors and the Audit Committee of CIL have been informed by the Company that the respective Subsidiaries (ECL and BCCL included) shall present the steps being taken & planned, for improving operational profitability in the immediate future.

Action: Director (Finance) / GM (Finance)

Timeline: 31 March, 2019

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3.3 Mitigation Plan for evacuation challenges for coal off-take

Coal reserves in India are spread across 8 states out of which 80% of the total reserves are concentrated in Orissa, Chhattisgarh, West Bengal and Jharkhand. CIL is highly dependent on railways for providing rakes for transportation of coal from these areas to the destinations of the consumers. (Railways accounts for ~ 53% of despatches in FY 2017-18). As of March 31, 2018, 56 power stations had coal stocks of less than 7 days' consumption mainly due to railway logistics constraints. In the year 2017-18 an average of 229.2 rakes/day was supplied from CIL Sidings against the target of 247 rakes/ day.

With the current expansion plan in place, more blocks for mining shall be allocated resulting in an increase in coal production. This increased production needs to be supported by adequate infrastructure for loading, handling and transportation. CIL shall consider other modes of coal transfer to meet the increased demand and match it to the production.

A meeting was held by the Minister of State (I/C) for Power and New & Renewable Energy in the presence of members from MOP, MOC, CIL and CEA during the month of January 2018 where discussions were held to increase the coal supply to the power plants. It was decided that 332 rakes per day would be supplied from CIL sidings, washeries and goods sheds of which 274 rakes per day were to be supplied to the power sector. However, only about 266 rakes per day could be supplied.

So far as CIL Sidings are concerned only 229.2 rakes/day were dispatched against the AAP target of 247 rakes/day during 2017-18, a shortfall of 17.8 rakes/day. In the current year (2018-2019), there is a projection of 278 rakes per day loading from CIL Sidings to achieve the off-take of 681.2 MT.

The following mitigation measures can be undertaken to improve the overall logistic supply chain of CIL:

Major Power plants & other non-major power plants located within 20 kms from pitheads to be persuaded to use elevated closed belt conveyors. Major Power plants & other non-major power plants located within 40 kms from pithead to be persuaded to construct MGR. Transportation of coal from stockyard/pit head to washery may be through MGR/Conveyor belts, wherever feasible

CIL shall carrying out a feasibility study for increasing the efficiency of operations at sidings. An internal assessment of CIL indicated that out of the operable 139 sidings across Subsidiaries, about 30% of the sidings accounted for ~75% of rakes loaded per day. Results of the study shall be taken up by each Subsidiary for improvement of the siding operations and eventual lowering of the loading time. Further, re-arrangement of the coal supply modes, shall be undertaken (for

instance, re-arrangement of the siding at Lingraj in MCL area shall potentially spare around 8 rakes per day), if the coal to NTPC Kaniha plant are supplied by MGR/Road.

On a case by case basis, wherever possible, capacity of MGR should be enhanced for all pithead power stations such that pithead power stations can be supplied only through MGR. Railway rakes can be spared to supply power stations at longer distances.

Projects undertaken through the joint venture route for construction of railway lines in areas like Tori-Shivpuri-Kathotia region, Jharsugdha -Barpali- Sardega, etc. would further add to the evacuation capacities in the medium to long term (a section of Tori-Shivpur line is scheduled to be commissioned progressively by June 2018 to improve transportation of coal from CCL area). Further, commissioning of the East Rail corridor and East – West Rail corridor for movement of coal would also improve the evacuation situation in the medium to long term.

Procurement of wagons through railway for dedicated routes should be considered for enhancing coal evacuation.

A Committee at subsidiary level within CIL (including Railways) comprising of GM (Sales) and GM (Planning) shall be set up to coordinate with the Ministry of Railways for:

a) Feasibility study to be conducted for rationalization of sidings. Rearrangement and consolidation of small sidings into bigger ones having multi rake loading facilities preferably through Rapid Loading System (RPLS)/ High Speed Loading/ Advanced Environmental-friendly Technology.
b) Augmenting railway lines / sectional infrastructure to enhance rake supply. For instance, doubling of Singrauli-Katni section would be required to enhance the number of rakes. Similarly, need for augmenting the Talcher-Paradip line shall be assessed in view of coastal power producers opting for a larger share of cheaper domestic coal (rather than imported coal)

CIL / Subsidiaries shall consider case-by-case feasibility for:

(a) Setting up centralized coal handling hubs to cater to multiple sidings through conveyors, and
(b) Use of pipe belt & rope belt conveyors, wherever feasible, for coal transportation within 50 km of the mines,
(c) Expediting last-mile rail connectivity projects,
(d) Usage of high capacity dump trucks (which can carry up to 60 tonnes of coal) shall be considered (depending on available road infrastructure) to improve evacuation further.

Formation of SPVs with the relevant State Governments and Railways, similar to the one formed in Chhattisgarh for the creation of rail lines at Korba/ Raigarh, shall be evaluated by CIL / Subsidiaries to enhance the rail infrastructure.

As per Coal Vision 2030 for Coal India Limited, the following additional evacuation measures have been proposed, and shall be considered:

1. Implement rapid loading system for mine clusters with annual capacity 5 MT and above

2. Subsidiaries shall plan a few centralized coal handling hubs to cater to multiple sidings through conveyors. Coal handling plants would also help them supply off sized coal.

3. Pursue with MoC to allow Subsidiaries greater flexibility in e-auctions with respect to maximum quantity, pricing, end-use, etc.

4. Mandate annual and rolling operational planning (progressively for mines) to enable stable production profile (adjusted for seasonal variation) that is in line with demand.

5. Evaluate techno-commercial feasibility of hub-spoke model for coal supply (focused at small and disaggregated demand, emergency procurement etc.)

6. Enable longer rake, higher axle load/ wagons with greater capacity

7. Ensure close integration of coal logistics with DFC in terms of first mile/ last mile connectivity and adequate siding infrastructure

8. Enable sharing of evacuation infrastructure such as sidings between the coal companies in an area

9. Target 15-20% coal transportation by alternate transportation models, particularly inland waterways. Collaborate with IWAI to identify investment opportunities in terminal, first/ last mile connectivity and other infrastructure to increase share of inland waterways in coal logistics, particularly NW1 and NW5. Encourage alternate modes of transportation through fiscal incentives/ exemptions

10. Evaluate feasibility of conveyor belts/ overhead ropeways for coal being transported 10 - 50 km. Facilitate to,
    a. do away with dedicated mine surcharge.
    b. allow change of transportation mode for coal linkage auction (at the cost of consumer)
    c. greater flexibility in coal swaps (across companies, end-use sector etc.)

Action: Director (Sales & Marketing) / GM (Sales & Marketing)

Timeline: 31 March, 2020

3.4 Mitigation Plan for safety risks associated with mining operations

Safety in mining operations remains a key consideration for Coal India Limited. While the overall status of accidents and fatalities across Subsidiaries have shown a declining trend, safety still remains a major concern at all the mines of CIL. The methodology for risk assessment and corresponding control measures at CIL/ Subsidiaries is summarized below.

METHODOLOGY OF RISK ASSESSMENT AND CONTROL MEASURES:

At the outset, it shall be pertinent to state, in brief, the methodology of risk assessment and control measures which are currently prevailing in mining industry. Key points are described below:

1. ESTABLISH THE CONTEXT:

   (i) Strategic: Physical environment; Stakeholders; Governmental environment
   (ii) Organizational: Goals and objective of the organization
   (iii) Risk management: Defining and recording goals , scope and limits of the study

2. IDENTIFY RISKS:

   This is the most important step of a risk assessment. There are many techniques available for identifying the risks. Some of these are:

   i. Action Error Analysis
   ii. Failure Mode and Effects Analysis (FMEA)
   iii. Failure Mode and Effects Criticality Analysis (FMCEA)
   iv. Fault Tree Analysis (FTA)
   v. Hazard and Operability Study (Hazop):
      a. Machinery Hazard Identification (MHI)
      b. Potential Human Error identification (PHEI)
   vi. Rapid Ranking
   vii. Workplace Risk Assessment and Control (WRAC)
   viii. What-If? Analysis

3. ANALYSE RISKS:

   A systematic use of available information to determine how often specified events may occur and the magnitude of their likely consequences- i.e. - risks to people / risk to property and production / risk to the environment

4. ASSESS AND PRIORTISE RISKS:

The process used to determine risk management priorities by evaluating and comparing the level of risk against predetermined standards, target risk levels or other criteria. Risks can be prioritized for treatment: risk reduction, risk control.

5. TREAT RISKS:

Risk treatment is selection and implementation of appropriate options for dealing with risks.

i. Eliminate; ii. Reduce; iii. Transfer; iv. Manage

6. MONITOR AND REVIEW:

The most important role of management is control. Control, in turn, entails:

i. Setting a standard
ii. Monitoring and measuring the actual performance
iii. Comparing the actual performance
iv. Acting to correct any deviation from the standard.

PRESENT STATUS OF RISK MANAGEMENT REGARDING MINE SAFETY IN CIL AND SUBSIDIARIES:

CIL and its subsidiaries have adopted the Australian Standard on Risk Management and trained a good number of mining executives in this methodology viz. WRAC, TARP etc.

Safety Management Plans (SMP) have been formulated for all mines incorporating the following:

i. Risk Matrix and Risk Level
ii. Consequence Criteria
iii. Risk Ranking, and
iv. Hierarchy of Control

Further, CIL has implemented the statutory provisions of Coal Mines Regulations 2017 and extant directives of DGMS related to safety in operations for both OC and UG mines.

MITIGATION PLAN FOR SAFETY RISKS ASSOCIATED WITH MINING OPERATIONS:

In addition to and supplementing the initiative of CIL towards ensuring safety in all the mines as stated above, several modules identifying the risks which are predominantly associated with safety risks in operations for both OC and UG mines, relevant to the mining technology in use, have been developed. They are as follows:

(i) Strata Control Risk for UG mines,
(ii) Fire and Explosion Risk for both UG and OC mines,
(iii) Inundation Risk for both UG and OC mines
(iv) Mine Geometry in OC mines
(v) Movement of Vehicles in OC mines
(vi) Dust Control in OC mines

As a first step to mitigate safety risks, each subsidiary shall examine whether the listed risks in these modules have already been identified in their risk assessment, and control measures and the SMP's. If not, it should be examined whether they are applicable, in entirety or in parts, to the mines in operation. If yes, they should be incorporated in their action plans for time bound implementation. Thereafter, subsidiaries shall present such action plans to CIL through RMC for supervisory monitoring.

In addition to the existing Safety Manual and guidelines of DGMS related to safety in operations, a framework for improving the safety in operations for both Open Cast and Underground Mines, specific to the mining technology in use, has been developed. As a first step to mitigate safety risks, each Subsidiary would need to formulate a time-bound plan to implement this framework, as applicable to each of the high-risk mines. Thereafter the action plan should be presented to CIL for supervisory monitoring.

The Safety Department of CIL has also formulated the following action plans for achievement of the safety objectives:

1. Conducting Safety Audit every year through multi-disciplinary Inter-Company / Area Safety Audit teams.
2. Preparation of Site-specific Risk Assessment based Safety Management Plans (SMPs) and implementation of control measures recognized thereby.
3. Preparation of Principal Hazards Management Plans (PHMPs)
4. Formulation and implementation of risk assessment based Standard Operating Procedures (SOPs) for all mining and allied operations.
5. Establishment of Geo-Technical Cell at Subsidiary HQ and large opencast mines.

6. Online Centralized Safety Monitoring System "CIL Safety Information System (CSIS)"
7. Adoption of the state-of-the art mechanism for Strata Management
   - Scientifically determined Rock Mass Rating (RMR) based Support System.
   - Strata Control Cell for monitoring efficacy of strata support system.
   - Roof bolting by using mechanized Drilling for Roof Bolting.
   - Use of Resin capsules in place of Cement capsules.
   - Use of modern Strata Monitoring Instruments.
   - Imparting quality training to support crews & front-line mine officials.

8. Improved Mechanism for monitoring of mine environment:
   - Continuous monitoring of mine environment by ETMS & LMD.
   - Mine Air Sample Analysis by using Gas Chromatograph for better accuracy.
   - Use of Personal Dust Sampler (PDS).

9. Safety measures for reduction of accident in OC mines:
   - Use of more number of Eco-friendly Surface Miner.
   - Training on Simulators to dumper operators.
   - Lighting arrangement using high mast towers for increasing level of illumination.
   - Dumpers fitted with Proximity Warning Devices, Rear view mirrors and camera, Audio-Visual Alarm (AVA), Automatic Fire Detection & Suppression system etc.
   - Ergonomically designed seats & AC Cabins for operators' comfort.
   - GPS based Operator Independent Truck Dispatch System (OITDS) in large OCPs for tracking movement of HEMMs inside OC mine.

10. Further actions include:
    - Educating on sleep hygiene –circadian rhythm
    - Involvement of family members of employee on awareness drive on safety.
    - Switching over to monitoring and investigation of leading indicators of safety: near misses, incidences, family counselling session, on the spot training of contractual workmen
    - Thrust on deliberating principal hazard with preventive measures to prevent disaster in mines at PSC meetings, WI inspections and ISO inspection.

The framework for safety considerations as referred to in the earlier section on Methodology & Risk Assessment of Safety Measures, been presented in the following section:

3.4.1. Mitigation Plan for Risks associated with operations in Underground Mines – Strata Control

Coal Mines Regulation 2017 has brought about significant changes from CMR 1957, in the provisions relating to Safety Management Plan (Regulation 104) and Strata Control and Monitoring Plan (Regulation 123).
In the following module, the risks identified and their mitigation plans are supplementary to the provisions of the CMR 2017 and DGMS Circulars related to the subject, based on the experience of operating mines. Provisions of CMR have not been duplicated here. However, in few cases guidelines of Regulations/Circulars have been reiterated in the relevant context.

A matrix of risks identified and mitigation thereof are given below (refer next page):

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Technology	Associated Risks (Development phase)			Risk Mitigation
(a) : (H) ; (b) : (M) (c) : (L) ; (d) : (L)	Immediate roof		Overlying strata	
(a) B&P Manual [Drilling, blasting, manual loading to tubs/mine cars /face conveyor etc.] (aa) Individual props (timber) /cogs (timber)…….. (H) (ab) Individual props (steel/friction))/steel chocks…. (M) (ac) Roof bolting with quick setting grout /Roof stitching….. (L)	Determine RMR * /Observe nature of roof viz. friable , laminated etc.	RMR < 20 : (VH) >20 <60 : (H) >60 <80 : (M) >80 : (L)	Determine RQD [Risk ∞ 1/RQD] Water bearing / Un-formed strata = (HR)	<u>Applicable to all method of work.</u> i. Frame Support Plans compulsorily on the basis of scientific study & follow religiously. ii. Reinforce support in weak / faulty / watery zones [masonry / concrete lining; steel arch etc.] iii. Minimum time lag between roof exposure and supporting to obviate bed separation. iv. Eliminate timber prop v. Use tested steel for roof bolts .Grouting material supplied for roof bolting must be tested for specified anchorage in UG before use vi. Train support personnel & provide them with proper tools and tackles vii. Devise a system to minimize exposure of persons in the green roof. viii. Complying with the SSR framed for the purpose. ix. Checking the quality of support by Mine Safety Officer with adequate documentation and its monitoring higher up.
(b) B&P Semi-mechanized [drilling, blasting, loading by SDL / LHD to tubs/mine cars/ face conveyor/ gate conveyor etc.] (ac) Roof bolting with quick setting grout /Roof stitching…… (L)	- do -	- do -	- do -	

Technology	Associated Risks (Development phase)			Risk Mitigation
(a) : (H) ; (b) : (M) (c) : (L) ; (d) : (L)	Immediate roof		Overlying strata	x. Systematic monitoring of support by anchorage testing machines, use of gadgets viz. load cells, tell-tales, convergence recorders etc. xi. Learn from previous cases of roof failure.
(c) B&P (R&P) Mechanized [Coal getting by CM's , Roof Bolters , Shuttle Cars , Feeder Breakers , Gate conveyor etc.]	Determine RMR * /Observe nature of roof viz. friable , laminated etc.	RMR < 20 : (VH) >20 <60 : (H) >60 <80 : (M) >80 : (L)	Determine RQD [Risk ∞ 1/RQD] Water bearing /, Un-formed strata = (HR)	
(d) Longwall [Coal getting by Road Headers/CM's, Roof Bolter/ Gate conveyor etc.]	- do -	- do -	- do -	
* at several locations distributed in the property				

Note:

This element is common to all UG mines of all subsidiaries of CIL. Every subsidiary shall conduct further detailing of mitigation measures depending upon specific situation of each mine.

Technology	Associated Risks (Depillaring /Extraction phase)	Risk Mitigation
(a) B&P Manual - Caving	Weak roof /too early caving	➢ Reduce area of exposure at face; ➢ Minimum hard cover o f 15 m; ➢ Diagonal line of extraction; ➢ Do not keep standing pillars for long; ➢ Adopt stowing if feasible. ➢ RMR based support design and SSR framing
	Very hard roof/difficult caving, prone to bumps , air blast	➢ Straight line of extraction; ➢ Thick ribs and stumps of stook not to be left in goaf; ➢ Induce caving by goaf edge blasting; ➢ Adopt stowing if feasible.
- Stowing	Improper packing of goaf / accumulation of methane / caving of strata in spite of stowing	➢ Close co-ordination by CIL HQ S & R Division with Strata control cell of the subsidiary companies. ➢ Ensure proper technique of positioning the Barricades / proper hydraulic gradient ; ➢ Use of sand booster pump in adverse L/H ratio
(b) B&P Semi-mechanized	-do-	-do-
(c) B&P (R&P) Mechanized [Coal getting by CM's, Roof Bolters, Shuttle Cars, Feeder Breakers, Gate conveyor etc.] - caving	i. Diagonal Cut method: Cut length will most likely to be too long for safe mining.	➢ Pillar size should be adequate to enable safe splitting and fender operation. ➢ Snooks are to be reduced carefully depending upon conditions.

Technology	Associated Risks (Depillaring /Extraction phase)	Risk Mitigation
(c) B&P (R&P) Mechanized [Coal getting by CM's, Roof Bolters, Shuttle Cars, Feeder Breakers, Gate conveyor etc.] - caving	ii. Split & Fender Extraction : Fender width may be too narrow for stability	➢ Adequate size of pillars should be chosen. ➢ In general f.o.s. of pillars (after split) should not be less than 2. However, stipulated size of pillars during development as per CMR 1957, have much more f.o.s.
	iii. General issues of risk : [In most cases CM gets buried and fatality occurs] (a) Age of standing pillars is sometimes 30-40 years resulting in time dependent deterioration of roof and bed separation. It also leads to spalling at pillar sides, after the 1st working. (b) Long shut down of operation (mainly break down of CM) resulting in loss of strata integrity at goaf edges (c) Snooks/stubs left out in the goaf delays caving and generates dynamic stress on the working face (d) Shallow cover creates risk of uncontrolled caving (e) Removing floor coal as a 2nd operation creates unstable W/H ratio for a fender and also prolongs exposure of M/c and men in extraction area	➢ Remedial support, especially at intersections, side bolting etc. is needed. ➢ Predictive maintenance and availability of spares/ sub-assemblies of CM and other face equipment. ➢ Avoid large pillars ➢ W/H ratio should not be less than 1

Technology	Associated Risks (Depillaring /Extraction phase)	Risk Mitigation
(d) Longwall [Coal getting by Shearer, AFC, PSLW, Feeder Breaker, Stage Loader, Gate conveyor etc.]	1. Cavability of superincumbent strata	➢ Adequate density of Bore Holes in the area earmarked for LW faces and physio-mechanical properties of strata obtained from cores are two very important requisites for a safe LW operation. ➢ Study of cavability and support resistance (t/m^2) by a scientific agency should be undertaken compulsorily.
- retreating with caving	2. Shallow cover : (uncontrolled caving / dead load on PS / spontaneous heating in caved goaf	➢ Provide additional capacity in Power Supports ; ➢ Packing / Blanketing of fractured surface with earth and compaction by dozing prevents entry of air in the goaf;
	3. Zone of increased stress (30 m from face)	➢ Additional support in both gate roads
	4. Very strong super-incumbent strata	➢ Hard roof management has not been perfected / induce caving from surface by BH blasting ➢ Provide additional capacity in Powered Supports;
	5. Steep gradient of face	➢ Monitor verticality of support on daily basis (preferably by computer programme)
	6. Uncontrolled ground movement / collapse of face	➢ <u>Ground movement monitoring</u>: o Ongoing Strata Management Plan involving scientific agency viz. CMPDI / CMRI o Monitoring of main and tail gates with multiple anchor sonic probe extensometers (or equivalent), load cells and convergence recorders in gate roads ;

		o Monitoring of leg pressures and convergence surveys on a daily basis o Monitoring of health of the support units o Pressure profile o Convergence profile o Subsidence profile o Learn from previous collapse of LW faces (Khottadih, Churcha)

3.4.2 Mitigation Plan for Risks associated with operations in Underground Mines – Inundation

Danger from surface water and danger from underground inundation have been dealt with in Regulation 149 and Regulation 150 respectively in Coal Mines Regulation 2017 and several circulars have been issued by DGMS on these topics. In the following module, the risks identified and their mitigation plans are supplementary to the provisions of the CMR 2017 and DGMS Circulars related to the subject, based on the experience of operating mines. Provisions of CMR have not been duplicated here. However, in few cases guidelines of Regulations/Circulars have been reiterated in the relevant context

A matrix of risks identified and mitigation thereof are given below (refer next page):

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Technology	Associated Risks (Development phase)	Risk Mitigation
All technologies : (a) B&P Manual (b) B&P Semi-mechanized (c) B&P (R&P) Mechanized (d) Longwall	During Development Stage : (a) From surface water bodies (ponds, nullah, river etc.) Nullah/River /large water body in proximity of mine entries (H) i. Intervening barrier between bank of nullah / river / large water body and mine entries, comprise alluvium, running sand etc. even if the thickness of which is more than the stipulated minimum of 15 m , resulting in inrush of liquid matter within the mine	General precautions : ➢ Obtain reliable data of rainfall as well as HFL of water courses from District authorities / Railways / Weather offices ; ➢ Every mine management should have a clear idea about the catchment area affecting the mine, because heavy rainfall far away can cause rapid rise of water levels; ➢ Marking of HFL and Danger levels of water for withdrawal of persons from UG; ➢ Provide Floats, self-activated sirens, visual warnings, telephones/ walkie-talkies and post personnel during rainy season; ➢ Frame Standing Order for withdrawal of persons, Mock rehearsals and familiarization of all concerned ; ➢ Inspection of vulnerable sites by senior-most mine official / manager during heavy rains ➢ Courses of rivers/nullahs change over the years and in many cases, positions shown on old plans is not correct. Re-survey of the water courses to ascertain the accuracy of plans ; ➢ Confirmatory drilling to locate hard ground ;

Technology	Associated Risks (Development phase)	Risk Mitigation
All technologies : (a) B&P Manual (b) B&P Semi-mechanized (c) B&P (R&P) mechanized (d) Longwall	ii. FRL of mine entries are lower than HFL of water course (VH)	➢ Construct protective embankments as per statutory guidelines and adopt all precautions listed above. ➢ Strengthening of barriers by boulder Pitching / Construction of suitable embankment, if necessary. ➢ If Manager of the particular mine identifies inundation as a potential hazard, then: ➢ Every inspection of Manager, Safety Officer & Workman Inspector, PSC meeting and ISO Official (along with concerned Manager/ Safety Officer) shall emphasize on it. ➢ Mine Safety Management Plan (SMP) shall have Principal Hazard Management Plan (PHMP) by Trigger Action Response Plan (TARP).
	(b) UG water sources : i. Encountering un-plugged BH connected to aquifer/water logged seam (even lower seam) ; (VH) ii. Encountering fault plane connected to water-logged seam/ aquifer at higher FRL ; iii. Development in a strata of high make of water;	➢ In respect of known BH's, it is advisable to avoid them while drawing development projections, as far as possible. ➢ In case of inadvertent connection with unmarked BH, there is no other option than to plug the same with concrete cement grout. But before the plugging is accomplished this may play havoc, if pumping capacity is not adequate in the mine. ➢ Drilling holes in the region and injecting quick-setting cement grout at pressure by manual /hydraulic pump and walling off by masonry/concrete. ➢ Roof bolting in watery strata is difficult because cement capsule grout flows out before setting. Plugging the end with dry stemming clay and using resin capsules works. ➢ Provide adequate pumping capacity by doing hydro-geological studies.

Technology	Associated Risks (Development phase)	Risk Mitigation
All technologies : (a) B&P Manual (b) B&P Semi-mechanized (c) B&P (R&P) mechanized (d) Longwall	iv. Preventing inadvertent connection with water-logged working of in-seam, seam of upper or lower horizon or any seam of the adjacent mine (working or abandoned). Many abandoned shafts / inclines / workings remains unrecorded in colliery plans (VH)	Salient points of risk mitigation: ➢ Conducting check surveys while approaching old workings helps prevent danger; ➢ Every gallery to be advanced should have one central and sufficient number of flank holes to ensure a safe barrier ➢ Dewater old workings where feasible, even by submersible pumps through abandoned shaft / BH; ➢ Joint Survey Plan of all seams are a must for ensuring statutory barrier. Where the adjacent area is not approachable, AMP (Abandonment Mine Plans) should be obtained from the DGMS archive
	v. Leaking /Bursting of Water Dams	➢ Design of Water Dam should be done and its construction supervised by a qualified Civil Engineer taking into consideration long term static head of water to be held. Locking of the Dam with roof/floor/sides should be proper. ➢ Dams should never be made unapproachable by extracting panels on their dip-side; ➢ Specifications / details (particularly the head of water for which it has been designed) of Water Dams must be recorded in Water Danger Plan for future reference. ➢ Control valves etc. for sludge cleaning should be of non-corrosive material

Technology	Associated Risks (Depillaring /Extraction phase)	Risk Mitigation
Caving : (a) B&P Manual (b) B&P Semi-mechanized (c) B&P (R&P) mechanized (d) Longwall	During depillaring/extraction stage:	Before commencing extraction/depillaring, lot of circumspection is needed which are: a) Visualize what will be the future implication of caving of strata to dip side of the panel in the same seam or on other seams below, b) The effect of ongoing workings or abandoned workings of adjacent mines on the panel intended to be extracted.
	i. Shallow cover / Goaf connected to surface water body because of subsided craters and fissures.	➢ Dewater water body above before caving / Divert water course where feasible ➢ Packing / Blanketing of fractured surface with earth and compaction by dozing; ➢ Construct garland drain around the periphery of the area to be extracted; ➢ Monitor subsidence in systematic grid
	ii. Rainwater entering caved goaf of one mine gets passage to goaved out area of adjacent mine of the same seam. In many cases, mine boundaries of multiple seams are not vertically superimposed.	➢ Where overlapping workings exist in different seams which are worked from different mines, close communication and sharing of data among managers / safety officers of adjacent mines is imperative.

Technology	Associated Risks (Depillaring /Extraction phase)	Risk Mitigation
Caving : (a) B&P Manual (b) B&P Semi-mechanized (c) B&P (R&P) mechanized (d) Longwall	iii. Exhausted waterlogged workings of one seam gets connected to workings of another seam of the same mine through unplugged BH (even water from a lower seam can find way to an upper seam)	➢ Vertical sections of all coal horizons with faults and BH's across the boundary must be maintained, though it is not statutorily mandated.
	iv. Abandonment of one mine due to exhaustion of reserves gets gradually waterlogged and can seriously endanger the dip side / adjacent mine	➢ It may be necessary to keep certain key features viz. shafts/inclines or some part of workings approachable and ventilated, in spite of abandonment and continue pumping or maintain water level at particular FRL with warning systems in abandoned shafts.
	v. In the past, several mines worked the in-crop segment by OC and then have driven trunk galleries for UG mining from the dip most high wall. As a result, during rains, water of quarry catchment enters UG working without hindrance causing inundation of the UG workings	➢ It is advisable to encase the trunk roadways up to surface level with brickwork, concrete roof and OB (if available) to back-fill the void created by OC mining, at least for the relevant part of the quarry.
	vi. Inaccuracy of Mine Plans is a potent source of disaster of inundation	<u>Certain common negligence of Surveyors :</u> ➢ Old plans are not properly maintained, nor are they converted to the metric scale of current plans; ➢ Omitting important features (particularly abandoned shafts / inclines / BH's / Staple Pits / FRL's / features within the goaved out or stowed panels etc.) when copying one plan to another

Technology	Associated Risks (Depillaring /Extraction phase)	Risk Mitigation
Caving : (e) B&P Manual (f) B&P Semi-mechanized (g) B&P (R&P) mechanized (h) Longwall	vi. Inaccuracy of Mine Plans is a potent source of disaster of inundation	➢ Not showing the stations and traverses in the Joint Survey Plan. Many JSP's are simply copied and un-surveyed ➢ When subsidence occurs in an area due to caving, the surface contours are not resurveyed. ➢ Not maintaining AMP's of abandoned seams of the same mine or of adjacent mines.
	Past incidents of inundation	Learn from previous disasters due to inundation (Chasnala, Dhemo Main, Mahavir, Ghaslitand etc.) Learn from earlier investigation reports viz. HB Ghosh committee, Bagchi Committee etc. and cross check whether the recommendations are still being followed or not.

3.4.3 Mitigation Plan for Risks associated with operations in Underground Mines – Fire & Explosion

Precautions against fire have been dealt with from Regulation 134 - 142 and precautions against dust from Regulation 143 -146 in Coal Mines Regulation 2017 and several Circulars have been issued by DGMS in this regard. In the following module, the risks identified and their mitigation plans are supplementary to the provisions of the CMR 2017 and DGMS Circulars related to the subject, based on the experience of operating mines. Provisions of CMR have not been duplicated here. However, in few cases guidelines of Regulations/Circulars have been reiterated in the relevant context

A matrix of risks identified and mitigation thereof are given below (refer next page):

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Technology	Associated Risks	Risk Mitigation
All technologies : (a) B&P Manual (b) B&P Semi -mechanized (c) B&P (R&P) mechanized (d) Longwall	Fire due to exogenous causes (accidental) both at Surface and Underground: Fires due to Spontaneous Heating (endogenous) 1. Certain coal seams are prone to spontaneous heating e.g. (H) Seam IX (Kajora) in ECL Seam VIII (Jambad) in ECL (Especially bottom sec. Also several cases of Pillar fire in this seam) Seam VII A (Kenda)	CMR 2017 stipulated adequate measures to be taken against fires caused by exogenous reasons (other than spontaneous heating) [Regulations 134 (General precautions against fire) and Reg 135 (Surface precautions against fire) and Reg 136 (Underground precautions against fire) and related DGMS Circulars] ➢ Generally, Crossing Point Temperature of coal seams / sections are determined to find out the propensity of a particular coal to spontaneous heating. Presently countries like USA, Canada, Australia etc. are using Adiabatic Oxidation method such as R70 (Mean Temperature Rise from 40°C to 70°C), SHT (Self Heating Temperature, IRH (Initial Rate Heat – rising) and TTR (Total Temp. Rise) for this purpose which is said to be more accurate (but rather time consuming). CIMFR, reportedly, are doing these tests. China has developed 'Oxidation Kinetics' testing method which is claimed to be most comprehensive. This data will give a guideline in planning the size of a depillaring panel in a virgin seam so far as incubation period is concerned. ➢ If fire is a potential hazard for the mine, then: ➢ Every inspection of Manager/Safety Officer/Workman Inspector shall cover the issue. ➢ Every PSC meeting shall deliberate on the status of precautionary measures & further actions. ➢ ISO Official along with concerned Manager/Safety Officer during their inspection shall emphasize on it. ➢ Mine SMP shall have PHMP by TARP.

Technology	Associated Risks	Risk Mitigation
All technologies : (a) B&P Manual (b) B&P Semi -mechanized (c) B&P (R&P) mechanized (d) Longwall		➢ Collieries having a history of spontaneous heating in a working panel as well as in sealed-off panels should dig out past records to ascertain incubation period and form depillaring panels consistent with rate of production. Forming Sub-Panels with necessary isolating arrangement helps in case of seams prone to sp. heating.
	2. Working contiguous sections in a thick coal seam or contiguous seams [within the meaning of Reg. 104 (2) of CMR1957] is a High Risk area , in a seam prone to sp. heating, because liquidation of both the sections / seams gets prolonged and fire travels from one seam / section to the other. (H)	➢ During development, extreme care is necessary to ensure that parting does not get reduced below the mandatory minimum 3 m thickness (physically proving at frequent intervals by drill hole). Presence of shale bands in the parting calls for greater thickness of the parting to be maintained. ➢ During depillaring, if possible, hydraulic sand stowing should be adopted, working from bottom upwards. ➢ In case the sections / seams are working using the caving method, it is advisable that (a) ventilation circuit in both the sections are independent, (b) each section / seam should individually have Isolation Stoppings, (c) Staple Pits etc. made for evacuation of coal from top to bottom, are plugged while sealing the top section. The extraction shall be top downwards. Simultaneous extraction with bottom section with some lag, helps.

Technology	Associated Risks	Risk Mitigation
All technologies : (a) B&P Manual (b) B&P Semi -mechanized (c) B&P (R&P) mechanized (d) Longwall	3. Working shallow coal seams (< 100 m depth) by caving method : i. Risk of sp. heating due to surface air sucked through subsidence cracks by MMV, even after sealing of the goaved out panels. ii. Incidence of heating in working Long wall panels at shallow depth with consequent loss of equipment is there because of long period needed to complete the extraction. (Jhanjra) iii. Sp. heating in outcrop region of a coal seam (sometimes caused by illegal mining) 4. Mine entries endangered by Sp. Heating : It is very common that vertical shafts pass through multiple coal seams in a mine. If the sealed off upper seam(s) get affected by fire in course of time and if the sealing at Shaft Pillar is not proper, atmosphere in lower seams is vitiated by noxious gases carried by intake of air. In certain cases the shaft Pillar itself catches fire. Collapse of shaft pillar results in the head gear going down	In both cases (i) and (ii), surface blanketing with earth and compaction by dozing is a proved solution to contain the heating. Biological reclamation (plantation, agriculture on reclaimed land after settlement of strata) will effectively shut off entry of air. ➢ Very difficult to control. Blanketing by earth and compacting by dozing controls fire but illegal miners again open up. ➢ Cutting trench to dissect the seam so that fire does not travel towards dip. ➢ Sealing off near vertical shaft should be done at least one pillar in bye, so that if fire jumps the Isolation Stoppings (IS), another row of IS can be erected to contain the fire. ➢ In some old mines which are being worked till date, shaft pillars has been criminally robbed by splitting. The Isolation Stoppings of the sealed off seam must be accessible for inspection, collection of air samples etc. and landing arrangement at on setting level must not be dismantled for an exhausted seam.

Technology	Associated Risks	Risk Mitigation
All technologies : (a) B&P Manual (b) B&P Semi -mechanized (c) B&P (R&P) mechanized (d) Longwall	5. Un-extracted coal left out in goaf; (H) i. In conventional B&P mining / depillaring with SDL's and LHD's and even in Continuous Miner depillaring, left out coal in goaf is a cause of Sp. Heating in goaf, both in working panel as well as in sealed off panels.	➢ In conventional B&P mining height of extraction is limited by the size of individual props which is gradually replaced by roof bolting. In case of depillaring by SDL's / LHD's, although development drivages are mandated at maximum 3 m height, it is feasible to extract another lift of about 1-1.2 m of floor coal in the floor at the time of slicing with roof bolting and steel chocks in second operation. But in case of any coal seams superior to 4.0-4.5 m, some coal is bound to be left in goaf. In case of depillaring with Continuous Miner, seam height of about 5.0-5.5 m has been successfully worked upon. ➢ In both cases, it is the un-extracted stumps / ribs left, which do not allow full caving and the void left in the goaf is the cause of heating. It is advisable to rob the ribs / snooks as far as safely possible or decimate them even if the coal cannot be lifted out. ➢ In case of retreating Long Wall faces, the Shearer and Powered Supports should be chosen so as to extract the full height of the seam, as far as possible. Previously, height of extraction in LW faces was limited by the maximum extendable height of Powered Support available (3.5 -4 m) consequently lots of coal remained unrecovered in case of thick seams. Presently, in Indian mines (Jhanjra ECL), 5.50 m seam is being proposed to be extracted by deploying matching equipment. Shangwan mine in China has extracted 6.50 m by Shearer in one lift. ➢ But in mining methods like Sub-Level caving, considerable amount of coal is bound to be left in the goaf. In such situations, controlled dosing of nitrogen through perforated pipes left in the goaf, to keep the goaf atmosphere inert, has been successfully done in European mines (Blanzy coalfield in France). This can be emulated in CIL mines. Feedback from CIL is that Mist Spray in goaf has been successful in some mine.

Technology	Associated Risks	Risk Mitigation
All technologies : (a) B&P Manual (b) B&P Semi -mechanized (c) B&P (R&P) mechanized (d) Longwall	6. <u>Sp. Heating in stowed goaf</u> Several incidents of spontaneous heating have occurred in stowed goaf, which totally defeated the very purpose of stowing. Main reasons, identified were : i. Improper stowing due to non-adoption of proper mixing chamber of slurry, improper diameter of stowing range and adoption of stowing without proper study in adverse hydraulic gradient (H/L ratio); ii. When stowing lag occurred, extraction was still allowed to continue to achieve the target of coal production and the panel sealed off keeping the void. 7. <u>Sp. Heating in sealed-off panel in degree III gassy mine</u> This is a very high risk area. Usually methane percentage builds up to a very high level after sealing off. Fire Damp explosion and consequent fatality has happened in some mines when air leakage has taken place through improperly constructed Isolation Stoppings.	➢ It is always advisable to get a study made by CMRI before adopting and designing a stowing plant. ➢ Trough type (Marlbach) / Russian cistern type of mixing chamber prevents air pockets. Where hydraulic gradient is not favorable, larger dia. pipe range should be used (200 mm or even 250 mm HDPE instead of usual 150 mm CI) especially for coarse sand (of Damodar/Barakar unlike of Brahmani which contains argillaceous material) ➢ In very adverse hydraulic gradients, sand booster pumps may be installed or stowing from large dia Bore Holes strategically located near a group of panels. ➢ Internal Safety Organization (ISO) of Subsidiaries need to closely monitor stowing lag. In the past ECL was carrying huge stowing lag in some of the mines. ➢ It is to be ensured that the percentage of methane does not fall and consequently the mixture enters into the explosive range. Isolation Stoppings must be explosion-proof. Recess cut in roof, floor and sides should be as per Statute. Sealant may also be used. Pressure balancing techniques minimize leakage. Rule of thumb is that all danger of explosion is eliminated if O_2 concentration is kept below 3%.

Technology	Associated Risks	Risk Mitigation
All technologies : (a) B&P Manual (b) B&P Semi -mechanized (c) B&P (R&P) mechanized (d) Longwall	Fire Damp (methane) Explosion : <u>Certain High Risk situation are discussed here:</u> 1. Introduction of Mass Production technology e.g. Continuous Miner or PSLW faces may change the existing degree of gassiness (say Deg. II) to Degree III, because of rapid desorption of CH_4 from coal mass due to high rate of coal getting and creation of more surface area due to more fines in machine cut coal unlike blasted coal. 2. Failure of power frequently or for long period for Degree III mines 3. Extracted and sealed off coal seams containing reservoir of CH_4 or even virgin gassy seams, above or below (particularly splinter seam) can vitiate a working coal seam through suction of the MMV	CMR 2017 has extensively dealt with this subject in Reg. 153, Reg 166, and Reg 169 to 171 and DGMS issued many related Circulars. Certain other actions are stated as follows: ➢ Fresh Gas Survey as per procedure stipulated by DGMS, during coal getting operation in CM / PSLW faces. ➢ Ventilation standard, type of electrical apparatus, etc. are to be revised as per statutory provisions for Degree III mines. ➢ Degree III mines should have two distribution feeders from a power station or power from two power service providers, wherever feasible. Alternatively, diesel generators for standby for MMV and Winder must be installed. ➢ Regular gas survey in the working seam. ➢ CBM extraction may be a solution.

Technology	Associated Risks	Risk Mitigation
All technologies : (a) B&P Manual (b) B&P Semi -mechanized (c) B&P (R&P) mechanized (d) Longwall	4. If cross measure drifts are driven across a Degree III seam, then other seam(s) become vulnerable, even if the latter has not been categorized as Degree III. (e.g. Kalidaspur Project of ECL)	➢ All precautions including FLP electricals should also be taken for other seam(s).
	5. Sectionalisation of developed panels in a Degree III mine is often made with non-explosion proof (1m thick brick & cement) Isolation Stoppings, which eventually become a reservoir of CH_4 and may be a source of explosion if frictional sparks are caused by roof falls.	➢ Sectionalisation of developed panels by explosion proof stoppings, especially when number of stoppings are many, is very costly. Alternatively, ventilating the panels standing on pillars may be safer. In some mines, bleeding of gas from sealed-off panel was practiced which is fraught with danger.
	6. Some coal blocks have been allocated by Govt. where already CBM blocks were allocated.	➢ A whole new chapter XVI (Reg. 218 to 286) has been added in CMR 2017 on extraction of methane from mine working, but there is no directive on the safety aspect, whether mine working and CBM extraction can proceed concurrently.
	7. In certain mines, control of CH_4 concentration is not possible by general ventilation in spite of adhering to statutory standard.	Possible solutions for control of CH_4 emission are : ➢ In-seam methane drainage; ➢ De-gasification through cross-measure boreholes or by horizontal boreholes in advance of working sections, or ➢ Drainage of goaf

Technology	Associated Risks	Risk Mitigation
All technologies : (a) B&P Manual (b) B&P Semi -mechanized (c) B&P (R&P) mechanized (d) Longwall	Coal Dust Explosion: 1. Certain facts related to coal dust explosion, which are often overlooked by operational personnel, are reiterated for drawing attention: i. Destruction in coal dust explosion is extremely high as compared to fire damp explosion which is the most common source of ignition of coal dust. ii. To cause coal dust explosion, a shock wave is to be produced to raise a dust cloud around a flame, such as firedamp explosion, shot firing with non-permitted explosive, (only 10 gm of non-permitted explosive has been found sufficient to ignite fine coal dust, so does a detonating fuse). Outburst of CH_4 in a splinter seam was found to be the cause of Chinakuri 1&2 Pits coal dust explosion (19.02.1958)	Studies abroad and in India revealed that shot firing, frictional spark and electricity are major reasons to start a CH_4 explosion. ➢ Precautions to be taken to avert fire damp explosion are all relevant for coal dust explosion as well, e.g. * Measures against accumulation of CH_4 • Adequate ventilation quantity and velocity mandated by Statute ; • Coursing air right up to face etc.; * Measures against ignition of CH_4 : • No defective Safety Lamp; • Use of FLP / Intrinsically Safe apparatus ; • Compulsory testing of CH4 before energizing electricals, before shot firing ; • Automatic power cut off when % of CH_4 exceed stipulated limit; • Continuous monitoring of all vulnerable places with pre-warning alarm etc.

Technology	Associated Risks	Risk Mitigation
All technologies : (a) B&P Manual (b) B&P Semi -mechanized (c) B&P (R&P) mechanized (d) Longwall		➢ Preventive measures to stop Coal Dust explosion can be divided in 3 categories : • to reduce coal dust formation; • once formed it is to be suppressed by water spraying and inertisation of coal dust by stone dust; • stop explosion to propagate- wetting of coal, stone dust / water barrier etc.
	iii. Fineness of dust : coal dust between 10 and 100 microns is most explosive (although particle up to 750 microns can take part in explosion)	➢ Due to explosive nature of coal dust spray mist in CMs and Shearers for dust suppression assumes greater significance. Normally, these machines have interlock – power cannot be switched on to the drum without spraying. ➢ Less pick speed (< 4 m/s), sharpness of picks, proper pick lacing are essential. ➢ Requirement of water is about 20 l / t of coal production (2 % by weight)
	iv. Dust deposited on the roof bars is more explosive than that of on the floor. Top most layer of dust is the most dangerous.	➢ Reg. 144 (Executions of measures of dust control)(6)(a) CMR 2017 stipulates as under : "before treating with incombustible dust, all coal dust shall be cleaned ..... from the roof, sides, floor, props, cogs, bars, brattice cloth or any other objects or structure or place on which dust may deposit and all dust so collected shall be removed from the surface within 24 hours." Attention is drawn to ISO of CIL for above.

Technology	Associated Risks	Risk Mitigation
All technologies : (a) B&P Manual (b) B&P Semi -mechanized (c) B&P (R&P) mechanized (d) Longwall	v. More the Volatile Matter (VM) in coal, the more is the dust explosive. Dust with VM 20% to 36% is highly explosive. High Rank coals are less susceptible to explosion. vi. Other than VM, the ash content in coal is another factor affecting explosive potential of coal dust. Even 30 % VM coal fine ceases to be explosive with ash of 60 %. vii. Formation of CO in coal dust explosion is inevitable [$2C+O_2=2CO$ for incomplete combustion] and its content can go up to (5-6) % in mine air. Study has revealed that 70-80 % death due to coal dust explosion is because of poisoning by CO and not due to impact of explosion.	➢ Check Volatile Ratio [If the volatile content divided by the sum of the volatiles and fixed carbon exceeds 0.12, the dust is potentially explosive.] ➢ Reg 144 (3)(a) stipulates 75% incombustible matter in case of coal seam with less than 30 % VM and 85 % in case of more than 30 % VM. ➢ The required quantity of stone dust, X (gm/Kg of coal) needed to increase the ash content of dust up to the safe level can be calculated from the formula : $(A + X)/(1000 + X) = Y/100$ where, A = ash in coal (gm/Kg), and Y = required incombustible Content in final dust in % by wt. ➢ This aspect has to be considered during recovery operation

Technology	Associated Risks	Risk Mitigation
All technologies : (a) B&P Manual (b) B&P Semi -mechanized (c) B&P (R&P) mechanized (d) Longwall	2. Overview in respect of Coal Dust Explosion May be divided in 3 main groups : a. Means to reduce coal dust formation b. Once formed, it is to be suppressed c. Stop explosion to propagate	CMR 2017 has extensively dealt with the subject of 'Precautions against Dust' (Reg 143), 'Execution of measures for dust control' (Reg 144), 'Check on measures of dust control (Reg 145) and 'Stone Dust barriers' (Reg 146). DGMS have issued numerous related Circulars on this subject. By far these are the most comprehensive legislation of the entire CMR both on the matters of health hazard to workmen as well as of coal dust explosion. If the coal mines adhere to the Statutes and the directives of DGMS, that will be the best mitigation to risk. Suggestions: ➢ ISO of every subsidiaries have to make substantial effort to implement the Statutes; ➢ MM department may ensure that sufficient quantity of stone dust is available at all time in colliery store. ➢ CIL may encourage ancillaries to set up at least one plant in every subsidiary to crush and produce Limestone/Gypsum dust by giving land, financial help etc.; ➢ Adequate manpower must be allocated to dusting and sampling in every UG mine. Stone dusting should become a habit like daily coal production ; ➢ Company should set up laboratories to make all the analyses of dust samples in-house to cut down time ; ➢ Training of personnel including executives about dust control and dust treatment.

3.4.4 Mitigation Plan for Risks associated with operations in Opencast Mines – Mine Geometry

Coal Mines Regulation 2017 has framed few new Regulations regarding OC mining viz. 'Mechanised opencast working (Reg 106), Reclamation (Reg 107) Spoil banks and dumps (Reg 108) and Code of practice (Reg 110). Further, DGMS has issued several Circulars in this regard.

A matrix of risks identified in respect of the following elements technology wise (refer next page):

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Technology	Associated Risks	Risk Mitigation
Shovel-Dumper combination [Blast Hole Drill / Blasting by explosives /Excavators (Diesel/Electric)/Rear Dumpers]	Height and Width of benches: i. Risk arises when overhang is formed in front of the excavator while digging which when dislodged will damage the machine and cause injury to the operator; ii. Risk arises when width of bench is too narrow for safe movement and maneuver of HEMM and when blasted material spills down to lower bench ; Gradient of Haul Roads etc.: Steep gradient of Haul Roads creates risk of skidding; Lack of proper visibility at corners and bends creates condition of collision of Dumpers moving in opposite directions	➢ In mechanized OC mines, height of the bench in alluvial soil, morrum and similar soft ground shall not be more than 3m and the same in coal and OB (rock formation) shall not be more than the digging height of the excavator or reach the excavator [Reg 106] ➢ Statutory minimum width shall never be less than widest machine + 2m or 3 times the width of the largest vehicle plying or height of bench [Reg 106]. But in many cases, more space is needed for faster movement of large Dumpers (+ 100 T) for Dozer path as well as for providing space for poles for power lines, parapet walls. Wider benches are also needed for gentler slope of excavation. ➢ No road shall be steeper than 1 in 16 at any place. However, for temporary ramps, a gradient of 1 in 10 may be permissible in short stretches. In case of downhill movement of loaded Dumpers, gradient should be around 1 in 20.

Technology	Associated Risks	Risk Mitigation
Shovel-Dumper combination [Blast Hole Drill / Blasting by explosives /Excavators (Diesel/Electric)/Rear Dumpers]	Slope Stability of the mine excavation OC mines are getting deeper and deeper because production cost and safety concerns of UG mining is more. Many OC mines, presently, are planned up to a depth of 300 m or so. This is increasing the risk of stability of mine excavation. Loss of reserves in the batter is also another factor	➢ Operator of Dumper shall have a clear view of 30 m in haul roads ; In blind curves, installation of convex mirrors helps ➢ Roads above the levels of surrounding area shall be provided with parapet walls of 1 m ➢ Study of slope stability of the mine excavation, by a scientific agency is mandatory now [Reg 106(2)], in which hydro-geological data, HEMM configuration should be considered. ➢ The principles for Slope stability analysis for ultimate pit slope are generally carried out using limit equilibrium method (Bishop's method) with the help of the software "Galena". Geo-mechanical parameters / input data e.g., Density (Kg/m^3), Unit Wt. (KN/m^2) , Cohesion (KPa), angle of internal friction of all the lithological units viz. alluvium, clay, sandstone, shale and also coal and groundwater parameters of the area are used for the slope stability analysis. ➢ Stipulated Factor of Safety for the ultimate pit slope for the deepest pit is between 1.10 and 1.20, (with or without considering seismicity respectively) recommended by different International agencies (e g., "National Coal Board, U.K", etc.). A thumb rule for our coal measure strata, a safe slope may be around 28° to 35°

Technology	Associated Risks	Risk Mitigation
Shovel-Dumper combination [Blast Hole Drill / Blasting by explosives /Excavators (Diesel/Electric)/Rear Dumpers]	Slope Stability of Dumps (Internal and External) Due to constraint in availability of land, height of External Dumps being planned are often (+) 90 m high. So is the case of Internal Dumps. This is creating risk of dump failures. Inadequate management of dumps also creates environmental degradation by way of silting / changing course of water courses/ dust pollution etc.	➢ Coal blocked in batter increases with flatter slope, which may be considered for partial recovery by High Wall mining. External Dump : In active dumps exceeding 30 m, benching is to be done, height of benches not to exceed 30 m and slope 1 in 1.5 [Reg 108]. Physical reclamation: After completion of dumping and dozing, compaction is needed to preclude accumulation of water at the top of the dump. Thereafter, covering by top-soil will be done. The rills and gullies formed on the slopes all around need plugging with check dams. On the slopes of the dump, continuous contour trenches ½ m x ½ m section at interval of 5 m should be excavated, where possible, and soil properly shaped in a mound on the lower side which will facilitate plantation. It may be necessary to construct toe wall at certain stretches to protect road etc. In toe-walls, weep-holes for seepage should be provided to obviate built-up of hydro-static pressure at the base of the dumps. A 2 m by 2 m trench need to be dug all around the dump to arrest run-off of silt.

Technology	Associated Risks	Risk Mitigation
Shovel-Dumper combination [Blast Hole Drill / Blasting by explosives /Excavators (Diesel/Electric)/Rear Dumpers]	Slope Stability of Dumps (Internal and External) (contd.)	Biological reclamation: It should preferably be done with the help of experts from the Forest Department. In general, for bio-reclamation, intense planting of agave or treated seeds of acacia nilotica shall be planted on the mound formed by excavated soil on the outer side of 2m trench, on the mounds of the continuous contour trenches, on the rills and gullies where check-dams have been constructed, below the check-dams etc. Internal Dump: Back-filling of overburden in the quarry is for reclamation of the void created by mining, which is presently mandated (Reg 107) and as part of Mine Closure Plan. Generally internal dumping starts after 3 -5 years of starting of mine operation when sufficient space in dip/strike direction is available. ➢ It is to be ensured that Haul Roads and other utilities viz. pumping ranges, sump, power line etc. and the working benches of the quarry are safe from the loose overburden. ➢ Generally, it is planned that the advancing working face is at least 100 m away from the line where backfilled OB touches the quarry floor. This distance is quite variable, mainly governed by the grade of the de-coaled quarry floor. In case of certain steep seams viz. Manikpur, in Korba coalfield (Jatraj seam gradient goes up to 1 in 2.5) backfilling is ruled out.

Technology	Associated Risks	Risk Mitigation
Shovel-Dumper combination [Blast Hole Drill / Blasting by explosives /Excavators (Diesel/Electric)/Rear Dumpers]	Slope Stability of Dumps (Internal and External) (contd.)	➢ Height of the Internal Dump can be calculated from the Swell Factor (about 0.76) of blasted OB and applying a factor for subsequent compaction due to passage of HEMM and water spraying on the volume of OB. Stable slope angle depends on the factors already described viz. Density, Unit Wt. Cohesion, Angle of internal friction which govern the natural Angle of Repose of the litho-units of loose OB and also groundwater parameters and may be around 25° to 30°. DGMS stipulates that the slope must not exceed 37.5° (Reg 108). It is advisable to have study done by a scientific agency. Physical and Biological reclamation are essential for stability of Internal Dumps Physical reclamation: Back-filled area needs to be overlain by a layer of top-soil, either from top-soil dump or as a continuous process of excavation and back-filling, and leveled by Dozers and Graders. This process will continue till the limit of the pit is reached.

Technology	Associated Risks	Risk Mitigation
Shovel-Dumper combination [Blast Hole Drill / Blasting by explosives /Excavators (Diesel/Electric)/Rear Dumpers]	Slope Stability of Dumps (Internal and External) (contd.) Risks of slope stability of spoil heaps (internal dump) dumped by Dragline	Biological reclamation : Since bio-reclamation of waste is a very specialized subject, Forest Dept. of State Govt. or any specialized centre i.e.: NEERI should be engaged as consultant in this regard. In general, Biological reclamation of the excavated area is 2 years behind the physical reclamation because the filled-up area, though gets compacted by movement of HEMM (Dumpers, Dozers, Graders), needs some time to be firm and away from ground movement caused by drilling of deep blast holes and blasting by explosives. Broad outline of bio reclamation is to divide the area in blocks and raise a mixed plantation or make suitable for further agriculture. Study at NCL, of spoil heaps created by Dragline has shown that leaving coal rib against the internal dump was very useful from stability point of view .The shear strength parameters of rock strata between coal rib and the floor should be correctly determined to predict height and width of coal rib in improving f.o.s. of dump . Leaving coal rib also prevents spoil toe undercutting of dump during coal getting, which has been identified as major cause of failure of D/L spoil heap. Comparison of safe height of dump with and without rib.

Technology	Associated Risks	Risk Mitigation
Shovel-Dumper combination [Blast Hole Drill / Blasting by explosives /Excavators (Diesel/Electric)/Rear Dumpers]	Risks of slope stability of spoil heaps (internal dump) dumped by Dragline (cont.)	Slope / Dump Ht. with rib / Dump Ht. without rib 35° / 80 m / 67 m 32° / 90 m / 80 m [Coal ribs sometimes catches fire but gets covered in next cut.] Inclination of dump floor: There is steady decrease in stable height of dump with increase in inclination of floor .With increase in inclination, failure surface has a tendency to pass through interface material between dump and foundation. To improve the strength of interface material between dump and foundation : i. De-coaled area should be scraped as far as possible of left out crushed coal and rock material to make the floor more competent , ii. Quarry floor ripping can achieve improvement in stability by disrupting the potential failure plane through the weak interface between dump and foundation. Systematic observation of slope by advanced stability monitoring instrument is important.

Technology	Associated Risks	Risk Mitigation
Shovel-Dumper combination [Blast Hole Drill / Blasting by explosives /Excavators (Diesel/Electric)/Rear Dumpers]	Other risks of slope stability of dumps	Prevent build-up of seepage water pressure inside the dump leading to movement of rock material – full drainage system on top of the dump. Installation of piezometers wherever required to measure water pressure .Similarly, prevent build-up of water against uphill toe of the dump. Construction of toe-wall (1 m wide x 2 m ht.) with stone boulders (with weep holes) to prevent washing down of softer material during rains have been successful in some projects (Kusmunda)

3.4.5. Mitigation Plan for safety risks associated in open cast mine – Movement of vehicles

Technology	Associated Risks	Risk Mitigation
Shovel-Dumper combination [Blast Hole Drill / Blasting by explosives /Excavators (Diesel/Electric)/Rear Dumpers]	Analyses of fatalities in OC coal mines of CIL for the last 3 calendar years, 2015, 2016 and 2017 reveals that 35.80% fatalities occurred due to Dumpers and Trucks. [Source: Agenda note for 42nd meeting of The Standing Committee on Safety in Coal Mines on February 26, 2018 (MoC web site)] Note: 23 fatalities in one accident in Rajmahal influences the figures. If we consider, nos. of Fatal Accidents, not fatalities, then the share for this item goes up to 49 %. The above is to emphasize the magnitude of risk associated with movement of vehicles. i. Proper construction and maintenance of Haul Roads, both within the quarry as well as towards CHP , Dump(s) and Base Workshop	First major attention to this subject was drawn in the recommendation of Seventh Conference on Safety in Mines [1988]. Based on that DGMS issued circular in 1989 and later, detailing a host of mitigating measures which include, inter alia, framing of “Traffic Rules" , “Code of Practice” for prevention of accidents at dumps and stockpiles, maintenance of Haul Roads, Scheme of maintenance of HEMM, training /upgrading skill of operators ,improvement of lighting etc. Those are not recounted here. Yet, ISOs of subsidiaries should review that if any measures are still lacking or inoperative, corrective actions are to be taken. It has been noticed that in many OC mines, “Traffic Rules" are not mine-specific. Certain key issues , in addition to the circulars , are dealt here: Civil Engg. Dept. of CMPDI brought out an excellent and detailed guide lines for construction and maintenance of Haul Roads way back in 2001. Certain key matters , given below, which if implemented, will go a long way to avert accidents due to movement of Dumpers: ➢ Width of Haul Road as per size of Dumpers for single lane and double lane

Technology	Associated Risks	Risk Mitigation
Shovel-Dumper combination [Blast Hole Drill / Blasting by explosives /Excavators (Diesel/Electric)/Rear Dumpers]		➢ Camber, Super Elevation , Safe Horizontal and Vertical curves ➢ Paving: Specification for permanent and temporary Haul Roads ➢ Dozer path: width on one side or either side of Haul Road depending on dozer traffic and mine layout ➢ Side drains : 1 m deep on either side ➢ Grade: in no case to exceed 1 in 14 (preferable 1 in 16 , 1 in 20 for down ward load) ➢ Escape Lane: in case of down ward haul, when brake fails, to avoid collision with opposite lane dumpers. ➢ Parapet Wall: not < 1 m , when Haul Road is above the surrounding area ➢ Lay by: for narrow temporary haul roads to facilitate crossing of opposite direction or towing a disabled vehicle. ➢ Runway Vehicle Collision Berm: proper spacing and ht. of berm. Median berm is more effective. ➢ Road signs: in bifurcations, crossings, etc. In crossings, Rly type level crossing type of drop barrier with attendant and also red and green signals are necessary at certain points particularly during night hours.

Technology	Associated Risks	Risk Mitigation
Shovel-Dumper combination [Blast Hole Drill / Blasting by explosives /Excavators (Diesel/Electric)/Rear Dumpers]	ii. Some other aspects of Haul Road design and construction which prevents accidents	Studies have revealed that, ➢ Stopping Sight Distance: e.g. Vehicles at 30 Kmph require 167 m safe distance between them at 20 sec. reaction time of operator for seeing the hazard and applying brake. For vehicle (gross wt. 90 to 180 t) at 32 Kmph, distance limitation to preclude brake failure is 73.8 m. whereas, vehicle can be brought to stop at 68.6 m at 5% grade Haul Road), it will need 91.5 m at 10%. ➢ Overtaking Sight Distance for various speeds, e.g. at 20 Kmph, time component for overtaking maneuvers is 9 sec. and for opposite vehicle is 6 sec., the safe overtaking distance is 165 m whereas at 10 Kmph it is 300 m. ➢ Lighting: Proper selection of lamps (HPSV, LPSV etc.), Lighting System (Flood, High Mast, Mobile etc. depending upon need), Spacing and mounting height, Illumination level (20 Lux as the optimum as per IS 6665). In the interest of safety, economy and overall system efficiency, highest mounting source and largest light source practicable shall be used.

Technology	Associated Risks	Risk Mitigation
Shovel-Dumper combination [Blast Hole Drill / Blasting by explosives /Excavators (Diesel/Electric)/Rear Dumpers]	iii. Plying of Light Vehicles in the Haul Roads of quarry and other areas of OC mine: Innumerable accidents with HEMM have occurred involving LV's of mine officials (cars jeeps, shift bus , Canteen Van) , service vehicles (407, 1- tonner etc.) , explosive carrying vans , unauthorized / un-notified entry of contractors, suppliers and even visitors	➢ As far as practicable separate path for LV's are to be planned at the stage of planning the layout of Haul Roads, at least for the permanent stretch, with a divider. ➢ Roadside plantation in the divider makes it more defined and serves for dust suppression. ➢ LV's should have flag poles fixed on the side, which is visible from the lofty cabin of the operator of Dumpers. ➢ At the entry point of the mine, check posts are to be established with 24 x 7 attendants to see that no unauthorized entry takes place.
	iv. Parking of Dumpers and other matters: Improper parking (sliding of even stationary dumpers), lack of proper parking platforms within the quarry or at the mine entry (if the Base Workshop is far away),	➢ Plying of dumpers can be greatly reduced during tiffin-break, shift change, if parking lot in flat ground is created within the quarry. ➢ It is known that parking at grade is unsafe but in case of disabled trucks, in emergency, should be parked at right angles to the grade, parking brake applied and /or chocks applied fore/aft of the wheels and towed to parking platform or lay by at the earliest opportunity . ➢ Main Parking lot in the entry of the mine should be paved with slight cross-grade so that slushy condition is not created. The area should be such that space between vehicles are adequate for maneuver as well as movement of personnel against accidental run over.

Technology	Associated Risks	Risk Mitigation
Shovel-Dumper combination [Blast Hole Drill / Blasting by explosives /Excavators (Diesel/Electric)/Rear Dumpers]	v. Too many Dumpers/ Trucks for a given output moving about in an OC mine, enhances risk associated with not only movement but for management, maintenance, pollution.	➢ If size of Dumpers are increased consistent with increase of mine production, then no. of vehicles can be brought down. Two scenarios are given: a. A mine has been planned for (say) 2 Mtpa with 5 m^3 excavator and 40T Rear Dumper. Eventually, it starts producing much more. Instead of adding more nos. of 40 T Dumpers, the equipment profile may be changed to 5 m^3 Exc + 60 t Dumpers or even 10 m^3 + 100 T Dumpers by a revised PR, thereby reducing equipment. b. An approved Mine Plan for a large OC mine with S/Ratio about 4, with ultimate depth of 300 m, has been planned for 15 Mtpa with 78 nos of 170 T and 152 nos. 120 T Rear Dumpers [in combination with Exc.20 m^3 /10 m^3 /8.3 m^3] for OB and 77 nos. of 50 T Rear Dumpers [in combination with Exc. 4.5 m^3 /2.8 m^3] Total Dumpers in the quarry 399 nos. In this situation, it should be examined whether equipment can be further enhanced to say, 40 m Exc and 240 T RD in OB and 100 T RD with 10 m Exc. in coal (where seam thickness permits) to reduce dumpers.

Technology	Associated Risks	Risk Mitigation
Shovel-Dumper combination [Blast Hole Drill / Blasting by explosives /Excavators (Diesel/Electric)/Rear Dumpers]	vi. Contractors' men: It is a regular practice in OC mines to engage contractors for various jobs viz. making of Haul Roads , construction of retaining walls, pump foundations, laying pipe ranges, cable shifting etc. These types of workmen (i.e. other than who are operators) engaged by the contractors are mostly untrained and unaware of the dangers associated with large equipment on wheels. They loiter in the mine and often get involved in accidents.	➢ Further, as the depth increases, lead of dumpers increases and it is worthwhile to examine whether In Pit Crushing and conveying (IPCC) can be introduced for both OB and coal. ➢ Presently, nearly 50 % of excavated volume (coal + OB) production have been outsourced to contractors. Though, in general, their equipment productivity is good, they have a tendency to deploy large nos. of smaller size excavators and dumpers, presumably to cut down capital cost. While issuing Work Orders for outsourcing production, it will be worthwhile to specify size and type of HEMM desired in a particular situation. ➢ Contractor's workmen should be placed under direct supervision of Mining Sardar/ Foreman. Proper attendance record [in/out] to be maintained for them. ➢ Rest shelter, drinking water, lavatory etc., should be provided to them. ➢ Training, for simple but unknown things, e.g. a. more clearance to be maintained from moving equipment , because there is a blind zone of operator which a person on the ground cannot appreciate;

Technology	Associated Risks	Risk Mitigation
Shovel-Dumper combination [Blast Hole Drill / Blasting by explosives /Excavators (Diesel/Electric)/Rear Dumpers]	vi. Contractors' men: (contd.) Note : Fatalities for contractual employees was more than double than that of Departmental employees during the last 3 years,(2015–2017) in OC mines of CIL Fatalities of Departmental Employees : 24 Fatalities of Contractors' Employees : 57 Even if we discount 23 fatalities in Rajmahal, OC fatality is 1.5 times more. [Source: Agenda note for 42nd meeting of The Standing Committee on Safety in Coal Mines on February 26,. 2018 (MoC web site)]	b. a disabled truck with heated tyre should not be approached before 8 hours c. Observers should stay away by 450 m from the side of a tyre rim and locking ring when inflating tyre mounted on machine etc. d. Cable handlers shall maintain distance from the crawlers of moving excavators.

3.4.6. Mitigation Plan for safety risks associated in open cast mine – Dust Control

Technology	Associated Risks	Risk Mitigation
Shovel-Dumper combination [Blast Hole Drill / Blasting by explosives /Excavators (Diesel/Electric)/Rear Dumpers]	Haul Roads Universally water spraying by Water Sprinklers [of various capacities, 12 Kl, 28 Kl etc.] are used for dust suppression on Haul Roads. But there are many physical and technical limitations: i. Efficacy of water sprinkling is indeterminate. The disadvantage of use of water is that it must be reapplied on consistent basis. There are no published guidelines for determining optimum haul road watering intervals, because amount of water, traffic volume on the road, time between water applications, prevailing temperature and Relative Humidity etc. are variable.	US Dept. of Health and Human Services made extensive studies on dust control on haul roads. Some findings (Jan, 2012): (i) Control Efficiency of Total suspended Particulates (TSP) varies as wide as 40% in 1-hour interval of watering to 74 % for 3-4 hrs. interval of watering. In another study, when adequate watering was done at 10 AM between a temperature range of 25 C to 32 C with RH 37% to 64%, respirable dust level rose from almost zero to 11 mg/m^3 at 3 PM i.e. after 5 Hrs. [DGMS has recommended that av. concentration of respirable dust (< 5 microns) shall not exceed 3 mg/m^3 (Cir. Tech 2/1980] (ii) Salt solutions [$MgCl_2$ (H_2O_x), $CaCl_2$, hydrated lime and sodium silicates] mixed with water if used for haul road helps in high efficiency dust control because of hygroscopic and deliquescent nature. However, it is harmful to contaminate ground water and bad for human eye, skin and vegetation.

Technology	Associated Risks	Risk Mitigation
Shovel-Dumper combination [Blast Hole Drill / Blasting by explosives /Excavators (Diesel/Electric)/Rear Dumpers]	ii. Certain aspects of water sprinkling which is often overlooked	• CIL may like to do some experiment with salt solutions. (iii) Optimal haul road moisture content for best reduction of respirable dust was found to be approximately 2%. • Bituminous paving should be tried on permanent Haul Roads • Conclusion is that mine management should not be complacent by only deploying few Water Sprinklers on the haul roads but should monitor the efficacy by Dust Sampler as suggested by DGMS, arrive at requisite interval for sprinkling and the volume of water required. ISO and IED of CIL should make a database and formulate norm on this subject by studying various mine situations. ➢ A proper Water Sprinkler consists of a water tank, a pump and the plumbing associated to send water through nozzles located at the rear of the truck. Often the nozzles are choked, pump inoperative. By simply dropping water from the perforated pipe does not fulfill the purpose, it must impinge on the dust and has a spray coverage up to widest possible span.

Technology	Associated Risks	Risk Mitigation
Shovel-Dumper combination [Blast Hole Drill / Blasting by explosives /Excavators (Diesel/Electric)/Rear Dumpers]	iii. Non-availability of sufficient quantity of water. Most of the shallow [<`100 m depth OC mines] have very little water in the main sump(s) in the hot and dry season, when major requirement of water arises for dust suppression.	➢ Water sprinkling on un-metalled haul road should be followed up by deploying a Grader shortly afterwards, so that the wetted muck is scraped to the side of the road, lest it will again raise a cloud after drying. ➢ In old coalfield areas, Raniganj or Jharia coalfield many abandoned water logged UG pits and OC quarries are there, from where water requirement for sprinkling are met. In green field areas, may be BH's are to be made to get water in summer. ➢ In one study it was found that tapping sandstones are yielding an average of 100 to 120 m^3/day from dug wells and 20-40m^3 /hour from BH's in Barakar measure. ➢ It is a general practice to drain pumped out water of the mine to nearby village paddy fields or ponds as part of a community service. But to deal with shortage in dry season, some sort of storage /harvesting of rain water has to be thought of to avoid crisis in dry season. ➢ CMPDI norm for industrial water requirement: Water sprinkling on Haul Road : 67,500 litre /day / million tons of coal produced /annum Water for Dumper washing : 1800 litres / day / dumper [Dumper Washing Plant should have provision of recycling after filtering to conserve water]

3.4.7 Mitigation plan for Risks associated with operations in Opencast Mines – Fire & Explosion

Technology	Associated Risks	Risk Mitigation
Technologies : (a) Shovel-Dumper (b) Developed pillars by OC	Fire due to exogenous causes (accidental) is not dealt here. Fire in HEMM has been dealt in equipment section RTM of OC mine	DGMS has extensively dealt with this subject and issued guidelines in various Circulars.
	Fires due to Spontaneous Heating (endogenous)	DGMS has extensively dealt with this subject and issued guidelines in various Circulars.
	Certain special situations are cited 1. Certain seams are notorious for fires in OC mines: i. Jhingurda seam (131 m – 159 m) In Jhingurda OC mine, NCL, highly interbanded (40% – 50% dirt bands)	In Jhingurda OC mines, NCL, many methods like water injection etc. were tried but could not succeed to contain the heating because coal catches fire in a very short time. Finally, a. blasting of coal was restricted for only the volume which could be loaded without delay, or, b. to keep exposed coal covered by OB when no excavator was deployed for coal production and remove the OB shortly before blasting and loading. c. Hard cutting of coal by shovel bucket reduced incidence of fire, which was noticed in Jhingurda. Above experience may help to tackle fire in some other mines.

Technology	Associated Risks	Risk Mitigation
Technologies : (a) Shovel-Dumper (b) Developed pillars by OC	ii. R- VIII (Jambad seam) (16 m thick in 2 sections) in Jambad OCP in ECL. Seam VIII (Jharia Coalfield)	In case of Jambad OCP of ECL , where developed coal pillars of UG workings are extracted by OC mine since 1995,some experiments were carried out in 1997 with injection of 'Fire Retardant Sealant' into coal through holes drilled by BH drills after the holes were cooled by water . The system had very limited success in small area, with about 5 Kg of sealant per tonne of coal with enormous cost and was abandoned. Later, coal production continued with quenching of fire with water. One condition, inter alia, imposed by DGMS in the permission letter, was that the entire coal seam is to be kept submerged under water during monsoon and afterwards the accumulated water should be pumped out to resume coal production after the monsoon. For some period after monsoon, fire was in control, but it was found that during dry season every year, fire flared up. It appeared that the hydrostatic head acting on the coal massif opened up the cleats and joint planes of coal and while dewatering was done, air entry to the cracks and fissures thus created, gave renewed impetus to spontaneous heating.
	2. Risk associated with drilling and blasting in fiery seam viz. Blast Hole drill catching fire , cloud of coal fines exploding within the confines of the hole, high explosives coming in contact with fire during charging etc.	DGMS circulars (1985 & 1990) specified, inter alia, that temperature of blast holes should not exceed 80° C and holes to be kept submerged in water. Pyrometers should be available in all OC Mines. Blast Hole drills should be equipped with wet drilling arrangement. These aspects need attention.

Technology	Associated Risks	Risk Mitigation
Technologies : (a) Shovel-Dumper (b) Developed pillars by OC	3. Risk of equipment falling down into galleries on fire while working developed pillars by OC method.	DGMS usually impose a condition that a min. thickness of 3m of OB has to be left in the top of coal bench to bridge the width of developed gallery beneath so that (a) equipment can work on firm ground, and (b) shots are not fired in the UG gallery. In spite of the above several accidents, fatal and serious, have happened when Dozer or BH Drill has fallen down below in UG working with operator. ➢ How to ensure the specified parting? Presently, drills are available where drilling can be programmed to a pre-determined depth in the OB bench. But variation of thickness of coal seam has to be watched closely. Some pilot drilling may be necessary. ➢ One solution is that surveyor marks the outline of the galleries below on top of the bench. Plans should be accurate.
	4. Danger of Coal Dust Explosion while extracting pillars by open cast method Several incidents have occurred with or without fatality in the past. This matter is getting more importance now, when coal companies are outsourcing shallow UG developed workings to extract by OC method both for controlling spread of sp. heating as well as for recovery of resources.	Detailed guidelines have been issued by DGMS long before (Circular Tech. 3 of 1980 and Tech. 4 of 1983.) ➢ There is practical difficulty of cleaning the UG workings of coal dust, because most of them are un-approachable. Treating coal dust in such workings by sending stone dust and dispersing by compressed air, has not been done, other than in test condition. What most contractors are doing is quenching water before shot firing, then digging the fiery portion out. Small water gas explosions are happening without any major repercussions. It needs to be experimented whether nitrogen dosing can be economically done to deal with the fire.

Technology	Associated Risks	Risk Mitigation
Technologies : (c) Shovel-Dumper (d) Developed pillars by OC	5. Other cases of spontaneous heating in OC mines	i. In many cases major faults delineate the boundary of a quarry leaving remnant coal unextracted, close to the fault plane which initiates sp. heating. A major accident occurred in Jagannath OCP in the past when heated coal came in contact with water seeping in the fault plane and caused water gas explosion leading to many fatalities. ii. In some OC mines, excavated coal is dumped within the quarry bed, albeit temporarily, because of some problem of dispatch/ lack of space in the coal stock yard and the coal eventually catch fire and pollutes the quarry atmosphere. This is not a good practice .Often there is insufficient water for quenching. Dozing and compaction, particularly at the fringes, is the only solution. iii. Illegal mining patch, already on fire may get connected with advancing face of quarry. Blanketing with earth, dozing and subsequently digging out the heated coal can be a solution.

Action: Director (Technical) / GM (Safety)

Timeline: 31 March, 2020

3.5. Mitigation plan for technology upgradation and improvement in availability and utilization of HEMM

Company (CIL) has undertaken various initiatives for technology development, including introduction of high capacity equipment, Operator Independent Truck Dispatch Systems, vehicle tracking system using GPS / GPRS, CHP & Silos for faster loading and monitoring using laser scanners. CIL has also introduced Continuous Miner technology and Longwall technology at selected places. Man-Riding systems in major mines and the use of Tele-monitoring techniques continue to receive priority to increase production from underground mines.

A list of further initiatives to be undertaken to improve the availability and utilization of HEMM is listed in the following sections:

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3.5.1. Mitigation plan for technology upgradation and improvement in Availability and Utilization of HEMM

Sub-section: Availability of HEMM

<table>
<tr><th>Technology</th><th>Associated Risk</th><th>Risk Mitigation</th></tr>
<tr>
<td>Shovel-Dumper combination and Dragline

[Blast Hole Drill / Blasting by explosives / Excavators (Diesel / Electric) / Rear Dumpers / Dozers] / Dragline

Average % Availability:
Total Shift Hours (SH) = Working Hrs. + Unavailable Hrs. + Idle Hrs.

Total Available Hours (AV) = Working Hrs. + Idle Hrs.

Av. % availability = AV x 100 / SH</td>
<td>
<table>
<tr><th>Equipment</th><th>Norm 1980 (% Av.)</th><th>Actual CIL 2016-17 * (% of Norm)</th></tr>
<tr><td>Dragline</td><td>85</td><td>93</td></tr>
<tr><td>Shovels:</td><td>80</td><td>95</td></tr>
<tr><td>Dumpers</td><td>67</td><td>109</td></tr>
<tr><td>Dozers</td><td>70</td><td>96</td></tr>
<tr><td>Drills</td><td>78</td><td>106</td></tr>
</table>
* Data obtained from Annual Reports and Accounts (Final), CIL, 2016-17 [Annexure 14], and CIL Reports.
</td>
<td>Note: The recommendation of a committee constituted by MoC “for revision of norms for Availability and Utilization of HEMM by the coal companies “under the Chairmanship of Addl. Secretary, Coal vide even no. Dated 7 May & 22 May, 1999, which, inter alia, states that existing annual productivity norms of all HEMM will be enhanced by 10% for planning new opencast projects.
This will take care of increase in working days from 300 to 330 day
“However, norms would need to be improved further because of technological changes that has taken place since 1980, when the norms were last revised, in manufacturing, maintenance and operation of HEMM for which CMPDIL will have to make detailed assessments for fixing the HEMM norms on scientific basis.”
The CIL committee on “Revision of norms of productivity of HEMM” constituted by Chairman, CIL on 22.03.2003 to function under the overall guidance of CMD, CMPDI to review the productivity of HEMM used for planning of opencast mines recommended to increase the productivity of mining equipments for new opencast mines in a range of 10% to 17%.[as per input of CMPDI]
Subsequently, CIL formed another committee to review the existing norms in May 2013 which came out with a report “Review of Availability and Utilization of HEMM” in April 2015.
The recommendation of the committee are briefly :
i. Availability & Utilization of Norm for Dragline, Shovels, Dumpers should remain unchanged
ii. Availability norms for dozers & drills should remain unchanged. No utilization norms to be defined as these are need based equipments.
iii. Surface Miner : Availability : 80% and Utilization : 60%</td>
</tr>
</table>

Technology	Associated Risk	Risk Mitigation
Shovel-Dumper combination and Dragline [Blast Hole Drill / Blasting by explosives / Excavators (Diesel/Electric) / Rear Dumpers / Dozers] / Dragline	Factors affecting availability of HEMM: 1. Maintenance (planned) : i. Unavailable Hours are : Daily shift maintenance, 100 Hrs. maintenance, 500 Hrs. maintenance, 1000 Hrs. maintenance, Capital overhaul ii. Idle Hours are : Shift change , Tiffin break , Others (Blasting/Shifting of Eqpt. etc.), Stoppage due to rain * CMPDI formulated a manual long before covering all aspects of Haul Road design and construction	Some points are mentioned for clarification of the basics. ➢ To cut down Unavailable Hours, certain elements of planned maintenance can be examined : ▪ 100 Hrs. /500 Hrs. /1000 Hrs. maintenance do not take much time, but Capital Overhaul does (e.g. after every 10000 hrs. working for an Excavator or 2500 hrs. working for a Dozer). Effort should be made to substantially reduce the duration of capital overhaul. Now with availability of improved quality of indigenous equipment -, there is scope for this. ▪ Similarly time for daily maintenance during shift change can be reduced by planning staggered shifts for maintenance staff. To cut down idle hours ➢ Shift change and tiffin break, can be reduced by providing transport to operator, canteen van, etc. But, above all, discipline and improving work culture are two most important factors which prevents wastage of time for these two elements. ➢ Stoppage of work due to rain can be cut down substantially: [Note: Coalfields have rainy days for about 120 days in a year (mostly concentrated from mid-Jun to mid-Oct. where heavy rain occurs on some days and sporadic rain during others.)] ➢ Dumpers can ply in moderate rainfall if ▪ The haul roads are constructed with correct specs and profile*, side drains and proper grade (< 1 in 16 up hill and < 1 in 20 downhill for loaded trucks); ▪ Platforms are constructed on top of active dumps to prevent accumulation of water ; ▪ Constant availability of dozer(s) on top of the dump ➢ Time due to other reasons (blasting Etc.) can be reduced by not doing blasting every

Technology	Associated Risk	Risk Mitigation
Shovel-Dumper combination and Dragline [Blast Hole Drill / Blasting by explosives / Excavators (Diesel / Electric) / Rear Dumpers / Dozers] / Dragline	Factors affecting availability of HEMM: ii. Idle Hours are : Shift change , Tiffin break , Others (Blasting/Shifting of Eqpt. etc.), Stoppage due to rain	Above mentioned, are some of the actions which can bring about improvement in availability of HEMM. Certain other actions may be taken depending upon local conditions. It is important to note that in some mines when a new equipment is commissioned , there is a tendency of operational personnel to do away with the structured maintenance schedule and flog the equipment to overuse , resulting in serious breakdowns after few years .

Technology	Associated Risk	Risk Mitigation
Shovel-Dumper combination and Dragline [Blast Hole Drill / Blasting by explosives / Excavators (Diesel / Electric) / Rear Dumpers / Dozers] / Dragline	2. Breakdown : Major factor for unavailability of HEMM	➢ To minimize breakdowns , the following steps need be taken : • Following maintenance schedule scrupulously • Competent and trained operators to obviate mishandling • Use OEM recommended Oil and Lubricant • Quality of spares to be ensured (procure from OEM or established ancillaries) • Off-loading major overhauls to OEM (if necessary) • CBM (Condition Based Maintenance) has some advantages over planned maintenance: a) Improved system reliability b) Decreased maintenance costs. • However CBM has certain disadvantages which are as follows: a) High installation costs, for minor equipment items often more than the value of the equipment; b) Increased number of parts (the CBM installation itself) that need maintenance and checking; It is preferable, due to its costs, to do Condition Monitoring (real time) for very costly equipment viz. Draglines (NDT of the boom, main motor etc.) or Large Excavators etc. but not for less important parts of machinery despite obvious advantages Secondly, introducing CBM will invoke a major change in how maintenance is performed, and the whole maintenance organization in a company. CIL may take a view whether any particular project can be brought under CBM or not.

Technology	Associated Risk	Risk Mitigation
Shovel-Dumper combination and Dragline [Blast Hole Drill / Blasting by explosives / Excavators (Diesel / Electric) / Rear Dumpers / Dozers] / Dragline	2. Breakdown : Major factor for unavailability of HEMM	➢ To resolve breakdowns with minimum loss of working hours, the following steps need be taken : • Availability of R&M spares /sub-assemblies /insurance items. • Formulation of realistic Material Budget and timely placement of Supply Order because there is long lead time for spares of imported or even some indigenous equipment. • Enhance Facility and capability of Unit / Regional / Central Work Shops. [Washing arrangement, Machine Shop, EOT crane, Tyre Handler etc. • Trained personnel : Mechanics / Supervisors / Engineers • Facilitate opening of Service Centres by major suppliers of equipment for large mines. • Standardization of equipment (at least project wise)

Technology	Associated Risk	Risk Mitigation
Shovel-Dumper combination and Dragline [Blast Hole Drill / Blasting by explosives / Excavators (Diesel / Electric) / Rear Dumpers / Dozers] / Dragline	3. Improper selection of HEMM 4. Inadequate support from OEM: In case of HEMM supplied with manufacturing defects.	➢ Careful selection of equipment on the basis of mine- specific geo-mining conditions of coal and OB need to be taken into account in certain cases. ➢ OEM must depute its rectification team at the mine site with necessary assys/sub-assys/repair kits etc. to cut down logistic problem of transportation of defective equipment to OEM's workshop as well as to save time.

3.5.2. Mitigation plan for technology upgradation and improvement in Availability and Utilization of HEMM

Sub-section: Utilization of HEMM

<table>
<tr><th>Technology</th><th>Associated Risk</th><th>Risk Mitigation</th></tr>
<tr>
<td>Shovel-Dumper combination and Dragline

[Blast Hole Drill / Blasting by explosives / Excavators (Diesel/ Electric) / Rear Dumpers/Dozers] / Dragline

Average % Utilization :

Total Shift Hours (SH) = [Working Hours (WH) + Unavailable Hours + Idle Hours)

Av. % Utilization = WH x 100 / SH</td>
<td>
<table>
<tr><th>Equipment</th><th>Norm 1980 (% Av.)</th><th>Actual CIL 2016-17 * (% of Norm)</th></tr>
<tr><td>Dragline</td><td>73</td><td>72</td></tr>
<tr><td>Shovels:</td><td>58</td><td>72</td></tr>
<tr><td>Dumpers</td><td>50</td><td>70</td></tr>
<tr><td>Dozers</td><td>45</td><td>53</td></tr>
<tr><td>Drills</td><td>40</td><td>56</td></tr>
</table>
*Note: Data obtained from Annual Reports and Accounts (Final), ECL 2016-17 [Annexure 14], and CIL Reports
</td>
<td>
➢ Unlike % Availability, % Utilization figures of HEMM in ECL mines are much below the CMPDI norm.
➢ Reasons stated in the Directors Statement in the Annual Report 2016-17 are:
• Performance of HEC D/Line not satisfactory
• D/Line of Sonepur Bazari under breakdown since June 2016 and non-availability of imported spares,
• Land and R&R problem in BCCL,MCL,SECL
• Heavy rainfall in NCL,MCL
</td>
</tr>
</table>

Technology	Associated Risk	Risk Mitigation
Shovel-Dumper combination and Dragline [Blast Hole Drill / Blasting by explosives / Excavators (Diesel/ Electric) / Rear Dumpers/Dozers] / Dragline	1. Operational Factors affecting utilization of HEMM: a. Shift Change :Equipment lying idle as operators take time in walking from time office to the machine due to long distance / Indiscipline and bad work culture	➢ Provide transport to operators of Excavators, BH Drills, as well as to maintenance gang ➢ "Hot Seat" exchange ➢ Prevent delay in Time Office (common in General Shift)/ Continued dialogue with Trade Unions
	b. Tiffin break : Operators coming to the canteen at Pit mouth (even by shift bus) wastes time / Bad work culture in some subsidiaries	➢ Provide Canteen Van / Introduce "Dubba System" ➢ Stagger Tiffin hours for different Equipment
	c. Crowding of Dumpers at Excavator : Due to Improper fragmentation, toe because of bad blasting / Non-availability of dozer at face / Mismatch of bucket capacity of excavator and size of Dumper	➢ Proper blast design and charge ➢ Proper selection of size and nos. of Excavators and Dumpers at the planning stage ➢ Proper nos. of Dumpers assigned to different excavators ➢ Introduction of Truck Dispatch System (TDS / OITDS) in large mines & wherever techno-economics permits and in a phased manner.
	d. Idle Excavator in absence of Dumpers : Slowing down speed of Dumpers due to bad haul road / crowding of Dumpers at OB dump (unavailability of dozer) / crowding of dumpers at CHP /stockyard	➢ Ensure Haul roads are constructed with correct specs and profile , side drains and proper grade ➢ Introduction of Truck Despatch System (TDS / OITDS) in large mines & wherever techno-economics permits and in a phased manner.

Technology	Associated Risk	Risk Mitigation
Shovel-Dumper combination and Dragline [Blast Hole Drill / Blasting by explosives / Excavators (Diesel/ Electric) / Rear Dumpers/Dozers] / Dragline	e. Interruption due to rains / summer heat: Skidding / stuck up of Dumpers during rain is common / Flooding of lower benches. During peak summer , temperature in the open in some of the coalfields go to (+) 50 Degree Celsius which is dangerous for men and machine	➢ Dumpers can ply in moderate rainfall (say 50-60 mm in a day) if the haul roads are prepared properly, as mentioned earlier ; ➢ Creation of sump of adequate capacity with proper capacity of Pumping, prevents drowning of coal benches at lower level. ➢ During peak summer: • 1st shift should start work punctually at 5 AM and work up to 11 AM without any tiffin break and stop. • 2nd shift to start at 3 PM instead of 1 PM and work continuously up to 9 PM (end of shift)
	f. Incorrect deployment of Excavators in different benches of the quarry causes avoidable marching (especially of large excavators) and idling.	➢ Planning group of the project should prepare short term plan and advise the operational personnel for day to day deployment of equipment. ➢ In addition to day to day planning, it is necessary to foresee the near future configuration of the mine , which can obviate idling of equipment ➢ Dragline is an inflexible machine. Improper / inadequate blasting, lack of advance of upper shovel benches will cause idling.

Technology	Associated Risk	Risk Mitigation
Shovel-Dumper combination and Dragline [Blast Hole Drill / Blasting by explosives / Excavators (Diesel/ Electric) / Rear Dumpers/Dozers] / Dragline	2. External Factors affecting utilization of HEMM: a. Non availability of land: It is a chronic problem especially when forest Land is involved. Failing to advance the upper OB benches due to shortage of land, mine operators tend to make benches narrow and the high wall steep, because of anxiety to achieve production target creating an unsafe condition. Ultimately, equipment become idle one by one unless the matter is resolved. b. Proximity of habitation: Around the periphery of the mine which is not in the purview of Relocation and Resettlement (R&R), DGMS imposes constraint on blasting to maintain the stipulated safe distance as a result of which utilization suffers c. Power cuts: It is a malaise in some of the states. Ironically, prolonged power cut occurs during heavy rain when it is most needed , causing flooding of the lower benches, drowning of pumps	➢ It appears that there is no standard remedy. Every state has made their own norms about compensation, employment, CSR activities etc. which are sometimes not in consonance with declared policy of CIL. Dialogue with the land ousted, involving the State officials is the only solution. In the past thousands of Ha of land were acquired under CBA with comparative ease, however the same has become difficult now. ➢ Acquisition of Forest land is quite a tortuous process. For that, a proposal has to be initiated as soon as the PR is approved and a dedicated team must pursue the entire process leading to approval both at State and Centre. ➢ Presently, with improved blast design, it is very much possible to minimize fly rock and Peak Particle Velocity (PPV) much below permissible limit. As a result, DGMS has permitted blasting with greatly reduced safe distance. ➢ In the Projects where R&R is envisaged, action is to be initiated much in advance, because this is a time consuming process. ➢ Introduction of alternative feeder should be considered. ➢ Provide diesel pumps as standby, at least for the face pumps and adequate capacity of water lodgment (sump).

Technology	Associated Risk	Risk Mitigation
Shovel-Dumper combination and Dragline [Blast Hole Drill / Blasting by explosives / Excavators (Diesel/ Electric) / Rear Dumpers/Dozers] / Dragline	d. Human interference: Thin coal seams/bands in OB benches are removed as waste. When this is dumped, scores of surrounding people will invade the slope to collect coal lumps. In order to avert fatal accidents, entire operation has to stop. This is a chronic problem in some of the subsidiaries. Fatality has also occurred leading to agitation for compensation, stopping entire mining operation. Even villagers invade the working faces in the darkness in the night shift to collect lumps from the blasted coal in faces, stopping entire operation of the mine.	➢ In-house security set up is helpless. Even CISF in ECL could not handle this in the past. It appears that unless State machinery deals with this with severity, working hours will continue to be lost. ➢ Fencing with alarms/sirens, watch towers with CCTV cameras could be installed.

3.5.3. Mitigation plan for technology upgradation and improvement in availability and Utilization of HEMM

Sub-section: Capacity Utilization

Technology	Associated Risk	Risk Mitigation
Shovel-Dumper combination and Dragline [Blast Hole Drill / Blasting by explosives /Excavators (Diesel/Electric)/Rear Dumpers/Dozers] / Dragline / Surface Miner	Availability and Utilization of HEMM is definitely an index of measure of operational efficiency of an OC mine encompassing all aspects of machine use. But really what matters is the volume which is coming out of the mine consistent with the size of equipment deployed, i.e. Productivity and justifying the investment towards the same. It is necessary, therefore, to assess the standard productivity of every equipment as accurately as possible and then compute the aggregate productivity of all production related HEMM to arrive at the Mine Capacity. The ratio the actual performance of the mine with the Mine Capacity will give Capacity Utilization. The assessed capacity of each equipment should also be compared with the claimed capacity stated by the manufacturer.	➢ Annual productivity of HEMM should be calculated from the basics and factors affecting the calculation are broadly as follows : • Category of rock in terms of Compressive Strength [Kg / cm^2] e.g. Cat1, Cat2, Cat 3, Cat 4 in ascending CS. • Swell Factor and Weight / unit volume of categorized rock. • Bucket Fill Factor. • Solid bucket capacity : m^3 • Dumper carrying capacity : T • Struck capacity of dumper : m^3 (as per manufacturer's catalogue) • Time for loading a Dumper : min • Load per Dumper : m^3 • Hourly output of Shovel : m^3 • No. of hours worked annually : * ➢ Similarly Annual Productivity of Rear Dumpers for various leads in combination with different capacity of Shovels can be calculated. Speed of dumpers should be adopted from manufacturer's catalogue keeping in mind the condition of haul roads

Technology	Associated Risk	Risk Mitigation
Shovel-Dumper combination and Dragline [Blast Hole Drill / Blasting by explosives /Excavators (Diesel/Electric)/Rear Dumpers/Dozers] / Dragline / Surface Miner	CMPDI came out with a report long before [Nov.1983] with various combination of Excavators and Dumpers. Some examples will be pertinent : Annual Productivity (3-Shift Operation) — Mm^3 1. Walking Dragline : Bucket 24 m^3 (90° swing) : 3.31 (120°swing) : 3.00 2. Elec. Rope Shovel : Bucket 10 m^3 + 120 T RD : 1.95 Bucket 20 m^3 + 170 T RD : 3.76 3. Rear Dumper : 85 T + 10 m^3 Elec.Rope Shovel : Lead 1 Km : 0.2795 Lead 3 Km : 0.1728 120 T + 10 m^3 Elec.Rope Shovel : Lead 1 Km : 0.4205	* Normally annual working hours of Excavators is taken as 5000 hrs. during calculation, considering the mine being worked for 300 days. If mine is worked for more no. of days, annual productivity should proportionately increase. Many CIL mines are working almost non-stop for the whole year. Because of this, annual productivity figures given in the column alongside, came under scrutiny by MoC and external agencies. Some private mine operators and contractors of CIL are achieving higher annual productivity of their HEMM. As per input of CMPDI The CIL committee on “Revision of norms of productivity of HEMM” constituted by Chairman, CIL on 22.03.2003 to function under the overall guidance of CMD, CMPDI to review the productivity of HEMM used for planning of opencast mines recommended to increase the productivity of mining equipments for new opencast mines in a range of 10% to 17%.

Action: Director (Technical) / GM (Planning)

Timeline: 31 March, 2020

3.6. Mitigation Plan for unviable underground mining operations

Broad Mitigation Action Plans to assess the viability for a turn-around of the loss-making UG mines, would involve a case-by-case evaluation of each specific mine by each Subsidiary company. Some of the relevant considerations for the Subsidiaries would involve the following:

1. Optimum scale of production from a district: Minimum performance of Equipment of t / machine / day needs to be defined for manual loading, semi-mechanised (SDL/LHD), CM, PSLW etc.

2. Optimum size of the mine [number of districts / volume of production], consistent with investment:
   a. If there is shortage of working area, possibility of recovery of sealed off / waterlogged seams (if any) shall be evaluated;
   b. Possibility of release of working area below built-up surface features by relocation;
   c. Adoption of sand stowing where possible;
   d. Opening of new seams either with same mine entries or sinking additional declines /pits; amalgamation of two or more unviable entities.

3. Identifying surplus manpower [severance/ redeployment/ other options]: Identification of surplus manpower shall be done keeping in view the need to retain skilled & experienced workers. Redeployment options shall be identified and implemented (with help of additional incentives, if any, on case to case basis). Voluntary Retirement Schemes (VRS) for workmen shall be applied for identified surplus manpower which cannot be redeployed / re-skilled.

4. Developing normative costs for each loss-making unit: Normative costs shall be developed [by IED study or otherwise] to improve certain Efficiency Ratios viz. Powder Factor, OMS, Units of Power/t etc. Thereafter, actual performance needs to be monitored and compared by a dedicated group and corrective action taken. For instance, if the pumping cost is high due to stage pumping, BH pumping can be adopted, if feasible, which would result in savings in cost of pipes, cables and power. Similarly norms shall be developed for consumables (POL, Wire ropes, Roof bolts, Cement capsule etc.) corresponding to the mining technology in use (reference to be made to the K Kapila recommendations, with revisions).

5. Reduction of Area Overheads & avoidable expenditure: Rationalization of Areas (wherever feasible / unless geographically far apart), shall be done to reduce Area overheads. Avoidable expenditures (power theft, OT, etc.) shall be identified and minimized.

6. Workload for time rated workers shall be considered. Currently NCWA specified work load for piece rated workers (such as coal loaders) are in practice.

7. Cost Sheet modifications for cost control: Necessary modifications shall be made to the cost sheet formats for better decision making [such as segregation of fixed and variable costs (e.g. for power), functional costs (strata control, blasting, pumping, ventilation, etc.), segregation of manpower costs for actual mining UG operations and surface workmen, etc.]

8. Focus on marginally loss making mines: In 2016-17, there were 251 loss making UG mines across 6 Subsidiaries & NEC. Out of these, in 59 mines, there was no production recorded. A feasibility assessment shall be made, and recommendations of prior feasibility studies implemented by each Subsidiary (such as through additional mechanization, manpower redeployment, etc.) shall be considered to convert the marginally loss making mines into break-even / viable state, in the short term to medium term.

   Further to the Strategic Plan of the Ministry of Coal (Feb 2011) and the Report on the Working Group for Coal & Lignite (Nov 2011), some of the relevant considerations for CIL as a holding company to guide the Subsidiaries shall include the need to increase adoption of state-of-the-art technologies in UG coal mining like longwall technology, continuous miner technology, etc. to ensure safe and speedy evacuation of coal. While the pre-dominant technology in use for underground coal production has been semi-mechanized through long haul dumps (LHDs) and Side Discharge Loaders (SDLs), CIL has already introduced Continuous Miner technology and Longwall technology at selected places, Man Riding system in major mines and use of tele-monitoring techniques in UG mining operations. A mine-wise / Area-wise evaluation shall be made (considering geo-mining conditions) across all Subsidiaries having UG operations, to assess further opportunities of upgrading the mining technology in the medium term, which would have a leveraging effect in reducing the cost per tonne (CPT) of UG operations.

Each Subsidiary company shall be required to prepare and present a comprehensive plan to CIL in terms of the measures to be taken for improving efficiency and reducing costs of operations and unsafe geo-mining conditions of the mine.

Action: Director (Technical) / GM (Planning)

Timeline: 31 March, 2021

3.7 Mitigation Plan for competition Risk from Commercial Mining & Alternate energy sources (renewables)

Pursuant to Government of India's policy for opening up the coal sector for commercial mining, coupled with the growing share of renewables as an alternative source of energy, the competition landscape for Coal India is gradually changing. Keeping this in view, a slew of mitigating plans (medium to long term) have been envisaged through the 'Coal Vision 2030' for Coal India, including but not limited to, the following:

- Formulate a domestic coal price index
- Establish an online platform for coal trading / transactions for spot / forward auction of coal by Subsidiaries.
- Take steps for cost reduction by reducing & rationalizing total manpower:
    i. Reduce number of labour intensive mines
    ii. Periodic review of the R&R policy should be conducted.
- Enable use of up to 100 MT of coal by 2030 under PPP/ Private mode by converting coal into methanol, fertilizer through gasification technology.
- Utilization of ash utilization in coal mine filing, collaborate and develop necessary frameworks, infrastructure and cost sharing mechanisms
- Create joint forum of key power developers and coal mining companies to undertake investment in R&D for Carbon Capture and Sequestration (CCS) and coal washing technologies in India.

Action: Director (Sales & Marketing) / GM (Sales & Marketing)

Timeline: 31 March, 2022

Section 4:

Standard Operating Procedures (SOP)

4.1 SOP for implementation guidance for mitigation plan relating to resolution of Overdue Receivables

SNo	Activity Description	Input	Output	Frequency	Responsibility
1	The following activities may be considered to reduce disputed overdue receivables:				
1.1	CIL to notify standardized joint reconciliation template for this purpose.	Approval of GM (Marketing), CIL for standardized template	Notification in CIL website	One-time	GM (Marketing), CIL
1.2	Joint reconciliation shall be performed by all Subsidiaries with CPSEs and State Gencos on a monthly basis. Status of reconciliation across all customers to be sent to respective Subsidiary's Boards and to CIL for information.	Joint Reconciliation Template	▪ Joint Reconciliation Statement signed-off by CIL Subsidiary and Customer ▪ Status of Reconciliation to Subsidiary Board and GM (Marketing) at CIL	Monthly	GM (Marketing) of Subsidiary Company
1.3	Monitoring shall be strengthened by Subsidiary Companies to identify cases where reasons for the disputes have not been investigated / evaluated for accepting or rejecting such customer claims, either in part of in full.	Reference of Disputed receivables	Preparation of case files for every disputed case to pursue for resolution	As and when required	▪ GM (Marketing), Subsidiary Company ▪ Legal Cell, CIL

SNo	Activity Description	Input	Output	Frequency	Responsibility
1.4	Disputes which cannot be settled bilaterally beyond a period of 60 days from the date the dispute was first raised, shall be referred to ADRM forum for resolution. Status of all references to ADRM shall be shared by Subsidiary Company with CIL on a quarterly basis.	Customer-wise case history of disputed receivables	Application to ADRM		GM (Marketing) of Subsidiary Company
1.5	▪ Evaluation and identification of the reasons for the disputed receivables from the State Gencos / State power corporations to determine if the dispute will be resolved bilaterally between the subsidiary and the customer ▪ Formulation of acceptable time frame for applying to ADRM for each specific dispute where a resolution is unlikely to be achieved directly with the customer ▪ Monitor orders passed by ADRM closely for implementation and ensuring that no disputed cases are left unattended by any Subsidiary. ▪ Reporting to functional Directors and the Risk Management Committee/ Board of Subsidiaries on progress made in reducing the disputed receivables.	▪ Reference of Disputed receivables ▪ ADRM Orders	▪ Preparation of common set of guidelines for the subsidiaries to follow disputed receivables with similar root causes / reasons that are repetitive in nature. ▪ Common template for reconciliation with customers notified by CIL for use by all Subsidiary companies. ▪ Presentation to RMC / Board of Subsidiaries	As and when required	Cross-functional empowered team comprising of following from each Subsidiary: 1. GM (Sales) 2. GM (Quality Control) 3. GM (Finance)

SNo	Activity Description	Input	Output	Frequency	Responsibility
2	The following activities may be considered to reduce undisputed overdue receivables:				
2.1	Subsidiaries shall institute / enhance a direct follow-up mechanism for expediting collection of aged undisputed dues from the customers and circulate a periodical report to relevant functional Directors and / or Board for their information and further direction	Outstanding debtors ageing report	Periodical report of follow ups and realization of collection	Quarterly	Director (Sales & Marketing) / GM (Sales & Marketing), Subsidiary Companies
2.2	FDs and Audit committee shall review on quarterly basis to ascertain doubtful & bad debts	Outstanding debtors ageing report	List of cases of doubtful and bad receivables	Quarterly	FDs and Audit Committee, Subsidiary Companies
2.3	For any delayed payment of receivables, interest is to be charged mandatorily. Company may consider appointment of chartered accountancy / consultancy firms to conduct bill wise reconciliation and their fee shall be decided by the Audit Committee.	Collection report	Bill Wise Reconciliation	One time	GM (Sales & Marketing), Subsidiary Companies Audit Committee, Subsidiary Companies

SNo	Activity Description	Input	Output	Frequency	Responsibility
2.4	▪ All debtors are to be analyzed bill wise and notice is to be sent to customers advising them to make payments. If the dues outstanding for 6 months or more are not settled, dispatch of coal should be regulated. ▪ Audit Committee of CIL has recommended that in respect of dues which are even less than 6 months but more than 15 days, interest should be charged for all sales with effect from 1st April'2018 and recovered from the Customer. A statement of up-to-date accounts indicating the interest due thereon shall be sent to all the customers every month. Subsidiaries should also try and recover previous interest amounts (if any) billed to customers.	Details of customer-wise dues	Demand notice to customers for overdues Intimation to GM (Production) to regulate coal supply (case-to-case basis) Statement of up-to-date Accounts	Monthly	GM (Finance) and GM (sales & Marketing), Subsidiary Companies
2.5	Due to difference of opinion regarding the reasonable certainty for recognizing interest income, an opinion from Expert Advisory Committee (EAC) of The Institute of Chartered Accountants of India (ICAI) should be obtained regarding recognition of interest income on delayed payments for the period till 31st March'18 and from 1st April'18 in view of the revised instruction about the procedure of recovery.	Subsidiary-wise details of accrued interest income	Application to EAC of ICAI	One-time	GM (Finance), CIL

4.2 SOP for implementation guidance for mitigation plan relating to reduction of default risk for Redeemable Preference Shares

SNo	Activity Description	Input	Output	Frequency	Responsibility
1	GM (Finance) will evaluate, based on cash flow analysis of the pertinent Subsidiaries, the feasibility of issuing fresh Redeemable Preference Share Capital, and apprise Director (Finance), CIL of such evaluation.	Financial	Cash flow evaluation document	One time	GM (Finance), CIL
2	The Director (Finance) / GM (Finance) of the respective Subsidiaries (ECL and BCCL) will present the steps being taken & planned, for improving operational profitability, to the Board of Directors & the Audit Committee of CIL.	MIS, operational data & financial statements of pertinent Subsidiary Companies	Presentation to BOD & AC	One time	Director (Finance) / GM (Finance), Subsidiary Companies

4.3 SOP for implementation guidance for mitigation plan relating to evacuation challenges for coal off-take

SNo	Activity Description	Input	Output	Frequency	Responsibility
1	Transport coal from stockyard/pit-head to washery to use MGR/Conveyor belts, wherever feasible	Site evaluation	Site evaluation report	One Time	Director (Sales & Marketing) / GM (Sales & Marketing), Subsidiary Companies
2	GM (Sales & Marketing) shall carrying out a feasibility study for increasing the efficiency of operations at sidings.	Site evaluation	Site evaluation report	One Time	GM (Sales & Marketing), CIL
3	On a case by case basis, wherever possible, GM (Sales & Marketing) to enhance capacity of MGR for all pithead power stations, such that pithead power stations can be supplied only through MGR.	Site evaluation	Site evaluation report	One Time	GM (Sales & Marketing), Subsidiary Companies

SNo	Activity Description	Input	Output	Frequency	Responsibility
4	Director (Sales & Marketing) / GM (Sales & Marketing) to consider procurement of wagons through railway for dedicated routes to enhance coal evacuation.	Feasibility study	Feasibility study report	One Time	Director (Sales & Marketing) / GM (Sales & Marketing), CIL
5	Committee will conduct feasibility study for rationalization of sidings, including consolidating small sidings into bigger ones having multi rake loading facilities preferably through Rapid Loading System (RPLS) / High Speed Loading / Advanced Environmental-friendly Technology.	Feasibility study	Feasibility study report	One Time	Committee comprising of CIl & Subsidiary Companies
6	Director (Sales & Marketing) / GM (Sales & Marketing) of Subsidiaries shall consider case-by-case feasibility for: ▪ Setting up centralized coal handling hubs to cater to multiple sidings through conveyors, and ▪ Use of pipe belt & rope belt conveyors, wherever feasible, for coal transportation within 50 km of the mines, ▪ Expediting last-mile rail connectivity projects, ▪ Usage of high capacity dump trucks (which can carry up to 60 tonnes of coal) shall be considered (depending on available road infrastructure) to improve evacuation further.	Feasibility studies	Feasibility study reports	One Time	Director (Sales & Marketing) / GM (Sales & Marketing), Subsidiary Companies

SNo	Activity Description	Input	Output	Frequency	Responsibility
7	Director (Sales & Marketing) / GM (Sales & Marketing) will evaluate implementing rapid loading system for mine clusters with annual capacity 5 MT and above	Project Plan	Project Implementation Report	One Time	Director (Sales & Marketing) / GM (Sales & Marketing)
8	GM (Sales & Marketing) of Subsidiaries shall plan a few centralized coal handling hubs to cater to multiple sidings through conveyors.	Feasibility study	▪ Feasibility study report	As & when	Director (Sales & Marketing) / GM (Sales & Marketing)

SNo	Activity Description	Input	Output	Frequency	Responsibility
9	A Nodal Committee within CIL comprising of GM (Sales) and GM (Planning) shall be set up to coordinate with the Ministry of Railways for: a) Rearrangement and consolidation of small sidings to bigger ones having multi rake loading facilities. b) Augmenting railway lines / sections to ensure uninterrupted supply. For instance, doubling of Singrauli-Katni section would be required to enhance the number of rakes. Similarly, need for augmenting the Talcher-Paradip line shall be assessed in view of coastal power producers opting for a larger share of cheaper domestic coal (rather than imported coal)	Nodal Committee formation	Periodic coordination meetings with Ministry of Railways	As & when	GM (Sales & Marketing) and GM (Planning), CIL
10	GM (Sales & Marketing) to enable sharing of evacuation infrastructure such as sidings between the coal companies in an area	Feasibility Study	Feasibility Report	As & when	GM (Sales & Marketing), CIL
11	Target 15-20% coal transportation by alternate transportation models, particularly inland waterways.	Feasibility Study	Feasibility Report	As & when	Director (Sales & Marketing) / GM (Sales & Marketing), Subsidiaries

SNo	Activity Description	Input	Output	Frequency	Responsibility
12	Evaluate feasibility of conveyor belts/ overhead ropeways for coal being transported 10 - 50 km. Facilitate to, ▪ do away with dedicated mine surcharge. ▪ allow change of transportation mode for coal linkage auction (at the cost of consumer) ▪ greater flexibility in coal swaps (across companies, end-use sector etc.)	Feasibility Study	▪ Feasibility Study Report ▪ Policy Notification to Consumers	One Time	Director (Sales & Marketing) / GM (Sales & Marketing), CIL and Subsidiaries
13	Operationalize any other action points adopted by the Board of CIL as relates to mechanisms for enhanced coal evacuation and off-take	Coal Vision 2030 Report	Action Taken Report	As & when	Director (Sales & Marketing) / GM (Sales & Marketing) at CIL and Subsidiaries

4.4 SOP for implementation guidance for mitigation plan relating to Safety in Mining Operations

SNo	Activity Description	Input	Output	Frequency	Responsibility
1	CIL and its subsidiaries have adopted the Australian Standard on Risk Management and trained a good number of mining executives in this methodology viz. WRAC, TARP etc. Safety Management Plans (SMP) have been formulated for all mines incorporating the following: i. Risk Matrix and Risk Level ii. Consequence Criteria iii. Risk Ranking, and iv. Hierarchy of Control Further, CIL has implemented the statutory provisions of Coal Mines Regulations 2017 and extant directives of DGMS related to safety in operations for both OC and UG mines. In addition to and supplementing the initiative of CIL towards ensuring safety in all the mines as stated above, several modules identifying the risks which are predominantly associated with safety risks in operations for both OC and UG mines, relevant to the mining technology in use, have been developed. They are as follows:	Coal Mines Regulations 2017 and extant directives of DGMS related to safety in operations Safety Handbook CIL & Subsidiaries' notifications and circulars relating to operational safety, issued from time to time	Operational Safety Practices Action Taken Report on adoption of additional safety practices adopted by Subsidiaries	Ongoing	GM (Safety) and GM (Production), CIL and Subsidiary Companies

SNo	Activity Description	Input	Output	Frequency	Responsibility
	(i) Strata Control Risk for UG mines, (ii) Fire and Explosion Risk for both UG and OC mines, (iii) Inundation Risk for both UG and OC mines (iv) Mine Geometry in OC mines (v) Movement of Vehicles in OC mines (vi) Dust Control in OC mines As a first step to mitigate safety risks, each subsidiary shall examine whether the listed risks in these modules have already been identified in their risk assessment, and control measures and the SMP's. If not, it should be examined whether they are applicable, in entirety or in parts, to the mines in operation. If yes, they should be incorporated in their action plans for time bound implementation. Thereafter, subsidiaries shall present such action plans to CIL for supervisory monitoring. In addition to the existing Safety Manual and guidelines of DGMS related to safety in operations, a framework for improving the safety in operations for both Open Cast and Underground Mines, specific to the mining technology in use, has been developed. As a first step to mitigate safety risks, each Subsidiary would need to formulate a time-bound plan to implement this framework, as applicable to each of the high-risk mines. Thereafter the action plan should be presented to CIL for supervisory monitoring.	Coal Mines Regulations 2017 and extant directives of DGMS related to safety in operations Safety Handbook CIL & Subsidiaries' notifications and circulars relating to operational safety, issued from time to time	Operational Safety Practices Action Taken Report on adoption of additional safety practices adopted by Subsidiaries	Ongoing	GM (Safety) and GM (Production), CIL and Subsidiary Companies

SNo	Activity Description	Input	Output	Frequency	Responsibility
2	The Safety Department of CIL has also formulated the following action plans for achievement of the safety objectives: 1. Conducting Safety Audit every year through multi-disciplinary InterCompany / Area Safety Audit teams. 2. Preparation of Site-specific Risk Assessment based Safety Management Plans (SMPs) and implementation of control measures recognized thereby. 3. Preparation of Principal Hazards Management Plans (PHMPs) 4. Formulation and implementation of risk assessment based Standard Operating Procedures (SOPs) for all mining and allied operations. 5. Establishment of Geo-Technical Cell at Subsidiary HQ and large opencast mines. 6. Online Centralized Safety Monitoring System "CIL Safety Information System (CSIS)" 7. Adoption of the state-of-the art mechanism for Strata Management • Scientifically determined Rock Mass Rating (RMR) based Support System.	Guidelines / Action Plans contained in Mitigation Action Plans	Action Taken Report	Monthly	GM (Safety) and GM (Production), CIL and Subsidiary Companies

SNo	Activity Description	Input	Output	Frequency	Responsibility
	• Strata Control Cell for monitoring efficacy of strata support system. • Roof bolting by using mechanized Drilling for Roof Bolting. • Use of Resin capsules in place of Cement capsules. • Use of modern Strata Monitoring Instruments. • Imparting quality training to support crews & front-line mine officials. 8. Improved Mechanism for monitoring of mine environment: • Continuous monitoring of mine environment by ETMS & LMD. • Mine Air Sample Analysis by using Gas Chromatograph for better accuracy. • Use of Personal Dust Sampler (PDS). 9. Safety measures for reduction of accident in OC mines: • Use of more number of Eco-friendly Surface Miner. • Training on Simulators to dumper operators. • Lighting arrangement using high mast towers for increasing level of illumination.	Guidelines / Action Plans contained in Mitigation Action Plans	Action Taken Report	Monthly	GM (Safety) and GM (Production), CIL and Subsidiary Companies

SNo	Activity Description	Input	Output	Frequency	Responsibility
	• Dumpers fitted with Proximity Warning Devices, Rear view mirrors and camera, Audio-Visual Alarm (AVA), Automatic Fire Detection & Suppression system etc. • Ergonomically designed seats & AC Cabins for operators' comfort. • GPS based Operator Independent Truck Dispatch System (OITDS) in large OCPs for tracking movement of HEMMs inside OC mine. 10. Further actions include: • Educating on sleep hygiene – circadian rhythm • Involvement of family members of employee on awareness drive on safety. • Switching over to monitoring and investigation of leading indicators of safety: near misses, incidences, family counselling session, on the spot training of contractual workmen • Thrust on deliberating principal hazard with preventive measures to prevent disaster in mines at PSC meetings, WI inspections and ISO inspection.	Guidelines / Action Plans contained in Mitigation Action Plans	Action Taken Report	Monthly	GM (Safety) and GM (Production), CIL and Subsidiary Companies

SNo	Activity Description	Input	Output	Frequency	Responsibility
3.1	For the following technologies in use: B& P Manual, B&P Semi-mechanized, B&P (R&P) Mechanized, Longwall, in relation to the nature, RMR, RQD, etc. of immediate Roof and Overlying Strata, the following approach may be followed: i. Frame Support Plans compulsorily on the basis of scientific study & follow religiously. ii. Reinforce support in weak / faulty / watery zones [masonry / concrete lining; steel arch etc.] iii. Minimum time lag between roof exposure and supporting to obviate bed separation. iv. Eliminate timber prop v. Use tested steel for roof bolts. Grouting material supplied for roof bolting must be tested for specified anchorage in UG before use vi. Train support personnel & provide them with proper tools and tackles vii. Devise a system to minimize exposure of persons in the green roof. viii. Complying with the SSR framed for the purpose. ix. Checking the quality of support by Mine Safety Officer with adequate documentation and its monitoring higher up.	Guidelines contained in Mitigation Action Plans	Action Taken Report	Monthly	GM (Safety) and GM (Production), CIL and Subsidiary Companies

SNo	Activity Description	Input	Output	Frequency	Responsibility
	x. Systematic monitoring of support by anchorage testing machines, use of gadgets viz. load cells, tell-tales, convergence recorders etc. xi. Learn from previous cases of roof failure. Every subsidiary shall conduct further detailing of mitigation measures depending upon specific situation of each mine.	Guidelines contained in Mitigation Action Plans	Action Taken Report	Monthly	GM (Safety) and GM (Production), CIL and Subsidiary Companies
3.2	For the following technologies in use: B& P Manual, B&P Semi-mechanized, B&P (R&P) Mechanized, Longwall, in relation to the nature, RMR, RQD, etc. of immediate Roof and Overlying Strata, the following approach may be followed: 1. Reduce area of exposure at face 2. Minimum hard cover 15 m 3. Diagonal line of extraction 4. Do not keep standing pillars for long 5. Adopt stowing if feasible 6. Straight line of extraction 7. Thick ribs and stumps of stook not to be left in goaf 8. Induce caving by goaf edge blasting 9. Adopt stowing if feasible	Guidelines contained in Mitigation Action Plans	Action Taken Report	Monthly	GM (Safety) and GM (Production), CIL and Subsidiary Companies

SNo	Activity Description	Input	Output	Frequency	Responsibility
	10. Ensure proper technique of positioning the barricades/proper hydraulic gradient 11. Use of sand booster pump in adverse L/H ratio	Guidelines contained in Mitigation Action Plans	Action Taken Report	Monthly	GM (Safety) and GM (Production), CIL and Subsidiary Companies
3.3	For B&P (R&P) Mechanized, in relation to risks associated with Diagonal cut method, split & fender extraction, and other general issues of risk, the following approach may be followed: 1. Pillar size should be adequate to enable splitting and fender operation 2. Snooks are to be reduced carefully depending upon conditions 3. Adequate size of pillars should be chosen 4. In general, f.o.s. of pillars (after split) should not be less than 2. However, stipulated size of pillars during development as per CMR 1957, have much more f.o.s. 5. Remedial support, especially at intersections, side bolting, etc. is needed 6. Predictive maintenance and availability of spares / sub-assemblies of CM and other face equipment 7. Avoid large pillars 8. W/H ratio should not be less than 1	Guidelines contained in Mitigation Action Plans	Action Taken Report	Monthly	GM (Safety) and GM (Production), CIL and Subsidiary Companies

SNo	Activity Description	Input	Output	Frequency	Responsibility
3.4	For Longwall, in relation to risks associated with cavabilitiy of superincumbent strata, shallow cover, zone of increased stress, very strong superincumbent strata, steep gradient of face, uncontrolled ground movement/ collapse of face, the following approach may be followed: 1. Adequate density of Bore Holes in the area earmarked for LW faces and physico-mechanical properties of strata obtained from cores are two very important requisites for a safe LW operation. 2. Study of cavability and support resistance (t/m^2) by a scientific agency compulsorily. 3. Provide additional capacity in Power Supports 4. Packing/Blanketing of fractured surface with earth and compaction by dozing prevents entry of air in the goaf 5. Additional support in both gate roads 6. Hard roof management has not been perfected /induce caving from surface by BH blasting 7. Provide additional capacity in Powered Supports; 8. Monitor verticality of support on daily basis (preferably by computer programme) 9. Ground movement monitoring: • Ongoing Strata Management Plan involving scientific agency viz. CMPDI / CMRI	Guidelines contained in Mitigation Action Plans	Action Taken Report	Monthly	GM (Safety) and GM (Production), CIL and Subsidiary Companies

SNo	Activity Description	Input	Output	Frequency	Responsibility
	• Monitoring of main and tail gates with multiple anchor sonic probe extensometers or equivalent and load cells and convergence recorders in gate roads • Monitoring of leg pressures and convergence surveys on daily basis • Monitoring of health of the support units • Pressure profile • Convergence profile • Subsidence profile • Learn from previous collapse of LW faces (Khottadih, Churcha)	Guidelines contained in Mitigation Action Plans	Action Taken Report	Monthly	GM (Safety) and GM (Production), CIL and Subsidiary Companies

SNo	Activity Description	Input	Output	Frequency	Responsibility
4.1	Danger from surface water and danger from underground inundation have been dealt with in Regulation 149 and Regulation 150 respectively in Coal Mines Regulation 2017 and several circulars have been issued by DGMS on these topics. In the following module, the risks identified and their mitigation plans are supplementary to the provisions of the CMR 2017 and DGMS Circulars related to the subject, based on the experience of operating mines. Provisions of CMR have not been duplicated here. However, in few cases guidelines of Regulations / Circulars have been reiterated in the relevant context	Guidelines contained in Mitigation Action Plans	Action Taken Report	Monthly	GM (Safety) and GM (Production), CIL and Subsidiary Companies
4.2	For all technologies (B&P Manual, B&P Semi-mechanised, B&P (R&P) Mechanised and Longwall, in respect of risks arising during development stage from surface water bodies (ponds, nullahs, rivers, etc.), the following general precautions may be adopted: 1. Obtaining reliable data of rainfall as well as HFL of water courses from Dist authorities / Railways / Weather offices; 2. Every mine management should have clear idea about the catchment area affecting the mine, because heavy rainfall far away can cause rapid rise of water level;	Guidelines contained in Mitigation Action Plans	Action Taken Report	Monthly	GM (Safety) and GM (Production), CIL and Subsidiary Companies

SNo	Activity Description	Input	Output	Frequency	Responsibility
	3. Marking of HFL and Danger level of water for withdrawal of persons from UG; 4. Provide Floats, self-activated sirens, visual warnings, telephone/ walkie-talkie; post personnel during rainy season; 5. Frame Standing Order for withdrawal of persons, Mock rehearsal and familiarization of all concerned; 6. Inspection of vulnerable sites by senior most mine official/manager during heavy rains 7. Courses of rivers/nullahs change over the years and in many cases, position shown on old plans is not correct. Re-survey of the water courses to ascertain the accuracy of plans; 8. Confirmatory drilling to locate hard ground 9. Construct protective embankment as per Statutory guidelines and adopt all precautions listed above. 10. Strengthening of barrier by boulder Pitching / Construction of suitable embankment, if necessary.	Guidelines contained in Mitigation Action Plans	Action Taken Report	Monthly	GM (Safety) and GM (Production), CIL and Subsidiary Companies
4.3	For all technologies (B&P Manual, B&P Semi-mechanised, B&P (R&P) Mechanised and Longwall, in respect of risks arising during development stage from underground water sources, the following general precautions may be adopted: 1. In respect of known BH's, it is advisable to avoid them while drawing development projections, as far as possible.	Guidelines contained in Mitigation Action Plans	Action Taken Report	Monthly	GM (Safety) and GM (Production), CIL and Subsidiary Companies

SNo	Activity Description	Input	Output	Frequency	Responsibility
	2. In case of inadvertent connection with unmarked BH, there is no other option than plugging the same with cement concrete grout. But before the plugging is accomplished this may play havoc, if pumping capacity is not adequate in the mine. 3. Drilling hole in the region and injecting quick-setting cement grout at pressure by manual /hydraulic pump; Walling off by masonry/concrete. 4. Roof bolting in watery strata is difficult because cement capsule grout flow out before setting. Plugging the end with dry stemming clay and using resin capsules has worked. 5. Provide adequate pumping capacity by doing hydro-geological study 6. Conducting check surveys while approaching old workings helps prevent danger 7. Every gallery to be advanced should have one central and sufficient nos. of flank holes to ensure a safe barrier 8. Dewater old workings where feasible even by submersible pumps through abandoned shaft/BH; 9. Joint Survey Plan of all seams are a must for ensuring statutory barrier. Where the adjacent area is not approachable, AMP (Abandonment Mine Plan) should be obtained from DGMS archive	Guidelines contained in Mitigation Action Plans	Action Taken Report	Monthly	GM (Safety) and GM (Production), CIL and Subsidiary Companies

SNo	Activity Description	Input	Output	Frequency	Responsibility
	10. Design of Water Dam should be done and its construction supervised by a qualified Civil Engineer taking into consideration long term static head of water to be held. Locking of the Dam with roof/floor/sides should be proper. 11. Dams should never ever be made unapproachable by extracting panel on their dip-side; 12. Specifications /details (particularly the head of water for which it is designed) of Water Dams must be recorded in Water Danger Plan for future reference. 13. Control valves etc. for sludge cleaning should be of noncorrosive material	Guidelines contained in Mitigation Action Plans	Action Taken Report	Monthly	GM (Safety) and GM (Production), CIL and Subsidiary Companies
4.4	For all technologies (B&P Manual, B&P Semi-mechanised, B&P (R&P) Mechanised and Longwall, in respect of inundation risks arising out of caving during depillaring/ extraction stage, the following general precautions may be adopted Before commencing extraction/depillaring, lot of circumspection is needed viz. a) Visualize what will be future implication of caving of strata to dip side of the panel in the same seam or on other seams below, b) The effect of ongoing workings or abandoned workings of adjacent mines on the panel intended to be extracted. 1. Dewater water body above before caving /Divert water course where feasible	Guidelines contained in Mitigation Action Plans	Action Taken Report	Monthly	GM (Safety) and GM (Production), CIL and Subsidiary Companies

SNo	Activity Description	Input	Output	Frequency	Responsibility
	2. Packing/Blanketing of fractured surface with earth and compaction be dozing 3. Construct garland drain around the periphery of the area to be extracted 4. Monitor subsidence in systematic grid 5. Where overlapping workings exist in different seams which are worked from different mines, close communication and sharing of data among managers / safety officers of adjacent mines is imperative. 6. Vertical sections of all coal horizons with faults and BH's across the boundary must be maintained, though it is not statutorily mandated 7. It may be necessary to keep certain key features viz. shafts/inclines or some part of workings approachable and ventilated, despite abandonment and continue pumping or maintain water level at particular FRL with warning systems in abandoned shafts. 8. It is advisable to encase the trunk roadways up to surface level with brickwork and concrete roof and if OB is available to back-fill the void created by OC mining, at least for the relevant part of the quarry. Subsidiaries to learn from previous disasters due to inundation (Chasnala, Mahavir, Ghaslitand etc.) Learn from earlier investigation reports viz. HB Ghosh committee, Bagchi Committee etc. and cross check whether the recommendations are still being followed.	Guidelines contained in Mitigation Action Plans	Action Taken Report	Monthly	GM (Safety) and GM (Production), CIL and Subsidiary Companies

SNo	Activity Description	Input	Output	Frequency	Responsibility
5.1	Precautions against fire have been dealt with from Reg 134 - 142 and precautions against dust from Reg 143 - 146 in Coal Mines Regulation 2017 and several Circulars have been issued by DGMS in this regard. In the following module, the risks identified and their mitigation plans are supplementary to the provisions of the CMR 2017 and DGMS Circulars related to the subject, based on the experience of operating mines. Provisions of CMR have not been duplicated here. However, in few cases guidelines of Regulations/Circulars have been reiterated in the relevant context.	Guidelines contained in Mitigation Action Plans	Action Taken Report	Monthly	GM (Safety) and GM (Production), CIL and Subsidiary Companies
5.2	For all technologies (B&P Manual, B&P Semi-mechanized, B&P (R&P) Mechanized and Longwall, in respect of fire risks arising due to spontaneous heating (endogenous), CMR 2017 stipulated adequate measures to be taken against fires caused by exogenous reasons (other than spontaneous heating) [Regulations 134 (General precautions against fire) and Reg 135 (Surface precautions against fire) and Reg 136 (Underground precautions against fire) and related DGMS Circulars].	Guidelines contained in Mitigation Action Plans	Action Taken Report	Monthly	GM (Safety) and GM (Production), CIL and Subsidiary Companies

SNo	Activity Description	Input	Output	Frequency	Responsibility
	1. Generally, Crossing Point Temperature of coal seams / sections are determined to find out the propensity of a particular coal to spontaneous heating. Presently countries like USA, Canada, Australia etc. are using Adiabatic Oxidation method such as R70 (Mean Temperature Rise from 40°C to 70°C), SHT (Self Heating Temperature, IRH (Initial Rate Heat – rising) and TTR (Total Temp. Rise) for this purpose which is said to be more accurate (but rather time consuming). CIMFR, reportedly, are doing these tests. China has developed 'Oxidation Kinetics' testing method which is claimed to be most comprehensive. These data will give a guide line in planning the size of a depillaring panel in a virgin seam so far as incubation period is concerned. 2. Collieries having history of spontaneous heating in a working panel as well as in sealed-off panels should dig out past records to ascertain incubation period and form depillaring panels consistent with rate of production. Forming Sub-Panels with necessary isolating arrangement helps in case of seams prone to sp. heating.	Guidelines contained in Mitigation Action Plans	Action Taken Report	Monthly	GM (Safety) and GM (Production), CIL and Subsidiary Companies

SNo	Activity Description	Input	Output	Frequency	Responsibility
	3. During development, extreme care is necessary to ensure that parting does not get reduced below the mandatory minimum 3 m thickness (physically proving at frequent intervals by drill hole). Presence of shale bands in the parting calls for greater thickness of the parting to be maintained. 4. During depillaring, If possible, hydraulic sand stowing should be adopted, working from bottom upwards. 5. In case the sections/seams are worked by caving method, it is advisable that (a) ventilation circuit in both the sections are independent, (b) each section/seam are individually having Isolation Stoppings, (c) Staple Pits etc. made for evacuation of coal from top to bottom , are plugged while sealing the top section . The extraction shall be top downwards. Simultaneous extraction with bottom section with some lag, helps.	Guidelines contained in Mitigation Action Plans	Action Taken Report	Monthly	GM (Safety) and GM (Production), CIL and Subsidiary Companies
5.3	For all technologies (B&P Manual, B&P Semi-mechanised, B&P (R&P) Mechanised and Longwall, in respect of fire risks arising due to spontaneous heating (endogenous) in (a) un-extracted coal left out in goaf, (b) stowed goaf, and (c) sealed-off panel in Degree Three gassy mine, the following general precautions may be adopted:	Guidelines contained in Mitigation Action Plans	Action Taken Report	Monthly	GM (Safety) and GM (Production), CIL and Subsidiary Companies

SNo	Activity Description	Input	Output	Frequency	Responsibility
	1. In conventional B&P mining, height of extraction is limited by the size of individual props which is gradually replaced by roof bolting. In case of depillaring by SDL's / LHD's, although development drivages are mandated at maximum 3 m height, it is feasible to extract another lift of about 1-1.2 m of floor coal in the floor at the time of slicing with roof bolting and steel chocks in second operation. But in case of any coal seam superior to 4.0-4.5 m, some coal is bound to be left in goaf. In case of depillaring with Continuous Miner, seam height of about 5.0-5.5 m has been successfully worked. 2. In both cases, it is the un-extracted stumps/ ribs left, which do not allow full caving and the void left in the goaf is the cause of heating. It is advisable to rob the ribs/ snooks as far as safely possible or decimate them even if the coal cannot be lifted out. 3. In case of retreating Long Wall faces, the Shearer and Powered Supports should be chosen so as to extract the full height of the seam, as far as possible. Previously, height of extraction in LW faces was limited by the max. extendable height of Powered Support available (3.5 -4 m), consequently lot of coal remained unrecovered in case of thick seams. Presently, in Indian mines (Jhanjra ECL), 5.50 m seam is being proposed to be extracted by deploying matching equipment. Shangwan mine in China has extracted 6.50 m by Shearer in one lift.	Guidelines contained in Mitigation Action Plans	Action Taken Report	Monthly	GM (Safety) and GM (Production), CIL and Subsidiary Companies

SNo	Activity Description	Input	Output	Frequency	Responsibility
	4. But in mining methods like Sub-Level caving, considerable amount of coal is bound to be left in the goaf. In such situation, controlled dosing of nitrogen through perforated pipes left in the goaf, to keep the goaf atmosphere inert, has been successfully done in European mines (Blanzy coalfield in France). This can be emulated in our mines. Feedback from CIL is that Mist Spray in goaf has been successful in some mine. 5. It is always advisable to get a study made by CMRI before adopting and designing a stowing plant. 6. Trough type (Marlbach) / Russian cistern type of mixing chamber prevents air pockets. Where hydraulic gradient is not favorable, larger dia. pipe range should be used (200 mm or even 250 mm HDPE instead of usual 150 mm CI) especially for coarse sand (of Damodar/Barakar unlike of Brahmani which contains argillaceous material) 7. In very adverse hydraulic gradient sand booster pump may be installed or stowing from large dia Bore Hole strategically located near a group of panels. 8. Internal Safety Organisation (ISO) of Subsidiaries needs to closely monitor stowing lag. In the past ECL was carrying huge stowing lag in some of the mines.	Guidelines contained in Mitigation Action Plans	Action Taken Report	Monthly	GM (Safety) and GM (Production), CIL and Subsidiary Companies

SNo	Activity Description	Input	Output	Frequency	Responsibility
	9. It is to be ensured that the percentage of methane does not fall and consequently the mixture enters the explosive range. Isolation Stoppings must be explosion-proof. Recess cut in roof, floor and sides as per statute. Sealant may also be used. Pressure balancing technique minimize leakage. Rule of thumb is that all danger of explosion is eliminated if O2 concentration is kept below 3 %.	Guidelines contained in Mitigation Action Plans	Action Taken Report	Monthly	GM (Safety) and GM (Production), CIL and Subsidiary Companies
5.4	For all technologies (B&P Manual, B&P Semi-mechanized, B&P (R&P) Mechanized and Longwall, in respect of fire risks arising due to Fire Damp (Methane) Explosion, the following general precautions may be adopted CMR 2017 has extensively dealt with this subject in Reg. 153, Reg 166, Reg. 169 to 171 and DGMS issued many related Circulars. Certain other actions which may be considered are stated as follows: 1. Fresh Gas Survey as per procedure stipulated by DGMS, during coal getting operation in CM / PSLW faces. 2. Ventilation standard, Type of electrical apparatus, etc. are to be revised as per statutory provisions for Degree III mines.	Guidelines contained in Mitigation Action Plans	Action Taken Report	Monthly	GM (Safety) and GM (Production), CIL and Subsidiary Companies

SNo	Activity Description	Input	Output	Frequency	Responsibility
	3. Degree III mines should have two distribution feeders from a power station or power from two power service providers, wherever feasible. Alternatively, diesel generators for standby for MMV and Winder must be installed. 4. Regular gas survey in the working seam. 5. CBM extraction may be a solution. 6. All precautions including FLP electricals should also be taken for other seam(s). 7. Sectionalizing of developed panels by explosion proof stoppings, especially when no. of stoppings are many, is very costly. Alternatively, ventilating the panels standing on pillars may be safer. In some mines, bleeding of gas from sealed-off panel was practiced which is fraught with danger. 8. A whole new chapter XVI (Reg. 218 to 286) has been added in CMR 2017 on extraction of methane from mine working, but there is no directive on the safety aspect, whether mine working and CBM extraction can proceed concurrently. Possible solutions for control of CH_4 emission are: (a) In – seam methane drainage; (b) De-gasification through cross-measure boreholes or by horizontal boreholes in advance of working sections, (c) Drainage of goaf	Guidelines contained in Mitigation Action Plans	Action Taken Report	Monthly	GM (Safety) and GM (Production), CIL and Subsidiary Companies

SNo	Activity Description	Input	Output	Frequency	Responsibility
6.1	Coal Mines Regulation 2017 has framed few new Regulations regarding OC mining viz. 'Mechanized opencast working (Reg 106), Reclamation (Reg 107) Spoil banks and dumps (Reg 108) and Code of practice (Reg 110). Further, DGMS has issued several Circulars in this regard.	Guidelines contained in Mitigation Action Plans	Action Taken Report	Monthly	GM (Safety) and GM (Production), CIL and Subsidiary Companies
6.2	For Shovel-Dumper combination, for risks related to height of benches, gradient of haul roads, and slope stability of the mine excavation, the following general precautions may be adopted: 1. In mechanized OC mine, height of the bench in alluvial soil, morrum and similar soft ground shall not be more than 3 m and the same in coal and OB (rock formation) shall not be more than the digging height of the excavator or reach the excavator [Reg 106] 2. Statutory minimum width shall never be less than widest machine + 2m or 3 times the width of the largest vehicle plying or height of bench [Reg 106]. But in many cases, more space is needed for faster movement of large Dumpers (+ 100 T) for Dozer path as well as for providing space for poles for power lines, parapet walls. Wider benches is also needed for gentler slope of excavation when needed.	Guidelines contained in Mitigation Action Plans	Action Taken Report	Monthly	GM (Safety) and GM (Production), CIL and Subsidiary Companies

SNo	Activity Description	Input	Output	Frequency	Responsibility
	3. No road shall be steeper than 1 in 16 at any place. However, for temporary ramps, a gradient of 1 in 10 may be permissible in short stretches. In case of downhill movement of loaded Dumpers, gradient should be around 1 in 20. 4. Operator of dumper shall have a clear view of 30m in haul roads; In blind curves, installation of convex mirrors helps 5. Roads above the levels of surrounding area shall be provided with parapet walls of 1 m 6. Study of slope stability of the mine excavation, by a scientific agency is mandatory now [Reg 106(2)], in which hydro-geological data, HEMM configuration should be considered. 7. The principles for Slope stability analysis for ultimate pit slope are generally carried out using limit equilibrium method (Bishop's method) with the help of the software "Galena". Geo-mechanical parameters /input data eg, Density (Kg/m3), Unit Wt. (KN/m2), Cohesion (KPa), Angle of internal friction of all the lithological units viz. alluvium, clay, sandstone, shale and also coal and groundwater parameters of the area are used for the slope stability analysis.	Guidelines contained in Mitigation Action Plans	Action Taken Report	Monthly	GM (Safety) and GM (Production), CIL and Subsidiary Companies

SNo	Activity Description	Input	Output	Frequency	Responsibility
	8. Stipulated Factor of Safety for the ultimate pit slope for the deepest pit is between 1.10 and 1.20, (with or without considering seismicity respectively) recommended by different International agencies (e g., "National Coal Board, U.K", etc.). A thumb rule for our coal measure strata, a safe slope may be around 28° to 35° 9. Coal blocked in batter increases with flatter slope, which may be considered for partial recovery by High Wall mining.	Guidelines contained in Mitigation Action Plans	Action Taken Report	Monthly	GM (Safety) and GM (Production), CIL and Subsidiary Companies
6.3	Internal Dump: Back-filling of overburden in the quarry is for reclamation of the void created by mining, which is presently mandated (Reg 107) and as part of Mine Closure Plan. Generally internal dumping starts after 3 -5 years of starting of mine operation when sufficient space in dip/strike direction is available. 1. It is to be ensured that Haul Roads and other utilities viz. pumping ranges, sump, power line etc. and the working benches of the quarry are safe from the loose overburden.	Guidelines contained in Mitigation Action Plans	Action Taken Report	Monthly	GM (Safety) and GM (Production), CIL and Subsidiary Companies

SNo	Activity Description	Input	Output	Frequency	Responsibility
	2. Generally, it is planned that the advancing working face is at least 100 m away from the line where backfilled OB touches the quarry floor. This distance is quite variable, mainly governed by the grade of the de-coaled quarry floor. In case of certain steep seams viz. Manikpur, in Korba coalfield (Jatraj seam gradient goes up to 1 in 2.5) backfilling is ruled out. 3. Height of the internal dump can be calculated from the Swell Factor (about 0.76) of blasted OB and applying a factor for subsequent compaction due to passage of HEMM and water spraying on the volume of OB. Stable slope angle depends on the factors already described viz. Density, Unit Wt. Cohesion, Angle of internal friction of which govern the natural Angle of Repose of the litho-units of loose OB and also groundwater parameters and may be around 25° to 30°. DGMS stipulates that the slope must not exceed 37.5° (Reg 108). It is advisable to have study done by a scientific agency. Physical and Biological reclamation are essential for stability of Internal Dumps	Guidelines contained in Mitigation Action Plans	Action Taken Report	Monthly	GM (Safety) and GM (Production), CIL and Subsidiary Companies

SNo	Activity Description	Input	Output	Frequency	Responsibility
7.1	The following procedures shall be considered (in addition to extant Regulations) for movement of vehicles in operational mines: 1. Width of Haul Road as per size of Dumpers for single lane and double lane 2. Camber, Super Elevation, Safe Horizontal and Vertical curves 3. Paving: Specification for permanent and temporary Haul Roads 4. Dozer path: width / on one side or either side of Haul Road depending on dozer traffic and mine layout 5. Side drains: 1 m deep on either side 6. Grade: in no case exceed 1 in 14 (preferable 1 in 16, 1 in 20 for down ward load) 7. Escape Lane: in case of down ward haul, when brake fails, to avoid collision with opposite lane dumpers. 8. Parapet Wall: not < 1 m, when Haul Road is above the surrounding area 9. Lay by: for narrow temporary haul roads to facilitate crossing of opposite direction or towing a disabled vehicle. 10. Runway Vehicle Collision Berm: proper spacing and ht. of berm. Median berm is more effective.	Guidelines contained in Mitigation Action Plans	Action Taken Report	Monthly	GM (Safety) and GM (Production), CIL and Subsidiary Companies

SNo	Activity Description	Input	Output	Frequency	Responsibility
	11. Road signs: in bifurcations, crossings, etc. In crossings, Rly type level crossing type of drop barrier with attendant and red and green signals are necessary at certain points particularly during night hours. 12. Stopping Sight Distance: e.g. Vehicles at 30 Kmph require 167 m safe distance between them at 20 sec. reaction time of operator for seeing the hazard and applying brake. For vehicle (gross wt. 90 to 180 t) at 32 Kmph, distance limitation to preclude brake failure is 73.8 m. Whereas, vehicle can be brought to stop at 68.6 m at 5 % grade Haul Road), it will need 91.5 m at 10 %. 13. Overtaking Sight Distance for various speeds: e.g. at 20 Kmph, time component for overtaking man oeuvres is 9 sec. and for opposite vehicle 6 sec., the safe overtaking distance is 165 m whereas at 10 Kmph it is 300 m. 14. Lighting: Proper selection of lamps (HPSV, LPSV etc.), Lighting System (Flood, High Mast, Mobile etc. depending upon need), Spacing and mounting height, Illumination level (20 Lux as the optimum as per IS 6665). In the interest of safety, economy and overall system efficiency,	Guidelines contained in Mitigation Action Plans	Action Taken Report	Monthly	GM (Safety) and GM (Production), CIL and Subsidiary Companies

SNo	Activity Description	Input	Output	Frequency	Responsibility
	highest mounting source and largest light source practicable shall be used.	Guidelines contained in Mitigation Action Plans	Action Taken Report	Monthly	GM (Safety) and GM (Production), CIL and Subsidiary Companies

SNo	Activity Description	Input	Output	Frequency	Responsibility
8.1	For Fire due to spontaneous heating in OC Mines, Detailed guidelines have been issued by DGMS long before (Circular Tech. 3 of 1980 and Tech. 4 of 1983.) 1. There is practical difficulty of cleaning the UG workings of coal dust, because most of them are un-approachable. Treating coal dust in such workings by sending stone dust and dispersing by compressed air, has not been done, other than in test condition. What most contractors are doing is by quenching by water before shot firing, then digging the fiery portion out. Small water gas explosions are happening without any major repercussions. It needs to be experimented whether nitrogen dosing can be economically done to deal with the fire. 2. In many cases major faults delineate the boundary of a quarry. Leaving remnant coal unextracted, close to the fault plane initiates sp. heating. A major accident occurred in Jagannath OCP in the past when heated coal came in contact with water seeping in the fault plane and caused water gas explosion leading to many fatalities.	Guidelines contained in Mitigation Action Plans	Action Taken Report	Monthly	GM (Safety) and GM (Production), CIL and Subsidiary Companies

SNo	Activity Description	Input	Output	Frequency	Responsibility
	3. In some OC mines, excavated coal is dumped within the quarry bed, albeit temporarily, because of some problem of dispatch/ lack of space in the coal stock yard and the coal eventually catch fire and pollutes the quarry atmosphere. This is not a good practice. Often there is insufficient water for quenching. Dozing and compaction, particularly at the fringes, is the only solution. 4. Illegal mining patch, already on fire may get connected with advancing face of quarry. Blanketing with earth, dozing and subsequently digging out the heated coal can be a solution. DGMS has extensively dealt with this subject and issued guidelines in various Circulars. DGMS circulars (1985 & 1990) specified, inter alia, that temperature of blast holes should not exceed 80° C and holes to be kept submerged in water etc. Pyrometers should be available in all OC Mines. Blast Hole drills should be equipped with wet drilling arrangement. These aspects need attention.	Guidelines contained in Mitigation Action Plans	Action Taken Report	Monthly	GM (Safety) and GM (Production), CIL and Subsidiary Companies

SNo	Activity Description	Input	Output	Frequency	Responsibility
	To mitigate the risk of equipment falling down into galleries on fire while working developed pillars by OC method, DGMS usually impose a condition that a min. thickness of 3 m of OB has to be left in the top of coal bench to bridge the width of developed gallery beneath so that (a) equipment can work on firm ground, and (b) shots are not fired in the UG gallery. Inspite of the above several accidents, fatal and serious, had happened when Dozer or BH Drill has fallen below in UG working with operator. How to ensure the specified parting? Presently, drills are available where drilling can be programmed to a pre-determined depth in the OB bench. But variation of thickness of coal seam has to be watched closely. Some pilot drilling may be necessary. One solution is that surveyor marks the outline of the galleries below on top of the bench. Plans should be accurate.	Guidelines contained in Mitigation Action Plans	Action Taken Report	Monthly	GM (Safety) and GM (Production), CIL and Subsidiary Companies

4.5 SOP for technology upgradation and improvement in availability & utilization of HEMM

SNo	Activity Description	Input	Output	Frequency	Responsibility
1	The recommendation of a Committee constituted by MoC "for revision of norms for Availability and Utilization of HEMM by the coal companies“ under the Chairmanship of Addl. Secretary, Coal vide even no. Dated 7 May & 22 May,1999, which, inter alia, states that existing annual productivity norms of all HEMM will be enhanced by 10% for planning new opencast projects. This will take care of increase in working days from 300 to 330 days “However, norms would need to be improved further because of technological changes that has taken place since 1980, when the norms were last revised, in manufacturing, maintenance and operation of HEMM for which CMPDIL will have to make detailed assessments for fixing the HEMM norms on scientific basis.” The CIL committee on “Revision of norms of productivity of HEMM” constituted by Chairman, CIL on 22.03.2003 to function under the overall guidance of CMD, CMPDI to review the productivity of HEMM used for planning of opencast mines recommended to increase the productivity of mining equipment for new opencast mines in a range of 10% to 17%.[as per input of CMPDI] Subsequently, CIL formed another committee to review the existing norms in May 2013 which came out with a report “Review of Availability and Utilization of HEMM” in April 2015. The recommendation of the committee is briefly:	Availability Norms	Adherence to availability norms	Monthly	GM (Production), Subsidiaries & CIL

SNo	Activity Description	Input	Output	Frequency	Responsibility
	i. Availability & Utilization of Norm for Dragline, Shovels, Dumpers should remain unchanged ii. Availability norms for dozers & drills should remain unchanged. No utilization norms to be defined as these are need based equipment. iii. Surface Miner: Availability : 80% and Utilization : 60%. Some of the action points for technology-specific risk factors have been listed below:	Availability Norms	Adherence to availability norms	Monthly	GM (Production), Subsidiaries & CIL
2.1	To cut down Unavailable Hours, certain elements of planned maintenance can be examined: (a) 100 Hrs. /500 Hrs. /1000 Hrs. maintenance do not take much time, but Capital Overhaul does (e.g. after every 10000 hrs. working for an Excavator or 2500 hrs. working for a Dozer). Effort should be made to substantially reduce the duration of capital overhaul. Now with availability of improved quality of indigenous equipment, there is scope for this. (b) Similarly time for daily maintenance during shift change can be reduced by planning staggered shifts for maintenance staff.	Guidelines contained in Mitigation Action Plans	Action Taken Report	Monthly	GM (Production), Subsidiaries & CIL

SNo	Activity Description	Input	Output	Frequency	Responsibility
2.2	To cut down idle hours: (a) Shift change and tiffin break, can be reduced by providing transport to operator, canteen van, etc. But, above all, discipline and improving work culture are two most important factors which prevents wastage of time for these two elements. (b) Stoppage of work due to rain can be cut down substantially: [Note: Coalfields have rainy days for about 120 days in a year (mostly concentrated from mid-Jun to mid-Oct. where heavy rain occurs on some days and sporadic rain during others.)] (c) Dumpers can ply in moderate rainfall if The haul roads are constructed with correct specs and profile*, side drains and proper grade (< 1 in 16 up hill and < 1 in 20 downhill for loaded trucks); (d) Platforms are constructed on top of active dumps to prevent accumulation of water; (e) Constant availability of dozer(s) on top of the dump	Guidelines contained in Mitigation Action Plans	Action Taken Report	Monthly	GM (Production), Subsidiaries & CIL
2.3	To minimize breakdowns, the following steps may be taken: ▪ Following maintenance schedule scrupulously ▪ Competent and trained operators to obviate mishandling ▪ Use OEM recommended Oil and Lubricant ▪ Quality of spares to be ensured (procure from OEM or established ancillaries)	Guidelines contained in Mitigation Action Plans	Action Taken Report	Monthly	GM (Production), Subsidiaries & CIL

SNo	Activity Description	Input	Output	Frequency	Responsibility
	▪ Off-loading major overhauls to OEM (if necessary) ▪ CBM (Condition Based Maintenance) has some advantages over planned maintenance: a) Improved system reliability b) Decreased maintenance costs. ▪ However, CBM has certain disadvantages which are as follows: a) High installation costs, for minor equipment items often more than the value of the equipment; b) Increased number of parts (the CBM installation itself) that need maintenance and checking	Guidelines contained in Mitigation Action Plans	Action Taken Report	Monthly	GM (Production), Subsidiaries & CIL
2.4	To resolve breakdowns with minimum loss of working hours, the following steps may be taken: ▪ Availability of R&M spares /sub-assemblies /insurance items. ▪ Formulation of realistic Material Budget and timely placement of Supply Order because there is long lead time for spares of imported or even some indigenous equipment. ▪ Enhance Facility and capability of Unit / Regional / Central Work Shops. [Washing arrangement, Machine Shop, EOT crane, Tyre Handler etc. ▪ Trained personnel: Mechanics / Supervisors / Engineers	Guidelines contained in Mitigation Action Plans	Action Taken Report	Monthly	GM (Production), Subsidiaries & CIL

SNo	Activity Description	Input	Output	Frequency	Responsibility
	▪ Facilitate opening of Service Centers by major suppliers of equipment for large mines. ▪ Standardization of equipment (at least project wise)	Guidelines contained in Mitigation Action Plans	Action Taken Report	Monthly	GM (Production), Subsidiaries & CIL
2.5	Careful selection of equipment based on mine- specific geo-mining conditions of coal and OB need to be taken into account in certain cases.	Guidelines contained in Mitigation Action Plans	Action Taken Report	Monthly	GM (Production), Subsidiaries & CIL

SNo	Activity Description	Input	Output	Frequency	Responsibility
3	To improve utilization of HEMM impacted by operational reasons such as shift change, crowding of dumpers at excavator, idle excavators for absence of dumpers, incorrect deployment of excavators, interruption due to rains/ summer heat, etc., the following steps may be taken: (a) Provide transport to operators of excavators, BH Drills, as well as to maintenance gang; (b) Maintenance gang "Hot Seat" exchange (c) Prevent delay in Time Office (common in General Shift)/ Continued dialogue with Trade Unions. (d) Proper blast design and charge (e) Proper selection of size and nos. of Excavators and Dumpers at the planning stage (f) Proper nos. of Dumpers assigned to different excavators (g) Introduction of Truck Dispatch System (TDS / OITDS) in large mines & wherever techno-economics permits and in a phased manner. (h) Ensure Haul roads are constructed with correct specs and profile, side drains and proper grade.	Guidelines contained in Mitigation Action Plans	Action Taken Report	Monthly	GM (Production), Subsidiaries & CIL

SNo	Activity Description	Input	Output	Frequency	Responsibility
	(i) Introduction of Truck Dispatch System (TDS / OITDS) in large mines & wherever techno-economics permits and in a phased manner. (j) Creation of sump of adequate capacity with proper capacity of Pumping, prevents drowning of coal benches at lower level (k) Planning group of the project should prepare short term plan and advise the operational personnel for day to day deployment of equipment. (l) In addition to day to day planning, it is necessary to foresee the near future configuration of the mine, which can obviate idling of equipment (m) Dragline is an inflexible machine. Improper / inadequate blasting, lack of advance of upper shovel benches will cause idling.	Guidelines contained in Mitigation Action Plans	Action Taken Report	Monthly	GM (Production), Subsidiaries & CIL

SNo	Activity Description	Input	Output	Frequency	Responsibility
4	To assess the standard productivity of every equipment as accurately as possible and then compute the aggregate productivity of all production related HEMM to arrive at the Mine Capacity. The ratio the actual performance of the mine with the Mine Capacity will give Capacity Utilization. The assessed capacity of each equipment should also be compared with the claimed capacity stated by the manufacturer. 1. Annual productivity of HEMM should be calculated from the basics and factors affecting the calculation are broadly as follows: ▪ Category of rock in terms of Compressive Strength [Kg / cm^2] e.g. Cat1, Cat2, Cat 3, Cat 4 in ascending CS. ▪ Swell Factor and Weight / unit volume of categorized rock. ▪ Bucket Fill Factor. ▪ Solid bucket capacity: m^3 ▪ Dumper carrying capacity: T	Guidelines contained in Mitigation Action Plans	Action Taken Report	Monthly	GM (Production), Subsidiaries & CIL

SNo	Activity Description	Input	Output	Frequency	Responsibility
	▪ Struck capacity of dumper: m^3 (as per manufacturer's catalogue) ▪ Time for loading a Dumper: min ▪ Load per Dumper: m^3 ▪ Hourly output of Shovel: m^3 ▪ No. of hours worked annually (Note below) Note: Normally annual working hours of Excavators is taken as 5000 hrs. during calculation, considering the mine being worked for 300 days. If mine is worked for more no. of days, annual productivity should proportionately increase. Many CIL mines are working almost non-stop for the whole year. Because of this, annual productivity figures given in the column alongside, came under scrutiny by MoC and external agencies. Some private mine operators and contractors of CIL are achieving higher annual productivity of their HEMM. 2. Similarly, Annual Productivity of Rear Dumpers for various leads in combination with different capacity of Shovels can be calculated. Speed of dumpers should be adopted from manufacturer's catalogue keeping in mind the condition of haul roads	Guidelines contained in Mitigation Action Plans	Action Taken Report	Monthly	GM (Production), Subsidiaries & CIL

SNo	Activity Description	Input	Output	Frequency	Responsibility
	3. The CIL committee on "Revision of norms of productivity of HEMM" constituted by Chairman, CIL on 22.03.2003 to function under the overall guidance of CMD, CMPDI to review the productivity of HEMM used for planning of opencast mines recommended to increase the productivity of mining equipment for new opencast mines in a range of 10% to 17%.	Guidelines contained in Mitigation Action Plans	Action Taken Report	Monthly	GM (Production), Subsidiaries & CIL

4.6 SOP for implementation guidance for mitigation of unviable underground mining operations

SNo	Activity Description	Input	Output	Frequency	Responsibility
1	Broad Mitigation Action Plans to assess the viability for a turn-around of the lossmaking UG mines, would involve a case-by-case evaluation of each specific mine by each Subsidiary company. Some of the relevant considerations for the Subsidiaries would involve the following: 1. Optimum scale of production from a district: Minimum performance of Equipment of t / machine / day needs to be defined for manual loading, semi-mechanized (SDL/LHD), CM, PSLW etc. 2. Optimum size of the mine [number of districts / volume of production], consistent with investment: a. If there is shortage of working area, possibility of recovery of sealed off / waterlogged seams (if any) shall be evaluated; b. Possibility of release of working area below built-up surface features by relocation; c. Adoption of sand stowing where possible; d. Opening of new seams either with same mine entries or sinking additional declines /pits; amalgamation of two or more unviable entities.	Guidelines contained in Mitigation Action Plans	Action Taken Report	Quarterly	GM (Production), Subsidiary Companies & CIL

SNo	Activity Description	Input	Output	Frequency	Responsibility
	3. Identifying surplus manpower [severance/ redeployment/ other options]: Identification of surplus manpower shall be done keeping in view the need to retain skilled & experienced workers. Redeployment options shall be identified and implemented (with help of additional incentives, if any, on case to case basis). Voluntary Retirement Schemes (VRS) for workmen shall be applied for identified surplus manpower which cannot be redeployed / re-skilled. 4. Developing normative costs for each loss-making unit: Normative costs shall be developed [by IED study or otherwise] to improve certain Efficiency Ratios viz. Powder Factor, OMS, Units of Power/t etc. Thereafter, actual performance needs to be monitored and compared by a dedicated group and corrective action taken. For instance, if the pumping cost is high due to stage pumping, BH pumping can be adopted, if feasible, which would result in savings in cost of pipes, cables and power. Similarly, norms shall be developed for consumables (POL, Wire ropes, Roof bolts, Cement capsule etc.) corresponding to the mining technology in use (reference to be made to the K Kapila recommendations, with revisions).	Guidelines contained in Mitigation Action Plans	Action Taken Report	Quarterly	GM (Production), Subsidiary Companies & CIL

SNo	Activity Description	Input	Output	Frequency	Responsibility
	5. Reduction of Area Overheads & avoidable expenditure: Rationalization of Areas (wherever feasible / unless geographically far apart), shall be done to reduce Area overheads. Avoidable expenditures (power theft, OT, etc.) shall be identified and minimized. 6. Workload for time rated workers shall be considered. Currently NCWA specified work load for piece rated workers (such as coal loaders) are in practice. 7. Cost Sheet modifications for cost control: Necessary modifications shall be made to the cost sheet formats for better decision making [such as segregation of fixed and variable costs (e.g. for power), functional costs (strata control, blasting, pumping, ventilation, etc.), segregation of manpower costs for actual mining UG operations and surface workmen, etc.]	Guidelines contained in Mitigation Action Plans	Action Taken Report	Quarterly	GM (Production), Subsidiary Companies & CIL

SNo	Activity Description	Input	Output	Frequency	Responsibility
	8. Focus on marginally loss-making mines: In 2016-17, there were 251 loss making UG mines across 6 Subsidiaries & NEC. Out of these, in 59 mines, there was no production recorded. A feasibility assessment shall be made, and recommendations of prior feasibility studies implemented by each Subsidiary (such as through additional mechanization, manpower redeployment, etc.) shall be considered to convert the marginally loss-making mines into breakeven / viable state, in the short term to medium term.	Guidelines contained in Mitigation Action Plans	Action Taken Report	Quarterly	GM (Production), Subsidiary Companies & CIL
2	Each Subsidiary company shall be required to prepare and present a comprehensive plan to CIL in terms of the measures to be taken for improving efficiency and reducing costs of operations and unsafe geo-mining conditions of the mine.	Guidelines contained in Mitigation Action Plans	Action Taken Report	Quarterly	GM (Production), Subsidiary Companies & CIL

4.7 SOP for implementation guidance of mitigation plans for minimization of competition risk from Commercial Mining & Alternate energy sources (renewables)

SNo	Activity Description	Input	Output	Frequency	Responsibility
1	Establishment of an online platform for coal trading / transactions for spot / forward auction of coal by Subsidiaries	Inputs for RFP formulation Mine-wise coal grade information Coal Inventory information	Design, development and implementation of the platform Identified list of mines to be put up in spot & forward auction	One time	Director (Sales & Marketing) / GM (Sales & Marketing), CIL
2	Increase cost competitiveness by evaluating steps for cost reduction particularly through: 1. reducing number of labour intensive mines, and 2. periodic review of R&R policy for reducing total manpower	Feasibility Study R&R Policy document	Feasibility Study Report Revisions to R&R Policy	Annually	Director (Sales & Marketing), CIL
3	Enable coal gasification of up to 100 MT of coal by 2030 under PPP/ Private mode	Feasibility Study	Feasibility Study Report	One Time	Board of CIL

SNo	Activity Description	Input	Output	Frequency	Responsibility
4	Increase ash utilization in coal mine filing, collaborate and develop necessary frameworks, infrastructure and cost sharing mechanisms	Information on existing state of ash filling in mines of CIL	Establishment of a co-ordination committee involving MoC, MoP, MoEF and MoR	One Time	Director (Sales & Marketing) / GM (Sales & Marketing), CIL
5	Create joint forum of key power developers and coal mining companies to undertake investment in R&D for Carbon Capture and Sequestration (CCS) and coal washing technologies in India	Research on carbon capture and CCS technologies in use globally	Establishment of the Joint Forum	One Time	Board of CIL

Section 5:

Risk Management Calendar

The following 'Risk Management Activity Calendar' recommends the timelines when the risk management activities shall be undertaken by Coal India Limited:

Timeline / Activity	April	May	June	July	August	September	October	November	December	January	February	March
Risk Assessment												
Risk Competence Scan/ Concurrent Risk identification and prioritisation						For 1st half year (to be completed wihtin one month)						For 2nd half (To be completed within 15 days of the month)
Risk Mitigation												
Annual Risk Mitigation						For 1st half year (to be completed wihtin one month)						For 2nd half (To be completed within 15 days of the month)
Concurrent Risk Mitigation	Round the year (Status to be reported to the RMC by the 25th of the month immediately after the end of each quarter)											
Monitoring												
Periodic Monitoring by Risk Management Committee(RMC)	For 2nd half to be reviewed by RMC						For 1st half to be reviewed by RMC					
Board meeting to review annual risk assessment and mitigation results		To be presented to the BOD for review and consideration										

Thank You

<End of Report>

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Ref No.CIL:XI(D):04112:2019: 22438 Dated 15th Jan.'2019

To
GM(Environment),
Coal India Limited,
3rd Floor, New Town,
Rajarhat, Kolkata – 700 156.

Sub: Minutes of 377th CIL Board Meeting held on 20th December'2018.

Reproduced below is the relevant extracts from the minutes of 377th meeting of Board of Directors of Coal India Limited held on 20th Dec.'2018 at CIL (H/Q), New Town, Kolkata with regard to the following item:

"ITEM No.377:4(C)

Sub:- Risk Management Framework at CIL (Enterprise Risk Management, ERM, Phase-II)

4.3 Director(Technical) apprised the Board that in the 18th Risk Management Committee of CIL held on 12th October'2018, the Committee had recommended Risk Management framework for Coal India Limited (ERM on Phase-II) for consideration in the Board Meeting. This Risk Management Framework is prepared as required under SEBI(LODR) Regulations. Thereafter GM(Env.) made presentation.

Board observed that ECL and BCCL are still in their revival paths and might not have sufficient resources for redemption of preference shares. Hence Board advised to consider other alternatives as per the provisions of the Companies Act,2013. The Board also advised the consultant of CIL viz., M/S E&Y to submit detailed Standard Operating Procedures duly signed by the concerned executive against each Risk That Matters. Board also observed that payment to consultants should be made only after submission of Standard Operating Procedures against each Risk That Matters as highlighted in the Risk Management Framework.

With these observations, after detailed deliberations, Board accorded its approval to the Risk Management Framework of Coal India Limited as brought out in the agenda note."

This is for your information and taking necessary action please.

Yours faithfully,

15/1/19

(M.Viswanathan)
Company Secretary

Dr. I/C (Env.) – to circulate to all HoDs for needful 17/1/19