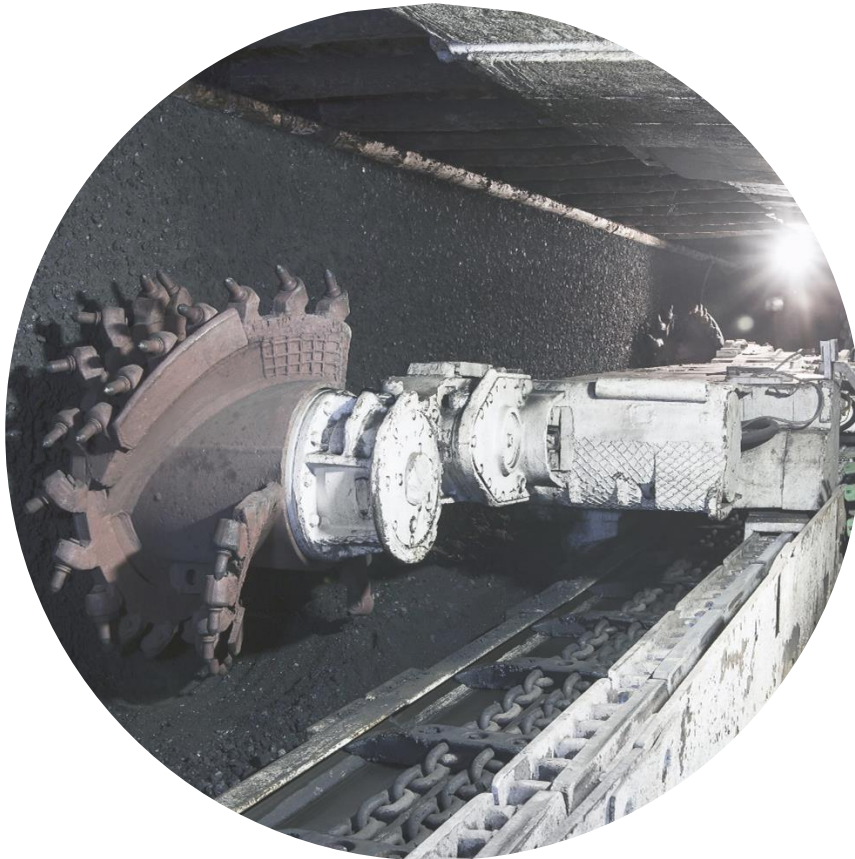




**Coal India Limited**  
A Government of India Undertaking  
A Maharatna Company



## UMANG 2023 – Underground Mining: Augmentation, New initiatives & Ground Breakings

Organized by IMMA Kolkata Chapter & Supported by CIL

Key summary notes

23<sup>rd</sup> December 2023

# About Coal India Limited

Coal India Limited (CIL) as an organized state owned coal mining corporate came into being in November 1975 with the government taking over private coal mines. With a modest production of 79 Million Tonnes (Mt) at the year of its inception CIL today is the single largest coal producer in the world. Operating through 82 mining areas CIL is an apex body with seven wholly owned coal producing subsidiaries and one mine planning and Consultancy Company spread over eight provincial states of India. CIL also fully owns a mining company in Mozambique christened as 'Coal India Africana Limitada'. It has core competence across the entire gamut of the coal business value chain. The business domain includes exploration, planning and design of mines, coal mining operations, coal beneficiation and marketing. CIL meets 42% of the nation's primary energy demand and caters to more than 83% of the nation's coal requirement.

CIL having fulfilled the financial and other prerequisites was granted the Maharatna recognition in April 2011. It is a privileged status conferred by Government of India to select state owned enterprises in order to empower them to expand their operations and emerge as global giants. So far, the select club has only seven members out of around 300 Central Public Sector Enterprises in the country.

CIL encompasses the whole gamut of identification of coal reserves, detailed exploration followed by design and implementation and optimizing operations for coal extraction in its mines. The subsidiary companies of CIL are:

1. Eastern Coalfields Limited (ECL), Sanctoria, West Bengal
2. Bharat Coking Coal Limited (BCCL), Dhanbad, Jharkhand
3. Central Coalfields Limited (CCL), Ranchi, Jharkhand
4. South Eastern Coalfields Limited (SECL), Bilaspur, Chhattisgarh
5. Western Coalfields Limited (WCL), Nagpur, Maharashtra
- Northern Coalfields Limited (NCL), Singrauli, Madhya Pradesh
7. Mahanadi Coalfields Limited (MCL), Sambalpur, Orissa
8. Coal India Africana Limitada, Mozambique (A foreign subsidiary)
9. The consultancy company is Central Mine Planning and Design Institute Limited (CMPDIL), Ranchi, Jharkhand.

CIL's strategic objective is to increase its mining capacities calibrated to the growing industry demands, and expansion of its customer base by growing its supply and consumer base, meanwhile aggressively explore diversification of its sectoral and product portfolio. In pursuit of diversifying its business interest, CIL has identified sectors aiming to establishing its industry leading presence across the Coal value chain from Production (augmenting production and strategic acquisition of assets), to Logistics to consumption (Power and other cleaner forms of coal consumption such as coal to chemical, etc.) Besides, CIL is also exploring the scope of diversification into areas of metal mining, power generation, renewable energy and coal gasification.

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# Abbreviations

Abbreviation	Description
Rs.	Indian Rupee
%	Percentage
BCCL	Bharat Coking Coal Limited
BHU	Banaras Hindu University
BT	Billion Tonnes
CBM	Coal Bed Methane
CCL	Central Coalfields Limited
CCDA	Councilor Constituency Development Allocation
CIL	Coal India Limited
CMD	Chairman-cum-Managing Director
CTL	Coal To Liquid
ECL	Eastern Coalfields Limited
GST	Goods and Service Tax
IIT	Indian Institute of Technology
ISM	Indian School of Mines
MDO	Mine Developers and Operators
MoC	Ministry of Coal
MT	Million Tonnes
NCL	Northern Coalfields Limited
NPV	Net Present Value
OEMs	Original Equipment Manufacturers
PSLW	Powered Support Longwall
PWBP	Protective Water Barrier Pillars
R&D	Research & Development
SCCL	Singareni Collieries Company Limited
SECL	South Eastern Coalfields Limited
UG	Underground
UCG	Underground Coal Gasification
WCL	Western Coalfields Limited

# 1 Introduction

## 1.1 Background and Context

Coal India Limited (CIL) is the largest coal mining company in the world, and it accounts for more than 80% of India's coal production. CIL is focusing on capacity augmentation, the introduction of alternate market structures, and potential diversification prospects and opportunities. Such strategic pursuits will help CIL in reducing its dependency on the coal business and ensure a sustainable source of income from other businesses.

While the core objective of the mining sector remains unchanged going forward: to extract and provide coal, metals and minerals to downstream sectors, many factors that have influenced how mining companies manage their sustainable development goals and responsibility to the society, have shifted in the recent years. There is an opportunity for the mining industry to reorganize, generate new value, and forge partnerships to create a more responsible and attractive future for the industry.

Coal has played a pivotal role in powering the nation's growth & has been the cornerstone of the country's energy needs. However, as a new era of sustainable progress is embarked upon, it is crucial that the future is aligned with environmental responsibilities.

Recognizing the need to evolve, Coal India Limited prepared its Underground Coal Mining Vision, which was released by the Hon'ble Cabinet Minister for Coal, Mines & Parliamentary Affairs, Shri Prahlad Joshi in June 2023. As part of the vision, CIL plans to produce 100 MT coal from underground mines by FY2027-28 and ramp it up to 125 MT by FY2029-30. The vision plan encompasses infusion of cutting-edge technology, sustainable practices, and a commitment to environmental stewardship. The vision for underground coal mining is rooted in the understanding that transitioning from surface mining to underground mining can have multifaceted benefits. Underground mining minimizes the impact on local ecosystems and reduces the carbon footprint associated with coal extraction. By minimizing the ecological impact associated with surface mining, mitigation of land degradation, reduction of water pollution, improvement in the air quality of coal mining areas and preservation of biodiversity is possible. The vision stands as a testament to the determination to strike a harmonious balance between economic growth and environmental preservation.

Against the backdrop of the present scenario, an international seminar on Underground Mining: Augmentation, New Initiatives & Groundbreakings (UMANG 2023) was organized by the Indian Mine Managers' Association (IMMA) and supported by Coal India Limited (CIL). This significant event took place at Coal Bhawan, New Town, Kolkata, on the 23rd of December 2023, in commemoration of the centenary year of the establishment of IMMA.

The underground coal mining sector faces a multitude of challenges that impede its growth. Addressing these challenges requires the urgent development of a conducive ecosystem, encompassing strategic policy decisions, the promotion of indigenous manufacturing, cultivation of in-house expertise, and the creation of a technically skilled workforce. Additionally, the acquisition of expertise in state-of-the-art technologies is imperative for India. The indigenization of equipment assumes a pivotal role in fostering underground mechanization, facilitated by the introduction of Continuous Miners, Highwalls and Powered Support Longwalls (PSLW), among other innovations. Recognizing the critical need for comprehensive solutions, IMMA has taken the initiative to organize the UMANG 2023 international seminar with support from Coal India Limited, marking a pivotal step towards addressing and overcoming the challenges faced by the underground mining sector.

## 1.2 Principal Objectives of the Seminar

The impetus behind hosting UMANG 2023, a gathering etched in the annals of underground mining exploration, was anchored in a deliberate focus on transformative themes. The seminar, conceived as a crucible of forward-thinking, unfolded against the backdrop of two central pillars: Mass production technologies and Safety and environment management in the realm of underground mining.

In the context of Mass Production Technologies, the seminar sought to unravel the complexities and innovations that define the future of underground mining. Participants, comprising industry leaders and innovators, immersed themselves in discussions not just to adopt technologies but to redefine the very fabric of underground mining practices. The central theme aimed at fostering an environment where the industry could collectively envision and pioneer new methodologies for enhanced productivity and operational efficiency beneath the Earth's surface.

Safety and Environment Management stood as a lodestar in the seminar's agenda, emphasizing strata control, mine ventilation, and related aspects in the unique context of underground mining. Deliberations encompassed the nuances of ensuring safety below the surface, with a keen eye on the environmental impact. Discussions on the imminent arrival of commercial mining, Mine Developers & Operators, and the exploration of Revenue Sharing models underscored the seminar's commitment to proactively addressing challenges while charting the trajectory for sustainable practices in underground coal mining.

The theme of advanced global technologies embraced a global perspective, weaving in insights from international experts hailing from Australia, South Africa, Poland, and beyond. The seminar, as a melting pot of ideas, facilitated a collective understanding of challenges and prospects associated with the adoption of advanced technologies in underground mining. The spotlight on emerging blasting technologies for both underground and opencast mines underscored the forward-looking ethos ingrained in the seminar's design.

Within the seminar's context, the collective commitment towards environment restoration took on a profound significance. It was not just about acknowledging environmental challenges but actively seeking solutions and establishing best practices for responsible underground mining. The seminar, therefore, stood as a rallying point for the industry's dedication to harmonizing underground mining operations with environmental stewardship.

The final thematic pillar, innovation & digital mining solutions, served as the heartbeat of the seminar. Here, the focus was not merely on outcomes but on nurturing a transformative mindset. Discussions on Research & Development (R&D) and the integration of automation and digital solutions in the unique context of underground (UG) mining embodied the seminar's aspiration to be a crucible for innovation, pushing the boundaries of what's achievable in underground coal mining.

In essence, the seminar was a deliberate exploration into the future of underground mining, where the chosen themes were not outcomes but guiding lights illuminating a path toward a more innovative, safe, and environmentally conscious underground mining industry.



## 2 Proceedings of the Conference

### 2.1 Inaugural Session

The inauguration session commenced with the traditional lighting of the lamp and felicitation of dignitaries. Shri K N Singh, President of IMMA, delivered the welcome address. This was followed by insightful speeches from

1. Shri P M Prasad, Chairman-cum-Managing Director (CMD), CIL
2. Dr. B Verra Reddy, Director Technical, CIL & CMD, CCL.
3. Shri Samiran Dutta, CMD BCCL.

The formal inauguration of the seminar occurred with the release of the UMANG 2023 Souvenir, featuring an address Shri N C Jha, Former Chairman of CIL, followed by a vote of thanks for the session by Shri R K Sharma, Honorary Secretary of IMMA.

The current section covers a brief layout of the address covered by each of the speakers.

#### **Shri K N Singh, President of IMMA**

The welcome address at the seminar was delivered by Shri K N Singh, President of IMMA. In his speech, he emphasized IMMA's steadfast dedication over the past century to advancing the science and art of mining. Noteworthy was the mention of IMMA's extensive efforts in organizing numerous nationwide seminars and workshops, serving as vital platforms for knowledge exchange and skill enhancement within the mining community. Furthermore, Shri K N Singh highlighted IMMA's active participation in various committees aimed at enhancing safety measures in mining environments, emphasizing the organization's commitment to fostering a secure and responsible mining industry. The address also outlined IMMA's alignment with the ambitious goal set by the Government of India to produce 100 million metric tons of coal from underground mines by 2028. To achieve this objective, the association proposed the adoption of mass production technology, signaling a strategic and innovative approach to meet the evolving demands of the industry.

#### **Shri Samiran Dutta, CMD, BCCL**

In the inaugural session the second address was delivered by Shri Samiran Dutta. He brought attention to the importance of coal in ensuring the energy security of the nation. He also stressed upon the need for rapid scaling up of underground production as a means to incorporate sustainability in coal mining operations. His address also focused on adoption of mass production technologies and digital technologies to increase productivity and output from underground projects. Shri Dutta also stressed upon the environmental benefits of underground mining. He congratulated the Director (Technical) and CIL team for coming out with the Underground Vision Plan of CIL. Further, he enumerated the various initiatives undertaken at BCCL including the progress of development of XV Seam at Moonidih and other identified projects of Block-II, Rajapur and Benidih for further introduction of mass production technologies. He hoped that the projects undertaken by BCCL along with the projects taken up by various other subsidiaries of CIL will spur technological advancements and innovation in underground coal mining.

### **Dr. B Verra Reddy, Director Technical, CIL & CMD, CCL**

During the inaugural session, the third address was delivered by Dr. B Verra Reddy, Director Technical at CIL, who is also holding additional charge as the CMD, CCL. Dr. Reddy, in his insightful address, brought attention to NITI Aayog's forecast, envisioning the nation's net coal production surpassing 1.5 BT in the near future and maintaining consistency until 2047. He acknowledged India's continued reliance on coal until achieving developed status and stressed the necessity of sustainable mining operations, particularly focusing on underground (UG) mining, for the next 2-3 decades.

Dr. Reddy emphasized the importance of learning from past failures, positioning sustainable UG mining as an imperative, and aligning practices with global standards observed in countries like China and the USA. Addressing the financial aspects of UG mining, he suggested potential incentives, such as a 50% rebate on revenue for commercial mining, recognizing the significant investment required for infrastructure development in UG mining. Advocating for the adoption of continuous miners over longwall technology, he underscored the commitment towards technology infusion as evidenced from drawing parallels with China's practices such as extraction of coal from seams of 18 to 20 meters.

The challenges associated with obtaining statutory clearance for open-cast mining were acknowledged by Dr. Reddy, who highlighted UG mining's strategic advantage in this context. Under the "Make in India" initiative, he encouraged the development of indigenous manufacturers for UG equipment to foster a competitive market. In conclusion, Dr. Reddy expressed anticipation for key recommendations to emerge from the seminar, propelling UG mining forward.

### **Shri P M Prasad, Chairman-cum-Managing Director (CMD), CIL**

In his address, Shri P M Prasad, Chairman of CIL, provided insights into the historical adoption of longwall technology by Singareni Coalfields Collieries Ltd. (SCCL) almost three decades ago. He highlighted the persistent concern of fire incidents in underground (UG) mining, citing the dedicated fire rescue operations conducted in the Wardha Valley of WCL for an extensive period of 6 to 7 months. Shri Prasad underscored the significant potential of continuous miners in UG mining, expressing that with commitment from mine managers, up to 20 continuous miners could be deployed within 1 to 1.5 years. Noting that India is yet to master longwall technology, he reflected on the historical shift in UG mining, with UG operations dominating in 1985-86, but later experiencing a substantial decline. Shri Prasad acknowledged India's status as the third-largest startup hub globally, foreseeing the positive impact of startups engaging in continuous miner manufacturing for the nation and other innovations in underground mining. He congratulated the various projects in India which has already adopted mass production technologies (MPTs) and expressed confidence in the success of the upcoming Moonidih longwall seam. Emphasizing the crucial role of academic institutions, he urged them to actively contribute to the success of UG mining in the country.

### **Shri N C Jha, Former CMD, CIL**

In his address to the seminar, Shri N C Jha, articulated a comprehensive vision for advancing coal mining practices in India. He advocated a strategic focus on paste fill technology to enhance coal extraction efficiency under Indian mining conditions. Emphasizing the significance of India's position as the third-largest startup hub, he underscored the need for a robust startup ecosystem to drive indigenous manufacturing development in the mining sector. Shri Jha stressed the dedication and commitment required from each mine manager to achieve underground (UG) mining targets. Given coal's substantial contribution to India's primary energy needs, he acknowledged the country's continued reliance on coal for the next two decades. Shri Jha also highlighted the challenge of bridging the considerable gap between global and domestic UG coal production, with India's coal reserves totaling approximately 360 BT. The deployment of continuous miners, shortwall, and longwall technology was recommended, contingent upon a thorough site study. For regions with high fault density, shortwall technology was favored, while greenfield mines were advised to consider promoting 100-

meter longwall technology. Shri Jha proposed a cost-effectiveness assessment of backfill technology, suggesting potential government assistance through GST CESS or CCDA funds. Additionally, he advocated for the promotion of paste fill technology, commonly used in metal mines, for coal mining applications. Stressing the importance of a scientific study in backfield areas, he concluded by recognizing the crucial role of mine rescue operations and recommended incentivizing trained personnel in this field.

### **Shri R K Sharma, Honorary Secretary, IMMA**

In his vote of thanks during the inaugural session, Shri R K Sharma, the honorary secretary of IMMA, expressed gratitude and highlighted key points from the speeches, focusing on underground (UG) mining, BCCL venturing into Mine Development Operator (MDO) scope in UG mining, and the integration of artificial intelligence in UG mining. He acknowledged the significance of UG mining in shaping the future of the industry, emphasizing the commitment required for its successful implementation. Shri Sharma specifically commended BCCL for its venture into MDO scope in UG mining, recognizing the potential impact on operational efficiency and sustainable practices. Additionally, he underscored the transformative role of artificial intelligence in UG mining, highlighting its potential to enhance safety, efficiency, and decision-making processes. Shri R K Sharma's remarks conveyed appreciation for the insights shared during the session, acknowledging the advancements and initiatives discussed that contribute to the evolving landscape of underground mining in India.

## **2.2 Technical Session I**

The technical session-I was chaired by Shri. N C Jha, Former Chairman CIL and Co- Chaired by Shri. A Ghatak, Director (T/RD&T), CMPDI. The session featured the following primary speakers who put forward their views on the various prospects of Underground Mining in India:

1. Dr. B Veera Reddy, Director (Technical) CIL and CMD, CCL.
2. Dr. Manoj, CSIRO Australia.
3. Shri. Ajay Kumar Sharma, Area General Manager, Pandaveswar Area, ECL.
4. Shri. K Nageswara Rao, Agent, SCCL.

The current section covers a brief layout of the address covered by each of the speakers. The detailed presentations made by the various speakers are available with Coal India Limited (CIL).

### **Dr. B Verra Reddy, Director Technical, CIL & CMD CCL**

Dr. B Verra Reddy delivered a comprehensive address, shedding light on the global landscape of coal production with a specific focus on India's underground mining scenario. Highlighting a stark contrast, Dr. Reddy emphasized that while major coal producers worldwide predominantly rely on underground mining methods, India's contribution to this method stands at a modest 4% over the past two years. Addressing the challenges hindering the growth of underground coal mining in India, he underscored safety concerns, lower productivity, and the absence of mass production technologies and skilled manpower. Dr. Reddy projected a significant shift towards underground mining due to a decline in open-cast production, and he identified several enablers for this transition. Stressing the importance of sustainable growth in the Indian coal sector, he presented CIL vision to scale up underground coal production to 100+ MT. The way forward, as articulated by Dr. Reddy, involved seeking assistance in re-categorization, permissions, reimbursement of costs, and policy support, showcasing a holistic approach for the holistic development of the underground coal mining sector in India.

### **Dr. Manoj, CSIRO Australia**

Dr. Manoj delivered a captivating address, delving into the application of numerical modeling methods for estimating the height of connective fractures during underground mining. He underscored the significance of well-calibrated models, emphasizing their ability to provide valuable insights into the development of connective fractures in the intricate underground mining process. Dr. Manoj highlighted the challenges associated with large-scale simulations induced by mining activities, acknowledging their complexity while also recognizing the promise they hold in offering a deeper understanding of water flow pathways and potential aquifer interference. Notably, he presented simulations conducted to estimate the magnitude of permeability increases, and the height of fractures derived from these simulations demonstrated a remarkable agreement with data reported in the mine reports where the simulations were conducted. This alignment between simulation results and real-world data showcased the efficacy and reliability of numerical modeling methods in predicting and understanding connective fractures in underground mining scenarios.

### **Shri. Ajay Kumar Sharma, Area General Manager, Pandaveswar Area, ECL**

In his presentation, Shri. Ajay Kumar Sharma eloquently briefed on the imperative need for the modernization of underground (UG) coal mines through the incorporation of mass production technology. He highlighted the environmental challenges associated with open-cast mines, including land degradation, impact on flora and fauna, as well as air and noise pollution. With shallower coal deposits expected to last for only another 20 to 25 years, Mr. Sharma underscored the urgency of developing mechanized underground coal mines for mass production in India. He emphasized the essential role of research and development (R&D) and skill development in achieving this objective, calling for concerted efforts in planning numerous mechanized faces. Encouraging indigenous manufacturers to produce cost-effective equipment and resolving service and spare parts issues were identified as key steps towards realizing the goal of Coal India Limited (CIL) to achieve 100 MT from underground coal mines by 2027-28. Mr. Sharma advocated for a balanced approach, ensuring that the ratio of coal production from underground mines aligns with international standards, ultimately securing the country's coal import independency. Moreover, he highlighted the inherent safety benefits of mechanized mines, emphasizing their higher productivity with minimal human resource engagement at hazardous sites. As India progresses in adopting modern technologies, Mr. Sharma's presentation underscored the importance of striking a harmonious balance between technological advancements, environmental concerns, and safety considerations in the future of underground coal mining.

### **Shri. K Nageswara Rao, Agent, SCCL**

Shri. K Nageswara Rao delivered a comprehensive address, focusing on the successful implementation of Longwall mining as a mass production technology in the Adriyala Longwall Project operated by Singareni Collieries Company Limited (SCCL) in Telangana, India. Shri Rao highlighted the critical role of coal-fired thermal power plants in meeting the country's energy demands, with opencast mines currently contributing 96% of total coal production. To supplement opencast production, he emphasized the necessity of higher coal production from underground mines, identifying Longwall mining as a crucial option, especially for deep seams. The paper provided a detailed account of the Adriyala Longwall Project, a high-capacity operation with a 2.81 MTPA production rate. He discussed the technologies adopted, salient features, challenges faced, and outlined the future trajectory of the project. A notable achievement highlighted in the presentation was the introduction of a wider longwall face, operating at 250 meters, a first in the Indian longwall mining landscape. Additionally, he discussed the success of two longwall panels with a unique geometry of 250 meters in width and 2500 meters in length, and the ongoing progress of a third longwall panel with similar specifications, showcasing the project's advancements and contributions to achieving higher coal production from underground mines in India.

## 2.3 Technical Session II

The technical session-I was chaired by Shri. Smarajit Chakrabarti, Former CMD, ECL and Co- Chaired by Shri. Niladri Roy, Director (Technical/ Operations), ECL. The session featured the following primary speakers who put forward their views on the various prospects of Underground Mining in India:

1. Shri. Anuj Kumar, Project Officer (PO), Churi, CCL.
2. Shri Sunny Rao, Manager, Moonidih Project, BCCL.
3. Shri. Suraj Prakash, CEO, TEXMIN Foundation IIT (ISM), Dhanbad.
4. Prof. GSP Singh and Dr. Ankush Galav (Research Associate), IIT BHU.

The current section covers a brief layout of the address covered by each of the speakers. The detailed presentations made by the various speakers are available with Coal India Limited (CIL).

### **Shri. Anuj Kumar, Project Officer, Churi, CCL**

Shri. Anuj Kr presented a compelling address focusing on the successful introduction of mass production technology in the Churi Underground Mine, outlining a strategic initiative aimed at reviving a less productive mine. The implementation of this technology resulted in a significant improvement in production levels, marking a transformative shift for the mine. One notable achievement highlighted by Shri. Anuj Kumar was the initiation of depillaring activities, targeting long-standing pillars to enhance the overall efficiency of the mining process. A remarkable outcome of this technological upgrade was the substantial reduction in manpower, with the workforce decreasing from an average of 2000 individuals to just 350. This not only attested to the efficiency gains brought about by mass production technology but also underscored the economic benefits of such advancements. Additionally, he emphasized that the introduction of this technology led to a noteworthy enhancement in safety standards at the Churi Underground Mine, further solidifying the positive impact of the strategic approach to revive and modernize the mine.

### **Shri Sunny Rao, Manager, Moonidih Project, BCCL**

In his presentation, Shri Sunny Rao provided a comprehensive overview of the geo-technical assessment of XV Seam at Moonidih Colliery, delving into the multifaceted challenges encountered in mining operations. Emphasizing the multidimensional aspects of planning and operational hurdles, the presentation shed light on the persistent geotechnical challenges posed by poor roof conditions, leading to frequent strata issues. The exploration of on-field constraints and their impact on production targets highlighted the critical need for optimized strata stabilization and ventilation strategies. The conclusion drawn from the studies underscored the valuable insights gained in ventilation planning, strata control, and stress measurement. However, the address acknowledged the persisting challenges, particularly in roof conditions, and proposed a new support design to address the unique geotechnical challenges of XV Seam. The reassessment of air quantity in proposed panels, considering changes in gallery dimensions, was identified as crucial to mitigate pressure drop and gas hazards. Shri Sunny Rao concluded by stressing the need for a comprehensive assessment of mine planning to ensure safe operations at great depths, emphasizing the importance of unlocking the mining potential of coal extraction while addressing challenges related to geology, heat, humidity, and methane gas mitigation.

### **Shri. Suraj Prakash, CEO, TEXMIN Foundation IIT (ISM), Dhanbad**

Shri. Suraj Prakash delivered an insightful address, providing an overview of the successful implementation of Mining 4.0 in the Indian mining industry and showcasing the achievements within the innovation and startup ecosystem. He

highlighted the noteworthy visits of the Hon'ble Minister of Parliamentary Affairs, Coal and Mines, Shri Pralhad Joshi, , and Shri V. L. Kantha Rao, IAS, Secretary to the Government of India, Ministry of Mines, at TEXMiN. During these visits, there was a fruitful exchange of feedback on the implementation of 3S Mining (Safe, Smart, and Sustainable Mining) to enhance the mining value chain. The speaker also emphasized the importance of implementing Mining 4.0 through the startup ecosystem and encouraged advancements in mineral exploration, including the development of modern and sophisticated exploration methods. Notable technologies presented during the address included research on cloud-based geospatial data processing, 3D holographic solutions for mines, tracking solutions, digital mining infrastructure, graphene-based nano-research, sensor-based tracking, and various innovations such as automated guided vehicles and mine-specific solutions. Shri. Suraj Prakash also showcased TEXMiN's commitment to advancing the mining sector through cutting-edge technologies and collaboration with the startup ecosystem.

#### **Prof. GSP Singh and Dr. Ankush Galav (Research Associate), IIT BHU**

In their presentation, Prof. GSP Singh and Dr. Ankush Galav focused on the critical issue of designing protective water barrier pillars (PWBP) for enhanced safety and productivity in underground coal mines, addressing the threat of inundation from waterlogged workings. The objective of their work was to develop scientific criteria and guidelines for designing PWBPs, considering different geo-mining conditions and varying strength and flow regimes. The study delved into examining loading and failure mechanisms, understanding the mechanical and hydraulic performance of PWBPs with changes in water head, and assessing the rational size of barrier pillar width under diverse conditions. The conclusion highlighted the inadequacies of the existing pillar design approach and emphasized the importance of controlling water head to meet the requirement of a controlled seepage rate. The research-based guidelines provided insights for rational design, offering potential solutions to avoid mine flooding and ensuring the adequacy of existing barriers in the face of water head variations. The findings underscored the significance of a systematic and scientific approach to enhance safety and productivity in underground coal mining operations.

## **2.4 Technical Session III**

The technical session-I was chaired by Shri. M P Dikshit, Former CMD, SECL and Co- Chaired by Shri. S K Singh, Former Chief Scientist, CIMFR. The session featured the following primary speakers who put forward their views on the various prospects of underground mining in India:

1. Shri. Tushar Chakraborty, Director, Deloitte.
2. Shri Raghunath TVSK, Deputy General Manager Hexagon.
3. Shri. Karthik Shankar, GTS Ltd.
4. Dr. S Samanta, Senior Officer (Mining), ECL.
5. Md. Amjath Basha, Dassault.
6. Shri. Bikram Kumar, Chief Manager (CMC), BCCL.
7. Shri. Amar Bhasin, Valley Longwall International.

The current section covers a brief layout of the address covered by each of the speakers. The detailed presentations made by the various speakers are available with Coal India Limited (CIL).

#### **Shri. Tushar Chakraborty, Director, Deloitte**

In his presentation, Shri. Tushar Chakraborty provided a comprehensive overview of the global energy outlook and the future of the coal sector in India, with a detailed analysis of commercial coal block auctions, key challenges faced by

commercial coal miners, opportunities, and the way forward. He emphasized four dominant trends shaping the global energy landscape: a declining role for hydrocarbons, rapid expansion in renewables, increasing electrification, and growing use of low carbon hydrogen. Notably, India's per capita energy consumption remains below leading nations. Mr. Chakraborty highlighted that coal-based generation in FY23 rose by 10.1%, reaching 1145.86 BU, with the total generation growing by 9% YoY and projected an estimated electricity generation of 2451 to 2742 BU for FY30, with the share of coal expected to decline from 71% to 62% by FY30 but with an increase in the absolute quantity. The commercial coal block auctions in 2020 marked a significant shift, opening the sector to private sector investment. He emphasized the potential growth in the non-regulated sector, driven by modern practices and digitization brought about by Mine Developer and Operator (MDO) partnerships. He stressed the importance of focusing on modern practices in Underground Coal Gasification (UCG), Coal-to-Liquid (CTL), and Coal Bed Methane (CBM) to reduce dependence on crude oil and natural gas imports. Capacity building and skill development were identified as key areas of focus and opportunities for Original Equipment Manufacturers (OEMs), academic institutes, and foreign players. Mr. Chakraborty concluded by underlining the ongoing significance of coal as a dominant source of energy for the next couple of decades, provided there is a greater emphasis on cost competitiveness, quality consistency, and substitution for imported coal in India's energy mix.

### **Shri Raghunath TVSK, Deputy General Manager, Hexagon**

In his presentation, Shri Raghunath TVSK provided a comprehensive overview of the digital solutions delivered by Hexagon in the mining sector, offering a holistic suite of tools that cater to various stages of the mining process. Hexagon's Mine Plan solution encompasses everything required by an exploration geologist for storing, managing, and analyzing drillhole data. The modeling component facilitates geological interpretation and accurate block modeling of deposits. The design tools offer 3D visualization and engineering CAD capabilities for open-pit, underground, and quarry operations, focusing on optimization and design. Scheduling involves optimization through haulage and activity-based Gantt-chart scheduling, while the Production segment introduces rapid, integrated, and standardized software for grade control, production planning, and reconciliation. In the realm of Mine Operation, Hexagon's Fleet Management solution aids in tracking all assets, Machine Guidance provides high-precision guidance for various equipment, Fragmentation Analysis improves process efficiency, Asset Health serves as a machine health platform with sensor and alarm information, and Operator Assist integrates solutions to help operators find the optimum reversing path for trucks. This comprehensive suite reflects Hexagon's commitment to providing advanced digital solutions that enhance efficiency and productivity across the entire mining operation lifecycle.

### **Shri. Karthik Shankar, GTS Ltd.**

In his presentation, Shri. Karthik Shankar provided a comprehensive overview of the digital transformation initiatives for the Indian mining industry by GTS Limited, emphasizing practical Net Present Value (NPV)-based strategic planning. The presentation covered various aspects of mining operations, starting with pit design and options for pit stage selection, best practice pit shell generation, and the determination of NPV-driven mining sequences. Simultaneous optimization and scheduling were addressed, incorporating constraints and hyper-tuning for cut-off grades, quality control, stockpiling, and blending. Fleet selection, simulation, and optimization, along with tactical planning for both long and short terms, were highlighted. The detailed mine plan outlined the mining sequence, activity-based costing, budget planning, and real-time production scheduling. Automation initiatives included a Fleet Management System for mining operations, Vehicle Intervention System for enhanced safety, Machine Guidance System for drills, dozers, and shovels, real-time fragmentation analysis, slope stability monitoring, operator training through virtual reality, and scheduling maintenance calls through real-time machine health monitoring. The presentation also emphasized continuous monitoring with IoT devices and smart sensors, environmental monitoring, cloud-based storage for sensor data,

predictive analytics for production processes, AI-driven analytics for dynamic operational adjustments, and blockchain for ethical mineral sourcing and enhancing transparency and accountability. Shri. Karthik Shankar concluded by highlighting the strategic decision-making capabilities enabled by digital twins, allowing for predictive simulations and addressing potential inefficiencies, bottlenecks, and pain points in the mining supply chain. The overall focus on leveraging digital technology for mining supply chain optimization was a key takeaway from the presentation.

#### **Dr. S Samanta, Sr. Officer (Mining), ECL**

Dr. S Samanta delivered an insightful presentation emphasizing the transformative impact of rapid technological development in the underground (UG) mining sector, specifically highlighting advancements in strata monitoring, paste filling techniques, and numerical modeling. Dr. Samanta underscored the role of artificial intelligence (AI) and machine learning in enhancing operational safety through live monitoring of strata conditions. This technological integration not only improves safety measures but also ensures real-time insights into the dynamic underground environment. In contrast, Dr. Samanta highlighted the environmental challenges faced by opencast miners, including land degradation, the impact on flora and fauna, and pollution of air and noise. The impending depletion of shallower coal deposits within the next 20-25 years further accentuates the need for sustainable alternatives and reinforces the urgency for embracing advanced technologies to ensure the future viability and safety of mining operations. The presentation aptly depicted the crucial role of technological innovations in shaping the future landscape of both underground and opencast mining.

#### **Md. Amjath Basha, Dassault**

In his presentation, Md. Amjath Basha provided a comprehensive overview of the digital transformation initiatives within the mining sector, shedding light on their portfolio and conducting insightful case studies for various clients in the underground (UG) mining domain. Basha highlighted the significance of embracing digital technologies to enhance operational efficiency, safety, and overall productivity in mining operations. The case studies presented were crucial in illustrating the practical applications and success stories of digital transformation, offering tangible insights into the positive outcomes achieved for different clients in the UG mining sector. By delving into these real-world examples, the presentation not only showcased the versatility of digital solutions but also emphasized their role in addressing specific challenges faced by clients in the mining industry. Basha's presentation offered a valuable perspective on how digital transformation is reshaping the landscape of UG mining and providing tailored solutions to optimize processes and outcomes for diverse clients in the sector.

#### **Shri. Bikram Kumar, Chief Manager (CMC), BCCL**

In his presentation, Shri. Bikram Kumar provided valuable insights into the concept of Mine Developer and Operator (MDO), elucidating how this business model operates within the mining sector. He further delved into the various forms of MDO operations, outlining the nuanced dynamics and potential pros and cons associated with each. By thoroughly examining the diverse modes of MDO, the presentation provided a holistic understanding of how this model can be tailored to meet the specific needs and goals of different mining ventures. Shri. Bikram Kumar's presentation contributed significantly to the understanding of MDO as a strategic framework in the mining sector, offering a comprehensive perspective on its operational intricacies and potential outcomes.



## Shri. Amar Bhasin, Valley Longwall International

In his presentation, Shri. Amar Bhasin provided valuable insights into the successful implementation of smart vehicles in operations at the Jharia project in Raniganj coalfield of Eastern Coalfields Limited (ECL). The presentation highlighted how these smart vehicles have significantly contributed to reducing the total travel time of workers within the underground mine while prioritizing safety. The inclusion of advanced safety features such as methane detectors and other safety amenities in the smart vehicles ensures a secure working environment for the miners. The use of alarm detectors for methane is particularly noteworthy, as it enhances the safety protocols in potentially hazardous underground conditions. By leveraging smart technology, the mine has not only improved operational efficiency by minimizing travel time but has also prioritized the well-being and safety of the workforce. Shri. Amar Bhasin's presentation underscored the practical and positive impacts of incorporating smart vehicles in mining operations, showcasing how technology can be harnessed to optimize productivity while ensuring a secure and efficient working environment.

## 2.5 Panel Discussion

The conference witnessed one panel discussion involving the various notable speakers of the conference and was moderated by Shri. Tushar Chakraborty, Director, Deloitte. The discussions of the panel revolved around the future roadmap of UG mining in India.

Table 1: List of Panelists & Topic for Panel Discussion

#	Panellist	Designation
Panel Discussion on <b>Future Roadmap of UG Mining in India</b>		
1	Dr. B Verra Reddy	Director (Technical), CIL & Chairman-cum-Managing Director, CCL (Additional Charge)
2	Shri. N C Jha	Former Chairman-cum-Managing Director, CIL
3	Shri. B N Pan	Former Chairman-cum-Managing Director, BCCL
4	Shri. Smarajit Chakrabarti	Former Chairman-cum-Managing Director, ECL
5	Shri. M P Dikshit	Former Chairman-cum-Managing Director, SECL

The panel discussion unfolded as an intellectual tapestry, weaving together multifaceted insights that cast a visionary light on the future of underground (UG) mining operations. At the core of these deliberations was the resounding call for the integration of cutting-edge technologies into the fabric of UG mining, highlighting their potential to revolutionize operational efficiency and foster sustainability. The discourse resonated with a shared understanding among panelists that the judicious infusion of technological advancements is not merely a choice but a necessity for the industry's evolution.

A recurrent theme throughout the discussion was the emphasis on collaboration as an engine for knowledge exchange and innovation. The panel recognized the interdependence among industry leaders, government bodies, and research institutions, portraying them as integral components of a collaborative ecosystem essential for propelling UG mining towards a technologically driven and sustainable future. The narrative shifted seamlessly to the crucial role of regulatory

support, portraying it as the linchpin for the sector's progression. The panel advocated for continuous support through robust policy frameworks and financial incentives, envisioning them as catalysts that would accelerate technological adoption and the incorporation of sustainable practices.

Environmental sustainability emerged as a cornerstone, with the panel engaging in thoughtful discussions around strategies and responsible mining practices. These considerations delved into ways to mitigate the ecological footprint of UG mining, reflecting a conscientious commitment to harmonize industrial activities with environmental preservation. The discourse then seamlessly transitioned to the critical importance of human resource development. Panelists underscored the significance of cultivating a skilled workforce through targeted skill-building initiatives, recognizing that a competent human capital is pivotal for steering the industry through evolving demands and technological advancements.

Addressing challenges head-on, the panel offered collaborative approaches as effective solutions. The spirit of unity and collective problem-solving underscored the industry's resilience and adaptability. The valedictory session, a culmination of these insightful discussions, provided a reflective platform. Expressing gratitude to participants, it underscored the pivotal role of collaboration, technological innovation, and sustainable practices in shaping the future trajectory of UG mining. The event stood not merely as a symposium but as a beacon illuminating a path towards a more sustainable, efficient, and technologically advanced UG mining industry.

Table 2: Summary of Major Insights from Panel Discussion

#	Focus Area	Insights
1	Integration of Technological Advancements	The panel highlighted the importance of integrating cutting-edge technologies to enhance efficiency and sustainability in UG mining operations.
2	Collaboration for Knowledge Exchange	Emphasis was placed on fostering collaboration among industry leaders, government bodies, and research institutions to facilitate knowledge exchange and technological innovation.
3	Regulatory Support	The need for continued regulatory support, including policy frameworks and financial incentives, to propel UG mining initiatives forward was emphasized
4	Environmental Sustainability	The panel discussed strategies for ensuring environmental sustainability in UG mining, considering the importance of responsible mining practices.
5	Human Resource Development	The role of skill development and human resource initiatives to meet the evolving demands of UG mining was highlighted, ensuring a competent workforce for the industry.
6	Addressing Challenges	The panel acknowledged the challenges faced by the UG mining sector and proposed collaborative approaches to address them effectively.

## 3 Key Outcomes from the Seminar

### 3.1 Background

UMANG 2023, stands as a testament to the collective pursuit of excellence in the field of underground mining. The event acted as a platform to bring together industry stalwarts, experts, and enthusiasts from across the globe to delve into an exchange of cutting-edge insights, innovative approaches, and emerging technologies that are reshaping the landscape of underground mining. With a primary focus on augmenting existing methodologies, introducing novel initiatives, and commemorating significant groundbreakings, UMANG 2023 aspired to foster a collaborative environment that will propel the industry towards sustainable growth and enhanced efficiency. Against the backdrop of a rapidly evolving mining landscape, this seminar promises to be a pivotal event, facilitating dialogue, networking, and knowledge-sharing among the trailblazers of the underground mining community.

### 3.2 Key Recommendations

#### **Rebate in revenue share (Bid Price) for UG mining**

- Incentivizing large scale underground mining through a rebate in revenue share/bid price up to 50% for coal blocks being auctioned for early operationalization and coal production would be beneficial for commercial miners. This would encourage companies to invest in underground mining, which is a more expensive and challenging process than open-pit mining. Underground mining also has a lower environmental impact.
- The rebate would help to offset the higher costs of underground mining and make it more competitive with open-pit mining. This would lead to an enhancement of number of underground mines being operated that finally would accrue several benefits:
  - Mining of coal in a socially and environmentally manner.
  - Gradual depletion of open castable coal at shallower depth shall compel increase in UG mine production
  - Reduced land acquisition for underground mines as compared to opencast projects. UG mining requires lower area on surface (~4 to 5 Ha.) which shall reduce R&R issues.
- Almost no land degradation, lower dust emissions, less deforestation and no impact on biodiversity and wildlife.
- Further, growth in UG mining shall be instrumental in extracting good quality coal lying in depths of more than 300 m with minimum contamination. This shall also aid in the substitution of imported coal in the country.

#### **Encouraging Make in India for sustained growth of equipment used in UG mining segment**

- The prohibitive cost of imported equipment along with long lead times for spare parts procurement contributes to a large extent in the non-viability of underground coal mining projects.
- The contribution of imported equipment is very high in the total project cost of UG mine and can thus be sustainable if the equipment used is produced domestically. Further the easy availability of spare parts for maintenance would obviate the downtime of machinery, loss of manhours and loss of revenue.
- Hence, it was recommended to encourage equipment manufacturers in from of Production Linked Incentive (PLI) schemes in line with other sectors such as automobiles, white goods, advanced cell chemistry batteries etc. or with the aid of capital subsidies. An indigenous manufacturing ecosystem shall be instrumental in rapid adoption of underground coal mining in the country.

### Enhanced use of Paste fill technology for better recovery

- Currently large quantity of good quality coal is available below the depth of 300 m and below dense surface features which can be mined with greater recovery without disturbing the surface or vicinity by using Paste fill technology. Paste fill technology is a relatively new method of filling mined-out areas in underground mines.
- Paste fill technology has several advantages over traditional methods of mine filling. It is more environment friendly. The slurry used in paste fill technology is a waste product from existing processes, i.e., fly-ash produced by power plants from burning of coal. Usage of fly ash generated from coal fuelled power plants is a challenge, which can be symbiotically utilized for paste filling technology in underground mines.
- As against traditional methods such as sand stowing, paste fill can be more effective in filling larger volumes of voids per unit time. Therefore, it is more compatible with use of mass production technology.
- The enhanced use of paste fill technology in mines can lead to several benefits, including:
  - Increased recovery of coal, which otherwise would have been lost or locked below surface features.
  - Paste fill method improves safety as it lends support to the roof/strata which otherwise caved in causing severe stress condition in the working area.
  - It is estimated to provide access to more than a billion tonne of coal in the country which includes high and very high-quality coal without effecting its surroundings.

### Introduction of Mass Production Technology (MPT)

- Mainly three types of mass production technology were focused upon: namely, Longwall, Board & Pillar with Continuous Miner and Highwall Mining.
- In longwall mining, coal is being extracted from a single faced panel of coal with a width of more than 150 m. It is a non-cyclic method where the flow the coal is continuous and is a method which is complies to total system safety.
- In the Indian conditions, which has traditionally worked its underground mines with board & pillar method, Continuous Miner is the most suited equipment and finds wide applicability. Here a continuous coal cutting machine cuts coal to develop board & pillar galleries or “de-pillar” the developed areas/areas standing on pillars.
- Highwall mining is mostly used at the batters of the opencast mine where the coal is usually lost forever. It also finds application at places or areas where there is restriction due to surface features in the highwalls of the opencast mines. It involves continuous getting of coal from the batter of the mines using a remotely operated continuous miner.
- The application of MPT can have a significant impact on the production and productivity of underground mines. it also increases the possibility of viability of underground projects.

## Planning and Implementation of large UG mines

- Increasing the sizes of mines is a positive step but proper planning and strategy is required to ensure it serves its purpose of greater efficiency and does not dwindle due to safety issues.
- The high-capacity mines with a production of 2 MTPA and above may thus be planned to enhance the productivity and viability of such projects by achieving economies of scale.
- Wherever feasible, the use of continuous miners (CM) and Powered Support Longwall (PSLW) technology would be an added advantage.
- These strategies will also lower the man-machine interaction and aid in enhancing safety, thereby also promoting 'Zero Harm' in underground mines.

## Digitization in Mining Operations

- By using digital technologies, coal mines can improve safety, productivity, and environmental performance.
- Some key initiatives which shall aid in rapid digitization of underground coal mines are enumerated below:
  - Real-time data collection and analysis: Fleet management system, Drill & Blast optimization solution, connected workers platform with robust digital communication network can be used for real-time data capture, performing advanced analytics towards quick decision-making.
  - Remote monitoring centre: Remote monitoring centre can be used to monitor coal mining operations and visualization of KPIs from a central location. This can help to improve safety & productivity of mining operations.
- Further, digitization of mines shall be instrumental in improving communication systems for underground mines. For example, coal mine safety monitoring system based on SCADA system can timely and accurately reflect dynamic situation of workers in the underground regions to above ground systems and personnel.
- Digitization would benefit in improved decision making & safety, reducing costs, increased quality control and enhanced process output.

## Annexure 1: Schedule of the Seminar

The seminar bore witness to some of the most distinguished speakers in the field of underground mining. The event was spread out for the whole day with speaker sessions covering a distinct aspect towards the outlook of underground mining in India and a panel discussion to identify novel ideas and strategies in the domain. The schedule of the seminar is provided below.

Table 3: Schedule of the Seminar

Schedule	Particulars
23 <sup>rd</sup> December 2023: IMMA UMANG 202	
9.30 – 10.15 a.m.	Inaugural Ceremony and Session
10.15 – 10.30 a.m.	Tea Break
10.30 – 11.45 a.m.	Technical Session-I
11.45 – 1.00 p.m.	Technical Session-II
1.00 – 2.00 p.m.	Lunch Break
2.00 – 3.15 p.m.	Technical Session-III
3.15 – 4.45 p.m.	Panel Discussion
4.45 – 5.00 p.m.	Valedictory Session
5.00 – 5.05 p.m.	Concluding remarks by Chairman-cum-Managing Director, CIL
5.05 – 5.10 p.m.	Vote of Thanks
5.10 p.m. onwards	High Tea

## Annexure 2: List of Speakers and Panelists for Panel Discussion

The current Annexure contains the List of Speakers and Panelists for panel discussion.

Table 4: Speakers and Panelists for panel discussion

S. No.	Name	Designation	Company
<b>Speakers</b>			
1	Shri. P M Prasad	Chairman-cum-Managing Director (CMD)	CIL
2	Shri K N Singh	President	IMMA
3	Shri. Samiran Dutta	Chairman-cum-Managing Director (CMD)	BCCL
4	Dr. B Verra Reddy	Director (Technical), CIL & CMD, CCL (Additional charge)	CIL
5	Shri. N C Jha	Former Chairman-cum-Managing Director (CMD)	Formerly CIL
6	Shri. R K Sharma	Honorary Secretary	IMMA
7	Dr. Manoj	-	CSIRO Australia
8	Shri. Ajay Kumar Sharma	Area General Manager, Pandaveswar area	ECL
9	Shri. K Nageshwar Rao	Agent	SCCL
10	Shri. Anuj Kumar	Project Officer, Churi Mine	CCL
11	Shri. Sunny Rao	Manager, Moonidih Project	BCCL
12	Shri. Suraj Prakash	Chief Executive Officer (CEO)	TEXMIN
13	Prof. G P Singh	Professor	IIT BHU
14	Dr. Ankush Galav	Research Associate	IIT BHU
15	Shri. Tushar Chakraborty	Director	Deloitte
16	Shri. Raghunath TVSK	Dy. General Manager	Hexagon
17	Shri. Karthik Shankar	-	GTS Ltd.
18	Dr. S Samanta	Sr. Officer (Mining)	ECL
19	Md. Amjath Basha	-	Dassault
20	Shri. Bikram Kumar	Chief Manager (CMC)	BCCL
21	Shri. Amar Bhasin	-	Valley Longwall International
<b>Panellists</b>			
1	Dr. B Verra Reddy	Director (Technical), CIL & CMD, CCL (Additional charge)	CIL
2	Shri. N C Jha	Former Chairman-cum-Managing Director (CMD)	Formerly CIL
3	Shri. B N Pan	Former Chairman-cum-Managing Director (CMD)	Formerly BCCL
4	Shri. Smarajit Chakrabarti	Former Chairman-cum-Managing Director (CMD)	Formerly ECL
5	Shri. M P Dikshit	Former Chairman-cum-Managing Director (CMD)	Formerly SECL

### Annexure 3: Glimpses of UMANG 2023

The current Annexure contains a few glimpses from UMANG 2023.



Figure 1: Lighting of Lamp Ceremony



Figure 2: Release of Souvenir, UMANG 2023





Figure 3: Participants from various companies and educational institutions



Figure 4: Glimpses from Proceedings of Conference



Figure 5: Glimpses from Speaker Sessions



Figure 6: Glimpses from Speaker Sessions



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