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Mining Engineers' Association of India
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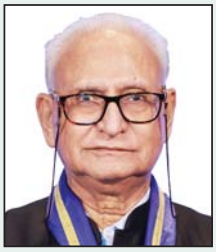

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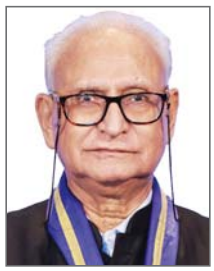
President's Message.....



Dear members..

While I am writing this message, the year 2023 is at its fag end and by the time it reaches you it will be a New Year 2024. I avail this opportunity and wish all our MEAI members and the EMJ readers a very happy and prosperous New Year.

I believe most of the Council Members and the Chapters' Chairmen and Secretaries must be busy packing their baggage to visit Jodhpur to attend the second Council Meeting there. Jodhpur, my native place, popularly known as the Sun City; I wish them comfortable stay and that they enjoy there the delicious food and mouthwatering local snacks like *Mirchi Bada, Pyaz Kaachori, Mawa Kachori, Makhaniya Lassi and rabari and many more varieties.* I also suggest they make a trip to the grand heritage building "Ummed Bhavan" built of the Local sandstone, which is more gracious than the famous Tajmahal.

The outcome of the opinion poll in relation to the appointment of the Vice President-III is likely to be the main attraction of the Council Meeting. It may decide whether the President be allowed to use the powers vested in him by the MEAI Constitution or all matters should be decided by election only.

The Rajasthan Chapter- Jodhpur will also be organizing an International Conference coinciding with this occasion on "Advanced Technologies in Exploration and Extraction of Minerals". While we are talking of advanced technologies, the technologies have miserably failed at Silkyari tunnel where 41 trapped mazdoors could finally be rescued by deploying age-old "Rat-hole Mining" method only. Had these rescue operations been carried out through a mining Organisation, the DGMS would never have allowed deployment of Rat-hole mining for this work. I believe the Organizers of the Conference will try to include this as a special topic for discussion during the conference.

The news about the celebration of Indian Mining day by different Chapters received a very good coverage in the last issue of MEJ. It turned out to be an IMD Special Issue. I feel we should now also organize "MEAI Foundation Day" at least at the Headquarters every year. The Secretary General may find out the date from the old records. Many Chapters are already organizing their Foundation Days. Such an activity will set a good tradition of celebration of Foundation days at all places.

Once again I wish Happy New Year to all.

S.N. Mathur
President

Mining Engineers' Association of India

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EDITOR'S DESK

Dr. P.V. Rao
Editor, MEJ

As yet another New Year is ushering in, it would be pertinent for us to recapitulate the successes and failures encountered during the concluded year, while setting the plans for the next year, especially in the context of NACRI on which MEAI (Association) has expended a great deal of its valuable resources. Conforming to its objectives, the Association formed a National Core Committee (NCC) on November 19, 2015, with the domain experts solicited from the mineral industry. The NCC was later rechristened as NACRI (National Committee for Reporting Mineral Resources and Reserves in India), as a not-to-profit self-regulating body, on April 22, 2017.

NACRI has been credited with the preparation of the Indian Mineral Industry Code (IMIC) for Reporting Mineral Resources and Reserves in India and also getting approved by CRIRSCO on August 1, 2019. IMIC is one of the 15 countries' codes approved by the International body CRIRSCO. These codes are treated at par in different geographies by the global stock exchanges and they are the only reporting standards recognized for the disclosure of Mineral Resources and Reserves for the listing of the exploration and mining companies worldwide. Since August 2019, 116 professionals, including 45 during the year 2023, have successfully completed the IMIC mandatory training and 29 of them registered as IMIC Competent Persons (RCP) by MEAI in India.

The NACRI/ MEAI have been in constant communication with the concerned authorities and Regulators in India to attain the recognition of IMIC as the reporting code. CRIRSCO Chairperson's recent communiqué with the concerned top central government authorities and Regulators in India, highlighting the importance implementing IMIC as the disclosure standard for Mineral Resources and Reserves to help raise capital by the Indian Exploration and Mining companies, attracted the attention of the Secretary, Ministry of Mines; and called a meeting on November 17, 2023 at New Delhi with the CRIRSCO Chairperson, representatives of SEBI, MEAI, NACRI and leading mining companies to discuss adoption of IMIC as the reporting standard in India. All the queries raised by the Mines Secretary regarding the organisation structure and management of MEAI, NACRI and CRIRSCO were convincingly responded and also substantiated with all the pertinent documents viz. NACRI Charter, MEAI bylaws, IMIC, Code of ethics and CRIRSCO Template.

To facilitate and to accelerate capital raising by the exploration and mining companies, it is imperative for SEBI to endorse the Made in India IMIC as the reporting standard, while protecting the investors interests, which has been the norm applied by the stock exchanges worldwide.

While concluding the meeting, Mines Secretary proposed that NACRI shall undertake mapping of five (5) MEMC compliant Geological Reports prepared by GSI/ MECL on graphite, copper and potash deposits, to IMIC to assess their adequacy and the intricacies involved in their conversion to IMIC, without upsetting the ongoing mineral blocks auction scheme. In less than 3 weeks, detailed comments/ observations along with the all-important "if not why not" table were submitted to the Ministry of Mines on 20-12-2023. NACRI emphasized a few critical aspects viz. enhancing the reports' reliability and inculcating confidence in the prospective investors in the Indian exploration and mining projects, which were either totally ignored or partially addressed in the five GSI / MECL reports.

MEAI/ NACRI representatives, in a stakeholders meeting called by the Mines Secretary on 22-12-2023 at Hyderabad, duly prompted the Mines Secretary of the successful accomplishment of the task assigned by him on 17-11-2023 to NACRI and urged the government to recommend to SEBI to consider IMIC as the disclosure standard by the stock exchanges for the listing of exploration and mining companies. He assured us of considering our request sympathetically.

While the government exploration agencies get financial support from the NMET Fund to explore the freehold areas, the existing lessees as well as the successful allotters of Composite Licenses and Mining Leases though the auctioning system entail mammoth investment support to intensify their exploration efforts within their concessions, supported by cutting-edge technologies. The massive capital required has to be garnered from either the public (through stock exchanges) or private equity or financial institutions. To facilitate and to accelerate capital raising by the exploration and mining companies, it is imperative for SEBI to endorse the Made in India IMIC as the reporting standard, while protecting the investors interests, which has been the norm applied by the stock exchanges worldwide.

Hereafter, MEAI/ NACRI shall focus their energies on getting the IMIC recommended to SEBI by the Mines Secretary, who has passionately renewed discussions with NACRI, to ensure their initiative meets its logical end. Let us commend the Mines Secretary's renewed efforts and stimulate him to take further constructive steps in making it mandatory for SEBI to authorize IMIC compliant reports for the listing of exploration and mining companies on Indian stock exchanges.

- Editor

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NEWS FROM THE MINERAL WORLD

Curb illegal mining in J&K

Illegal mining in mountains and rivers of Jammu and Kashmir is causing extensive damage to the eco-fragile environment. J&K is blessed with minerals like limestone, gypsum, coal, magnetite, lignite, granite and sapphire. Perennial left and right bank tributaries of Jhelum basin have rich deposits of minor minerals like boulders which are extracted for construction purposes.

In absence of regulation, organised mafia is having free run to vandalise our natural resources. There has been an increase in mining activities due to high demand of raw material for construction activities. Besides damage to our environment, J&K loses revenue which could be generated from royalties from leased mining blocks due to illegal mining.

Taking strong note, Chief Secretary, Atal Dulloo during a recent meeting impressed upon the Department of Mining to act tough against the menace in the Union Territory. The Chief Secretary directed to completely stop illegal mining saying the administration has to work on the two pronged strategy— devising the effective deterrents to curb it. He directed for increasing permits to include all the areas where people and public projects do not face any dearth of such construction material in the UT. The step taken by the Chief Secretary to safeguard the environment is appreciable and timely.

We have to understand that any mining activity in mountains, streams or rivers must be environmentally feasible. The constitution of the J&K Environment Impact Assessment Authority (JKEIAA) is in its final stage of constitution to make the availability of minerals more smooth in the market. We need minerals to meet our developmental needs. But the Government has to ensure that minerals should be extracted after following all procedures. On a daily basis, police has been seizing vehicles for their involvement in illegal mining in J&K. In Jammu district alone, 1378 vehicles have been seized in illegal mining cases this year. But there is no let up as the mafia behind the illegal mining gets away.

Illegal mining is in full swing in various areas of Kashmir including Pulwama, Anantnag, Shopian, and Kulgam districts in south Kashmir. Budgam and Ganderbal districts in central Kashmir are hotbeds of illegal mining. The mafia uses heavy machines like JCBs and cranes for illegal mining, destroying streams, particularly in Kashmir.

Karewas too have been bearing the brunt of illegal mining for soil extraction. Karewas form an important part of Kashmir's fragile eco-system. Known as Wuder, Karewas are flat-topped tablelands that are not just raised mounds of earth but repositories of geological and archeological treasures. Ironically, Karewas are being extensively destroyed for soil excavation.

Mining mafia is devastating Jhelum and its major tributaries like Doodh Ganga, Vaishav, Rambiara, Shali Ganga and other streams. On a petition of an environmental activist Raja Muzaffar Bhat, the National Green Tribunal (NGT) last year had ordered closure of mining operations in several areas of Budgam district calling into question the Environmental Clearances (EC) given for the operations. The NGT came up with an order exposing use of JCBs and other heavy machines for riverbed mining. On October 7, 2022, NGT imposed a penalty of Rs 35 Crores on J&K Government for constantly polluting Doodh Ganga. Earlier in 2022, the NGT had slapped Rs three crore penalty on the Government for illegal dumping of solid waste, liquid waste and undertaking illegal mining.

Our planners need to understand that J&K, owing to its unique topography, is prone to natural disasters. J&K has a history of earthquakes, floods and landslides. Environmentalists have been ringing alarm bells that natural disasters are triggered by haphazard developmental activities and vandalisation of our natural resources— water bodies, orchards, agricultural fields, mountains, glaciers and forests. Mountains, rivers and streams have a stable hydraulic regime and any disturbance in these can have devastating effects on the environment. Experts state that any mining of minor minerals boulder, gravel and sand has to be done in consideration of the entire regime of the river and its regenerative capacity of minor minerals.

We must ensure sustainable development to minimise damage to our fragile environment. This high time to curb illegal mining and prevent vandalisation of our mountains and streams. There is a need to set up inter and intra district special check posts to prevent transportation of illegal mining material. Besides, a real time monitoring system through CCTVs must be done at areas vulnerable to illegal mining. Government can't reach every area, and it is the responsibility of people also to take measures at their own level to prevent illegal mining in their respective areas. It is our duty to safeguard our natural resources as our survival depends on nature.

Executive Editor, Greater Kashmir / Dec 25, 2023

Mines Ministry to directly sanction exploration projects for critical minerals to notified agencies

The new approach is expected to ensure faster sanction of projects and quicker release of funds to exploration agencies

Exploration of critical and deep-seated minerals gets a boost | Photo Credit: Reuters Staff

In a major policy shift, the Mines Ministry will directly sanction exploration projects to notified private exploration agencies (NPEAs) for critical and deep-seated minerals.

The new approach, aimed at giving an impetus to exploration of critical and deep-seated minerals, is expected to streamline the process, ensure faster sanction of projects, and quicker release of funds to these agencies.

"The decision to allow NPEAs to directly submit projects will cut delays in sanction of projects, as well as help in faster execution of projects," a Ministry official said.

According to the official, besides stepping up the "pace of exploration" of critical minerals, the new approach could also help bring in international firms and new tech

Auction for Mineral Blocks Explored

"Further, these agencies will be allowed to bid in the auction of mineral blocks explored by them, which was not allowed earlier," the official explained.

The proposed policy changes are expected to encourage junior mining companies from around the world to take up exploration projects with NMET funding in India.

The new scheme is expected to draw many players to the exploration arena, including international ones, besides inducting new technologies in the field of exploration.

Amendments Made

Incidentally, the Mines and Minerals (Development and Regulation) Act, 1957, MMDR Act, was amended through the MMDR Amendment Act, 2021, w.e.f. 28/3/2021 which, inter alia, empowers the Central Government to notify entities, including private entities, that may undertake prospecting operations.

The interested private exploration agencies are required to obtain accreditation in accordance with the existing rules of the Mines Ministry, and then apply for their notification.

Beginning March 2022, the Ministry has notified 16 private exploration agencies to take up projects through State Governments funded by the National Mineral Exploration Trust (NMET).

So far, only 17 projects worth Rs 15.88 crore have been sanctioned to five NPEAs from NMET funds. Of the 17 projects sanctioned, 11 are of critical minerals.

A further amendment of the MMDR Act in August saw 24 minerals, including, graphite, nickel, PGE (platinum group of elements), REE (rare earth elements), and potash, among others, notified as Critical and Strategic minerals.

Post the amendment, the Centre can grant mineral concessions and prioritise auction.

"Authorising the Central Government to auction concession for these critical minerals would increase the pace of auction and early production of the minerals," the Mines Ministry said in a statement.

The Hindu, New Delhi | December 15, 2023

India pursues off-take agreements and investments in Australian mines for critical mineral supplies

The alliance seeks to secure minerals for India's expanding manufacturing capabilities and green energy endeavours.

India and Australia are in advanced talks to secure critical minerals like lithium, cobalt, and vanadium, among others, senior officials of India's Mines Ministry said.

According to multiple officials aware of the discussions, India is looking at securing "confirmed off-take agreements" or "investments in processing" or both, as it looks to meet green energy requirements and reduce carbon footprint.

Apart from NMDC, which recently commissioned a gold mine in Australia and is expected to start pre-PFS (pre-feasibility studies) there soon; KABIL (Khanij Bidesh India Ltd) – a JV of NALCO, Hindustan Copper and MECL – is also carrying out "due diligence" for two lithium and three cobalt mines in Australia.

India is also seeking access to additional mines, and PSUs like Coal India and NTPC, among others, have been asked to be look for more mines in the region. India's Mines Ministry is reportedly facilitating the process, too.

Unless commercial production has begun across mines, the exploration to mineral determination and

subsequent commercial production could be as long as three years.

"There are government-to-government level discussions happening, and some state-run companies are in talks too. Many of these are closed door discussions. We are supporting the PSUs and some of them are securing the mines themselves through subsidiaries set up there," Denise Eaton, Trade and Investment Commissioner, Australian Trade and Investment Commission, told *businessline.*

"We are keen to partner with India, which has the manufacturing capabilities and is looking to play a role in the upstream segments, while Australian companies play a role in the downstream sector," she added.

According to Eaton, India is among the top 5 priority markets (for partnerships) and Australia would want Indian companies to play a role in "across the entire ecosystem" which includes mining activities, processing, among others.

While the Australian government would not make any investments or get into the commercial aspects, it would "facilitate India companies" with access to resources, partnerships, investments, among others.

Securing Lithium

Incidentally, lithium continues to be the most sought-after mineral, apart from cobalt and vanadium, with the latter being used in space tech and defence, among others.

On the other hand, lithium, the white alkali material, is a key requirement in energy storage solutions and is used across batteries in electric vehicles and mobile phones, among others.

Studies suggest that in 2030, the global demand for the mineral is expected to surpass 2.4 million tonnes, doubling the demand forecast for 2025.

"Lithium continues to be the most sought after one. Most mines that we now have do have secure buyers, but there are ongoing discussions with Indian companies," she said.

Areas of mineral exploration cover, Western and Northern Australia, apart from the Queensland region.

International Alliance

Incidentally, India is looking at multilateral and bilateral partnerships with several countries to secure its share of critical minerals.

India's Mines Minister, Pralhad Joshi, in a written reply to the Rajya Sabha, had also confirmed that KABIL was engaging with several state-owned organisations in other countries, including Argentina and Australia, to acquire critical minerals. These engagements were mostly being made through the Ministry of External Affairs and the Indian embassies in these countries.

India is also a part of the Mineral Security Partnership, which it joined in June. The MSP comprises 13 countries and the European Union (EU) looking to catalyse public and private investment in critical mineral supply chains. The alliance's other members are Australia, Canada, Finland, France, Germany, Italy, Japan, Norway, the Republic of Korea, Sweden, the United Kingdom, the US, and the EU.

"The ministry is also actively involved in the Mineral Security Partnership (MSP) and other multilateral/ bilateral partnerships with various countries to secure the critical mineral(s)," Joshi said in response.

The Hindu, New Delhi | December 16, 2023

100 critical mineral blocks to be auctioned before Feb 2024: Mines minister

The Ministry of Mines will call bids for over 100 critical minerals blocks from February. Apart from onshore minerals, offshore minerals will also be put up for auction, Union Minister of Mines Pralhad Joshi said during the launch event of the National Geoscience Data Repository (NGDR) portal.

"More than 100 blocks of strategic and critical minerals will be brought for auction next year before February, and these blocks are ready with us," Joshi said.

"Around 15 offshore blocks will also be auctioned in March," Joshi added.

The announcement comes nearly three weeks after India initiated the process to auction 20 blocks of critical minerals, including the 5.9-million-tonne (mt) lithium reserves discovered in Jammu & Kashmir's Reasi district. The collective value of these 20 blocks was estimated at Rs 45,000 crore.

Highlighting the goal behind increasing critical mineral availability, Joshi said, "India is now considered as the World Factory. The shift from China is happening at a rapid pace. We must be ready to provide critical minerals to companies that come to India."

Around 500 blocks of minerals, including critical ones, have been given to the government by the Geological Survey of India (GSI). This year GSI will explore around 1,000 blocks.

Through an amendment to the Mines and Minerals (Development and Regulation) Act on August 17 this year, 24 minerals were notified as critical and strategic, and the central government was given the power to grant mineral concessions for these through auction.

Besides Lithium, the critical minerals on offer include titanium, bauxite (aluminous laterite), glauconite, nickel, chromium, potash, copper, graphite, manganese ore, molybdenum ore, phosphorite, platinum group elements (PGE), and rare earth elements (REE). These are used in sectors like renewable energy, defence, and agriculture.

Nitin Kumar, BS, New Delhi | Dec 19, 2023

Twenty-six coal mines to go under hammer in 9th round of commercial auction

This latest round of auctions marks a departure from previous practices by removing technical and financial qualifications for bidders, aiming to encourage wider participation.

New Delhi: The government will offer 26 coal mines spread across four states to bidders as part of the ninth round of commercial auction, to be launched on Wednesday.

The coal ministry, in a statement on Monday, said that this auction will notably have no sale or utilization restrictions on coal, and eligibility criteria for bidders have been abolished, fostering a more inclusive and competitive environment.

This latest round of auctions marks a departure from previous practices by removing technical and financial qualifications for bidders, aiming to encourage wider participation. The ministry emphasized that the auction terms are designed to ensure transparency and fair market-driven pricing.

The amendment of mineral laws has played a crucial role in revitalizing the coal sector. It has levelled the playing field for public and private entities, permitting auctions for diverse purposes, including both consumption and sale.

“The upcoming ninth round of commercial coal auctions is poised to enhance the participation of more private players in the coal sector, fostering competition, efficiency, innovation and contributing to sustainable development,” the ministry said in the statement.

Of the 26 mines on offer, seven are fully explored, and 19 are partially explored. The distribution of these mines is as follows: Madhya Pradesh with 12 mines, Chattisgarh with 8, Jharkhand with 5, and Telangana with 1.

The ministry also highlighted its key reforms, such as the creation of a Single Window Clearance System (SWCS) portal, which simplifies obtaining various clearances for coal mines. This, along with the introduction of a market-driven pricing mechanism, is expected to create a favourable environment for growth and innovation in the energy sector.

Vaageesh Thirumalai, Mint | 18 Dec 2023

Mining for critical minerals: what is the auction process, and why is it important?

Critical minerals are the resources of the future — and essential for the country’s economic development and national security. The government has identified 30 of these minerals, and created a legal framework for their mining in India.

This is the first time that rights related to the mining of lithium ore are being auctioned to private parties. Other minerals in the blocks include nickel, copper, molybdenum, and rare earth elements (REEs).

Twenty blocks of critical minerals are currently on auction for commercial mining by the private sector. The mineral blocks contain lithium ore, which has use in batteries and electric vehicles, and another 10 of the 30 minerals that the government declared as “critical” in July.

The bidding process began on November 29, and bids can be submitted until January 22 next year. The total value of these blocks is estimated at Rs 45,000 crore, subject to further discoveries or revisions in inferred reserves.

This is the first time that rights related to the mining of lithium ore are being auctioned to private parties. Other minerals in the blocks include nickel, copper, molybdenum, and rare earth elements (REEs). All these minerals are utilised in key supply chains for vehicle batteries, energy storage devices, consumer electronics, and vital industrial processes.

“Lithium is truly a mineral of the future… In today’s launch of critical mineral auctions, 2 lithium blocks have been offered. Once operational, they will help to cut down imports and build an #AatmanirbharBharat,” Minister for Mines Pralhad Joshi posted on X last month.

Where are these critical mineral blocks, and what rights are being auctioned?

The Notice Inviting Tender (NIT) floated by the Ministry

of Mines says the 20 blocks are spread over eight states. There are seven blocks in Tamil Nadu, four in Odisha, three in Bihar, two in Uttar Pradesh, and one each in Gujarat, Jharkhand, Chhattisgarh, and Jammu & Kashmir.

Only four of these 20 blocks are being auctioned for a Mining Licence (ML), which means that once the licence is granted, the licensee can begin mining operations after obtaining the requisite clearances.

Three of these four blocks are in Odisha, and contain deposits of nickel, copper, graphite, and manganese. The fourth block is in Tamil Nadu, and contains deposits of molybdenum.

And what sort of rights are being auctioned for the other 16 blocks?

The remaining 16 blocks are being auctioned for a Composite Licence (CL), which allows the licensee to conduct further geological exploration of the area to ascertain evidence of mineral contents.

Once the licensee collects sufficient information on mineral deposits, they can make an application to the relevant state government to convert their CL to an ML to begin mining operations pending requisite clearances. The licensee has three to five years to complete the prescribed level of exploration, failing which the licence will be withdrawn.

What are the other clearances that will be required before operations begin?

The NIT notes that out of the total concession area of 7,197 hectares (for all 20 blocks), 17 per cent or 1,234 hectares is forest land with status as per the PM Gatishakti portal, the digital platform to facilitate integrated planning and monitoring of infrastructure projects around the country.

Once granted a licence, the licensee will have to obtain 15 approvals and clearances before beginning operations. These include forest clearance, environmental clearance, Gram Sabha consent, etc.

The Indian Express, New Delhi | December 8, 2023

US claims huge chunk of seabed amid strategic push for resources

The US extended its claims on the ocean floor by an area twice the size of California, securing rights to potentially resource-rich seabeds at a time when Washington is ramping up efforts to safeguard supplies of minerals key to future technologies.

The so-called Extended Continental Shelf covers about 1 million square kilometers (386,100 square miles), predominantly in the Arctic and Bering Sea, an area of increasing strategic importance where Canada and Russia also have claims. The US has also declared the shelf's boundaries in the Atlantic, Pacific and Gulf of Mexico.

The long-awaited announcement earlier this week maps the outer reaches of the US continental shelf, the country's land territory under the sea. Under international law, countries have economic rights to natural resources on, and under, the seabed floor based on the boundaries of their continental shelves.

"It's a huge deal because it's a huge amount of territory," said Rebecca Pincus, director of the Polar Institute at the Wilson Center in Washington, which has devoted an entire web page to the ramifications of this week's news. "It's US sovereignty over the seabed floor, and so whether it's seabed mining, or oil and gas leasing, or cables, or what have you, the US is announcing the borders of its ECS and will have sovereignty over those decisions."

The US State Department said that the development "is about geography, not resources."

The US, like all countries, has "an inherent interest in knowing, and declaring to others, the extent of its ECS and thus where it is entitled to exercise sovereign rights" it said in an emailed response to questions. Continued mapping and exploration will be needed to understand

(Continued on Page 35)

GEOTECHNICAL ANALYSIS OF SILKYARA TUNNEL COLLAPSE: LEARNING FOR MINING INDUSTRY

Dr. Pramod Rajmeny, Geotech Consultant

Abstract

The collapse of Silkyara tunnel near Uttarkashi shook the country with a more powerful bang than those of normal firecrackers on the eve of this Dipawali. Even the country's top central and state leadership got seriously concerned and engaged every technical front to rescue the trapped 41 workers. Though it took a long 17 days to rescue them using the combination of the latest drilling technology – American Auger Drill to the Rat miners.

The episode aroused nationwide debate on every aspect of the tunnelling- the mode of tunnelling, support deployment, stability monitoring, etc. Even tunnelling in the Himalaya was questioned. But a large network of tunnelling carried out on the other side of Himalaya prompts the country to critically analyse the event and draw way forward so that the tunnelling could be kept continued at least from a strategic point of view. To this end, the situation has been geotechnically analyzed and its learnings for the mining industry are presented as seedlings.

1 INTRODUCTION

The prestigious Char Dham Mahamarg Pariyojana consists of building wide, all-weather-roads, between the Hindu holy towns of Gangotri, Yamunotri, Badrinath and Kedarnath. Moreover, these road networks serve the country's strategic needs. The Barkot- Silkyara tunnel is being excavated as part of it between Gangotri and Yamunotri. The tunnel is about 4.5km long between Silkyara to Barkot ends having a height of 8.5m and having width over 12m with circular roof profile (Fig. 1 & 2). The surface cover over the tunnel varies from a few tens of metres to about 350m.

The National Highways and Infrastructure Development Corporation (NHIDCL) awarded the tender for tunnel construction to Hyderabad-based Navayuga Engg Company which hired a German-Austrian engineering consultancy called Bernard Gruppe to design and build the tunnel. On 12th November 2023 at 05:30 am, 60m thick debris fall blocking the exit of the Silkyara-Barkot tunnel (under construction) at 260m from the tunnel entrance at the Silkyara side.

Once construction began, Navayuga ran into geological surprises. Since the start of tunnel driving, the geological conditions have proved to be more challenging than predicted in the tender documents.

All infrastructure projects in India, once beyond a stipulated threshold, have to get themselves an environmental clearance. Any proposed highway running longer than 100km, for instance, needs an environmental clearance. Given it is 900km, Char Dham needed one as well. However,

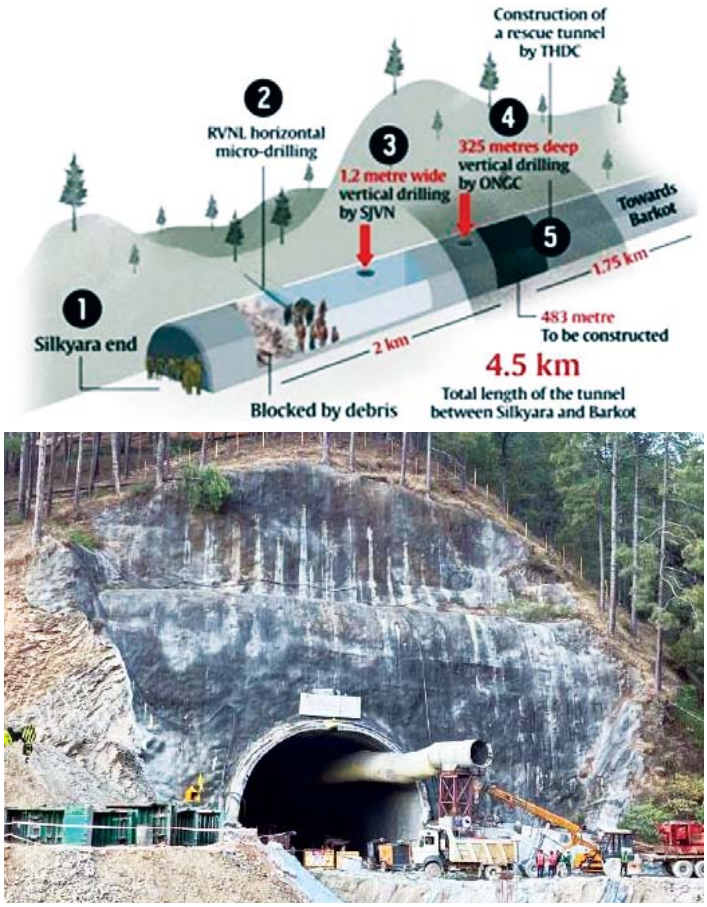

Fig. I Schematic representation of Silkyara Barkot tunnel project and the landscape

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Ex-Associate Vice President and Ex-Geotech Advisor- Hindustan Zinc Ltd., (Vedanta)

the project was split into 53 separate sections, none over 100km in length, and evaded the need for an environmental impact assessment.

This paper geotechnically analyses the causes of the collapse, discusses the circumstances in mining Industry where similar situations may arise and finally presents proactive way forward to sail smoothly and safely in mining ambience. Various experts in this field have analyzed the collapse and drilled down the causes. However, the instant exercise is intended not to indulge in any controversies arising out of regulatory or causative analyses. Instead it confines itself to the learning lessons for mining. The author is a geotechnical engineer having 4 decades of field experience of underground and open pit mining and widely travelled in Himalaya, therefore, has advantages of metamorphosing the circumstances leading to collapse of the Silkyara tunnel into learning for the mining sector.

Fig.2 Rescue operation by Auger Drill and Rat mining

2 GEOLOGY & GEO-TECTONICS OF SILKYARA TUNNEL SITE

The Silkyara tunnel is drilled through Quartzitic Phyllite having closely spaced foliation planes parallel to the bedding. The rock has a soapy feel and conspicuous phyllitic sheen, the rock is highly friable and fractured. The rocks belong to the Nathuakhan formation of Ramgarh Gr. (according to K S Valdiya Geol map, Lesser Himalayas).

The tunnel has been constructed almost along the NNW-SSE (regional strike of the area). Dip of the bed is ranging from 30-50° at the top of the hill with a dip direction towards the South-west (into the tunnel). At the top of the hill, Metasiltstone/ Quartzitic phyllite were exposed in the outcrops. A nallah (small stream) is present at top of the hill on its eastern slope above the tunnel crest but does not have much flowing water at present. The inside of the tunnel was almost dry from the first 260m up to the debris fall except at few places where dampness and dripping water were observed.

Despite the tunnel's relatively shallow depth of 140m, it is important to note that Uttarkashi is situated in the upper Himalaya region and is in proximity to the Main Central Thrust (MCT), Fig.3. This geological Faultline is where the Indian peninsular plate is pushed beneath the Eurasian Plate, stretching over 2,000km along the Himalaya line from northwest to southeast. Consequently, the area experiences significant shear stress due to continuous tectonic plate movement. It is learnt that Uttarkashi and surrounding areas have previously experienced some major seismic activity including a 7.8 magnitude earthquake in 1803 and 7 magnitude earthquake in 1991.

Fig.3 Showing Main Central Thrust zone along with Uttarkashi

In the case of the Silkyara-Barkot tunnel, the presence of the Barkot Thrust- a prominent fault line- indicates the likelihood of 'shear zones' that pose risks to the tunnel's stability. The seismic potential of the zone is an aspect not taken into consideration.

A shear zone is a thin zone within the Earth's crust or upper mantle that has been strongly deformed, due to the walls of rock on either side of the zone slipping past each other. In the upper crust, where rock is brittle, the shear zone takes the form of a fracture called a fault.

Geologically, the Barkot Thrust belongs to the category of thrust faults, which are fractures in the Earth's crust characterized by the relative movement and displacement of the adjoining rock layers. Thrust faults often develop in areas with compressional tectonic forces, shear forces act to push two sections of the Earth's crust into one another. The movement along these faults can take various directions, including horizontal, vertical, or oblique, and they play a significant role in shaping the Earth's crust and geological landscapes.

3 CAUSES OF THE ACCIDENT & THEIR ANALYSIS THROUGH GEOTECHNICAL PRISM

The incident came to national lime light and renowned specialists analyzed the event and offered the causes as witnessed in various social and print media. Experience in Himalaya tunnelling indicates that two types of incidents take place in the Himalayan belt- sudden release of large amounts of water and unexpected encounter of sheared rocks. The Main Central Thrust (MCT) passes a few kilometres north and northwest from the site (Fig.3). This means that this area is extremely sensitive to earthquakes and presence of sheared rocks.

Some of the causes which led to the collapse of the Silkyara Tunnel may include:

3.1 Inadequate understanding of geology: the tunnel design

One of the main causes attributed to the event is due to inadequate understanding of geology and non-compliance of regulations. The method of excavation, method of support should have been commensurate with rock characteristics.

Before carrying out the excavation, the planned tunnel area should be geologically defined by carrying out diamond drilling holes- specially by drilling horizontal and vertical diamond drill holes and logging their cores to determine rock type, joint patterns, etc. These cores should have been tested to determine physico-mechanical properties of each rock type. In addition, while carrying out tunnel excavation, every metre advanced should have been geologically and geotechnically mapped before clad with a support system. Based on this information, a litho cum structural model should have been prepared. These are the vital information to determine or decide the mode of tunnelling, size of tunnel span, type of support, etc.

Various experts opined that the Daily project progress reports should have been thoroughly scrutinized and Reports of geological and geotechnical investigations should have been taken seriously.

Designing Tunnels in weak ground

Weaker rock stuff, geologically ravaged by faulting, shearing, etc. does not permit wider spanned tunnelling for longer term stability point of view. The situation gets further worsened by their proximity with the seismic zone.

Digging a wide tunnel over 12m in width (8.5m high) and keeping it standing for a long time is really difficult. Under such conditions, it is better to excavate two parallel intermittently interconnected tunnels separated by a substantial natural rock pillar, if the situation permits. Making a wider tunnel and compartmentalizing it by a RCC barrier wall, literally may equip the tunnel with two modes of egress but geotechnically it is analogous to putting all the eggs in same basket as it happened in Silkyara trapping the workers.

Two modes of egress should be adequately away from each other, which can be determined by numerical modelling. Experience says that a parting of more than three times the diameter of the tunnel enables them to be almost independent from a stress point of view. The main theme behind keeping a suitable parting between them is that in case of any untoward incident, both the openings should not get disturbed and the other opening work as means of egress.

3.2 Use of explosive in weak rock matrix and seismic prone area: Mode of tunnelling

Carrying out excavation by conventional drilling blasting is one of the worst factors inducing instability of the Silkyara tunnel. As is known, the rocks constituting the area are weak, sheared and fractured – slate, siltstone, etc. and the site is near the Main Central Thrust (MCT), use of explosives could further worsen the stability of the area to a great extent. Repeated blasting in the area could trigger the faults. shears, etc.

Blasting process further weakens the already weak stuff and increases its probability of instability:

- Geological faults, shears work as conduits to blasting gases and allowing their deep penetration. It can induce instability in a wider region. Blasting gases are known to penetrate along these geological structures as deep as 20-30m and can destabilize the whole gamut.

- Likewise, higher magnitude of blast vibrations can profusely shatter the already weakened stuff and increase their probability of failure.

The author has witnessed triggering of geological faults by gaseous energy as far back as 20-25m from the blast site. Similarly, higher magnitude of blast vibrations having peak particle velocity around 40-50mm/sec (Rajmeny, et al. 2019) could trigger geological faults 40-50m away from the blast site. Therefore, blasting in the poor and sheared rocks traversed with faults/ shear could be one of the major sources of instability.

Mode of tunnelling

In normal ground conditions, the conventional method of tunnelling involving drill-blast is quite suitable. However, in weak rock stuff, ravaged by geological complications like faults, shears, and even aggravated by seismic proneness, it is better to deploy a non-blasting method – i.e. deploying Tunnel Boring Technique (TBM). Under such poor rocks, the tunnel should have been excavated by techniques like Tunnel Boring Method (TBM) rather than conventional drill & blasting method.

Experience suggests that in medium to strong rocks having Rock Mass Rating (RMR) more than 45 to 50, the conventional drilling-blasting method can be deployed with adequate support. However, the areas where the RMR is less than 40 and traversed with geological faults or shears, it is better to deploy a non-blasting method. The latter method should also be preferred in highly seismic prone zones, especially in the Himalayas.

3.3 Inadequate supporting of the tunnel

Normally, the roof collapses near the unsupported part of the tunnel near its advancing front. However, the Silkyara tunnel witnessed a massive collapse engulfing about 60-70m of length.

Collapse of the Silkyara tunnel loudly points out inadequacy of the support system. The collapse in sizeable length of the tunnel cannot be termed as local roof fall. It should have a weak zone either weak rock stuff or faulted zone or sheared zone which got collapsed. The triggering could be due to repeated blast vibrations or water seepage or combination of them. Hence, the geological structures were not respected in the design process. It also points out that normal or conventional technique of drill-blasting should not have been used in such a gamut, instead TBM should have been used.

Method and density of excavation support are decided based on the rock characteristics, stress regime, use of the tunnel, desired life of the tunnel, among other factors. Silkyara tunnel being a permanent conduit to connect two pilgrimage sites, the tunnel should have been supported heavily. The methods used to protect weak sections depend on the length and strata of the shear zone. This includes the use of fore poles, rock bolts, steep ribs, or shotcrete to reinforce the zone. During the excavating itself, the fore poling method of support with using Self Advancing Anchors is found to be very effective in the shear zone as a pre-support method. Later on, the section can be supported by a more substantial system.

Collapse of Silkyara Tunnel in completed section

The collapse of the area for a long section (50-60m) which has been completed in the Silkyara tunnel raises serious concerns. The collapse of Silkyara tunnel is characterized by:

- The collapse occurred much behind the face or advancing head of the tunnel,
- The auger drilling carried out smoothly for initial 50-60m from Silkyara end did not get or strike any steel girders or torrs except the last 10-12m where the auger got stuck and rat mining was carried out. It speaks very vividly that the tunnel length up to which auger drilling got carried out uninterruptedly, was not supported by any steel element.

The massive collapse of the tunnel for a long section could have been caused because of aligning of the tunnel axis with either a fault plane or hinge line of a wedge formation due to intersection of two prominent joint sets or a shear zone. Traversing the area by geological fault, shears weaken the whole rock gamut around it.

Geotechnically, a weak rock zone itself makes the area susceptible for collapse. A weak rock with lower Rock Mass Rating, enables it a less wide excavation to stand-up. Typically a 2.5-3m wide zone is difficult to stand in such a weak rock having RMR less than 40-45.

Moreover, the weak zone formed due to shearing or faulting has following special characteristics:

- In shear zone, roof heightening invariably takes place by chimneying effect. Unfortunately the chimneying can extend to great height and can make the whole gamut highly susceptible for collapse or instability. The author has witnessed chimneying of 40-50m high in a shear zone which was about 7-15m wide. It is contrary to normal roof collapsing and heightening restricted by a profile having inclination of 45° (from horizontal).
- These planes of weaknesses normally conduct water and further aggravate the instability.
- These planes of weaknesses conduct blasting gases to a large extent around them.
- When a geologically disturbed area is situated in a seismic zone, forms the worst geo-ambience. Any

seismic event can trigger the failure of the structure, degree of damage governed by the intensity of the tremor.

This inherent weak matrix in the roof missed appropriate interlocking with the support laid. It kept on increasing in size- along length and height. The situation might have further worsened by repeated blasting and ground water seepage. Under such conditions, the tunnel lining usually swells and failure symptoms like cracking, bulging, spalling appear on the lining surface. These symptoms got missed. The visual observations are vital in dealing with rock as the failure symptoms are most faithful in speaking about the health of its host.

Normally, the completed portion of the tunnel was supposed to be adequately supported by a permanent support system. In fact, with each round of blast of the tunnel, before applying permanent support, the roof and sides should have been geotechnically mapped for rock type, joint sets, their characteristics like Rock Mass Rating, etc. Capturing these rock fabrics and their kinematic analysis defines the mode of failure – planar, wedge, etc and the support system. In the seismic active zone, support should be capable of absorbing the shocks or seismic vibrations. Use of rigid support may be reviewed.

3.4 Inadequate Monitoring of the tunnel

Were adequate support structures provided to prop-up weak rock and was excavation process sufficiently monitored – these are the key questions to look into in the tunnel collapse. The tunnel, with progress, should have been monitored by stress-meter, extensometers, load cells (embedded in the support units like girders, rock bolts, etc), micro-seismic system, etc. Tunnel seismic prediction (TSP), which involves a seismic survey before initiating a new phase of the tunnel and also helps maintain safety during construction, may not have been taken into consideration in case of Silkyara tunnel. TSP is used to analyse what lies 100m ahead of the completed zone. Thus, the inadequate monitoring of the Silkyara Tunnel could not predict its failure.

The failure of the tunnel could not occur instantaneously. In fact, before failure, the rocks and the support emit ample symptoms like spalling, development of extension cracks, dislocation of existing planes of weakness, rock talk, etc. It means the focus of the tunnel was on daily progress rather than on stability of the tunnel and safety of all people deployed. The party carrying out tunnelling should have strong technical think tanks for capturing and understanding the visual observations.

Monitoring stability of the tunnels during and after tunnelling is very important. Normally, stability of the tunnels situated at shallow depth does not get reflected by stress probes but by deformation measuring instruments. Secondly, strata movement like roof heightening, etc is best reflected in load cells embedded in the supporting units like steel arches, girders, etc.

Regular inspection windows (using isolation gates) should be left in the tunnel supporting system. It will allow any chimneying of the shear zone, accumulation of water, etc. and would validate the instrumental trends.

3.5 In-experienced or ill-prepared party

The party deployed for excavation of the tunnel seems to be in-experienced and ill-prepared for this type of eventuality. While commencing work on such projects, one needs to have safety protocols in place and also have rescue plans in case of emergencies. But the situation was that even after so many days, there were talks of hiring foreign experts for rescue works. We have no option but to wait. In the hours and days after the collapse, further evidence of Navayuga unpreparedness came to light. Rescue equipment like drilling machines were not available at hand. They had to be flown in.

4 LESSONS FOR MINING INDUSTRY

The Silkyara tunnelling project distinguishes itself geotechnically as excavating a tunnel in weak and sheared rock matrix in seismic ambience. The rocks are fragile in nature- weak rock formations traversed with faults and intense shearing. While their proximity with Main Central Thrust, implied the seismic conditions. Presence of water further worsens the situation.

In the above context, the Indian mining Industry is better equipped and well placed:

- The Indian Mining Industry is adequately guarded by various provisions of Indian Statute like Reg 75 of MMR 2020 (draft) and respective CMR which spell that no person shall be employed/ remain below ground until the working is connected to surface with two shafts or other means of access.
- Furthermore, the width of most of the tunnels in case of underground mining is much smaller (almost half) than that of the Silkyara tunnel.
- Thirdly, mining in India is carried out at shallow to moderate depth where the seismic threat is much less as compared to that of the Himalaya MCT zone.

Thus, the innate proneness/ susceptibility of collapse gets reduced to a great extent. However, geo-mining conditions akin to Himalaya can arise in case of transition of open pit mining to underground.

Tunnelling is a basic building block of civil as well as mining arena and therefore, learnings from the Silkyara tunnel

collapse are also equally applicable and valuable for the mining domain as well. If excavation is initiated without preceding by an immaculate geological studies of the area, it is bound to encounter disastrous results. It is the geological and geotechnical details which provide accurate status of the strata to the planning engineer who then plans the excavation accordingly.

Mining involves excavation of a number of tunnels- a network thereof and then enlarging them to extract minerals (known as stoping), but its essentially tunnel excavation. However, it differs from civil projects in the sense that most of the mining tunnels are inter-connected and have a minimum of two access or ingress.

4.1 Situations akin to Silkyara in Mining gamut

In mining, making a lone opening may exist under following conditions:

- With increased degree of mechanization, ramps are driven for hauling ore for miles together in barren area.
- After reaching at a hauling horizon, the main haulage drive is excavated which is normally a single opening made at the deepest point of the mine (or planned hauling level).
- A lone drive is excavated all along the strike of the mine to prove mineralization/ ventilation purposes, etc.

Though some of these openings may be permitted by Mining Statute, they may be subjected to Himalayan conditions when they are driven through weak rock formation, near faults, shears and subjected to seismicity. The seismic ambience may be imparted due to:

- high stress concentration imparted due to depth,
- the transition of open pit into underground- interaction of open pit and underground usually imparts seismicity because of high stress concentration occurring at sharp edges.

In addition, heavy blasting occurring nearby – may be in its open pit arm, may induce high ground vibration which are transient in nature.

4.1.1 Seismicity due to higher stress concentration due to depth or tectonic activities

The high stress concentration arises when the excavation is situated at a depth. Normally, coal mines when reach to a depth more than 600-700m, experience stress induced wrath. Nevertheless, the mining belt, if subjected to tectonic activities- like intense folding/ faulting, etc. may abnormally experience high stress concentration at much shallower depth as faced by Zawarmines. The tectonics manifested in higher lateral stresses. Nowadays the faster extraction rate worsens the situation. At Zawar mines, typically, Mochia, high stress concentration was experienced at a shallow depth of 300-400m (Rajmeny et al., 2002).

4.1.2 Seismicity due to transition from open pit to underground extraction

With passage of time, many open pit operations are maturing and are starting the extraction of their underground arm like Malaj Khand, Rampura Agucha mine, to name a few. In the inclined deposit, when underground mining is started, the hangwall of mined out excavations or stoping voids (as commonly called) makes acute angle with the excavated pit walls and imparts micro-seismic field. One of such mines which experienced strong seismicity was Ernest Henry Australian mine (Fig.4) (McGrath et al, 2014).

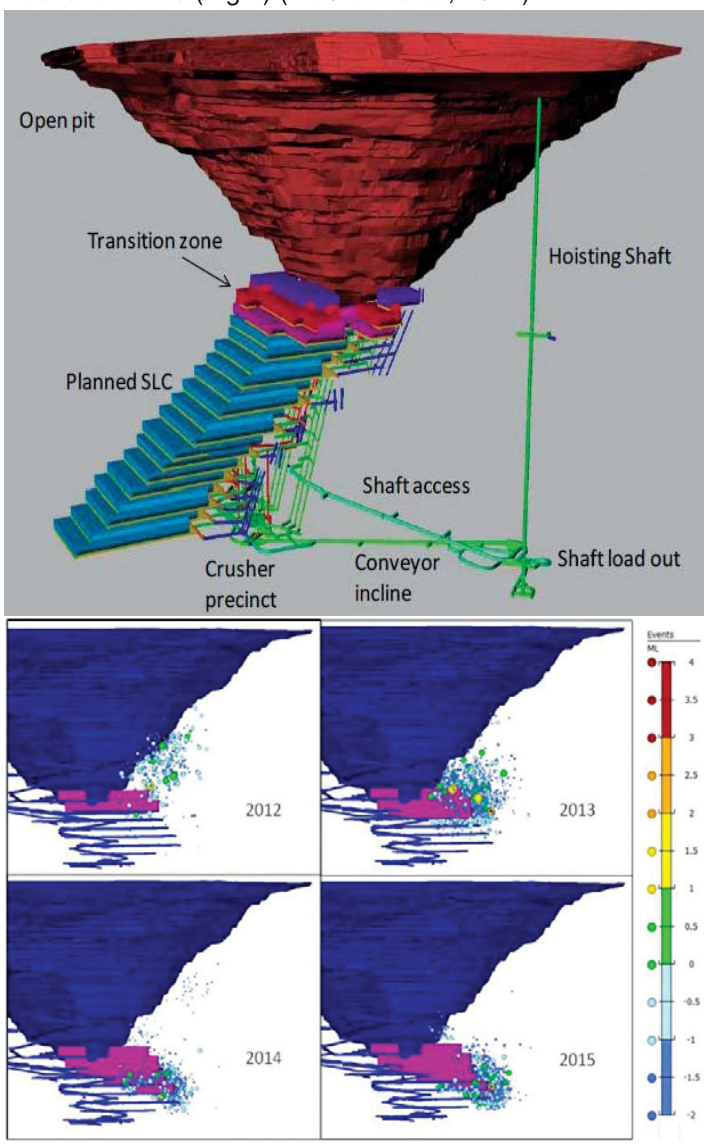

Fig.4 Ernest Henry open pit to transition and seismicity faced by it

Some Indian metal mines having a similar situation are deploying a wide spread micro-seismic monitoring network deploying about 10 geophones.

5 WAY FORWARD FOR MINING INDUSTRY: SOME GUIDELINES

Following the doctrine that prevention is better than cure. Based on experience of the author, some guidelines are presented for carrying out safe tunnelling:

1.1 Design process: Deciding mode of tunnelling

In most of the mining situations, the drill-blast method of tunnelling is used. The rock conditions in mining are in general stronger than those prevailing in the Himalaya belt. In mining conditions, the geological faults, shears may be encountered but on a very limited length. Therefore, conventional drill-blasting methods, using Jumbos, are quite common. However, while piercing through very weak rock stuff (like that present in Chromite belt of Odisha), non-blasting method like TBM should be preferred. The latter method is preferred when weak rock stuff like siltstone has the Uniaxial Compressive Strength (UCS) less than 25MPa and or RMR less than 40. Likewise, TBM should be preferred in above mentioned weak rock stuff and present in seismic prone areas.

1.2 Investigations prior to carrying out the excavation

While carrying out tunnelling, irrespective of the ground conditions, it is preferred to follow the below mentioned strategy:

- Geological investigation: Demarcate rock type, joint pattern, traversing of geological discontinuities like faults, shears, etc.:
  - Using available sources like literature, exposures on the hill, determine the preliminary geological setting.
  - Prepare the rock type or litho-model by carrying out adequate number of oriented diamond core drilling- may be all along the proposed tunnel profile and about 50m outby on either side of the planned tunnel axis
  - Log the diamond cores for determination of rock type, sequence of rocks, attributes of jointing like Rock Quality Designation (RQD), frequency and orientation of jointing, their spacing, etc.
  - Log major geological structures from the oriented core logs like faults, shear zones, etc.
  - Diamond drill holes can be drilled horizontal holes along the tunnel profile, few holes above the roof of the tunnel (to know the roof condition) and few vertical holes from the surface (if topography allows),
  - Core size around 50mm is required as per International Society for Rock Mechanics (ISRM),
  - Test cores of these holes (may be at about 20m interval) for determination of physico-mechanical properties like uniaxial compressive strength, tri-axial compressive strength, Young's modulus, Poisson's ratio, permeability, porosity, density, etc
- Geotechnical investigations should be carried out before hand and due weightage should be given to them. The geotechnical investigations may include:
  - From RMR, RQD and NGI- Q, determine the maximum stand-up span empirically using the Potvin approach.
  - Carry out dis-continuum numerical modelling to understand the role of major geological discontinuities like joint pattern, fault, shear, etc.
  - From these analysis, determine the best support method.

5.3 Investigations to be carried out during tunnelling

- After face advancing of 3m during the tunnelling and before applying support, geologically map the area for rock type, joint pattern, geological structures and digitze them in the litho-structural model and determine the rock characterization like RMR and NGI 'Q'. The rock characterization so determined more reliably represents the rock behaviour rather than that determined from diamond drill cores. These are the main sources of deciding the method of tunnelling, maximum stand-up span of the tunnel, intensity of supporting, etc.
- At suitable intervals, install stability monitoring instruments like stress-meter, extensometers, to measure change in stress, deformation occurring in and around the tunnel, load cells in the support elements, etc. Initially instrumentation intervals of 50-100m, may suffice.
- In seismic zones, install geophone to record any micro-seisms,
- Likewise, monitor the water flow coming from the weep holes- any variation in water content may indicate up-coming activity.
- Every day, monitor the condition of the tunnel lining for any cracking, peeling of plaster, etc.
- Monitor the drill penetration rate, event of drill string getting struck-up, etc. Correlate these with the litho-structural model.

6 CONCLUSIONS

The Silkyara episode has made the civil and mining communities realize how to design the tunnelling more scientifically, specially in seismic ambience. The event taught the importance of geological and geotechnical investigations to be carried out before the tunnel designing and during its execution along with to respect them more religiously rather than merely ornamenting the shelfs of offices. Even during

the tunnelling, it highlighted the need to regularly monitor the ground and support conditions using various probes. The provision of ensuring two ways of egress by creating a partition wall in the main tunnel has proved futile. Above all, it pointed out the need for technical competency of the agency carrying out tunnelling rather than merely excavating the tunnel.

In the above context, the Indian mining Industry is adequately guarded by various provisions of Indian Statute regulation Reg 75 of MMR 2020 (draft) and respective CMR which calls for providing two means of egress. Furthermore, the width of most of the tunnels in case of underground mining is almost half that of the Silkyara tunnel. Thirdly, mining in India is carried out at shallow to moderate depth where the seismic threat is much less as compared to that of the Himalaya MCT zone. Thus, the innate proneness/ susceptibility of collapse and people getting trapped gets reduced to a great extent.

However, geo-mining conditions akin to Himalaya can arise in case of driving lone excavations (a) for accessing the orebodies, making hauling roads for ore transportation or ventilation purposes and (b) transition of open pit mining to underground. The latter often induces seismicity and worsens the situation. Based on learning of the Silkyara Tunnel episode, some guidelines are suggested which can ensure safe tunnelling without trapping persons. In any case, regular visual monitoring supplemented with conventional instrumental monitoring is a key to ensure safe operation.

However, one of the main concerns in the mining arena is that big mining houses are outsourcing the development work to small contractors whose primary focus is on minimizing the cost. Unfortunately, these small contractors do not have the scientific temperament with them to understand the geology of the area and response of the ground to the tunnelling. Adherence to the guidelines would be more useful while deploying small contractors.

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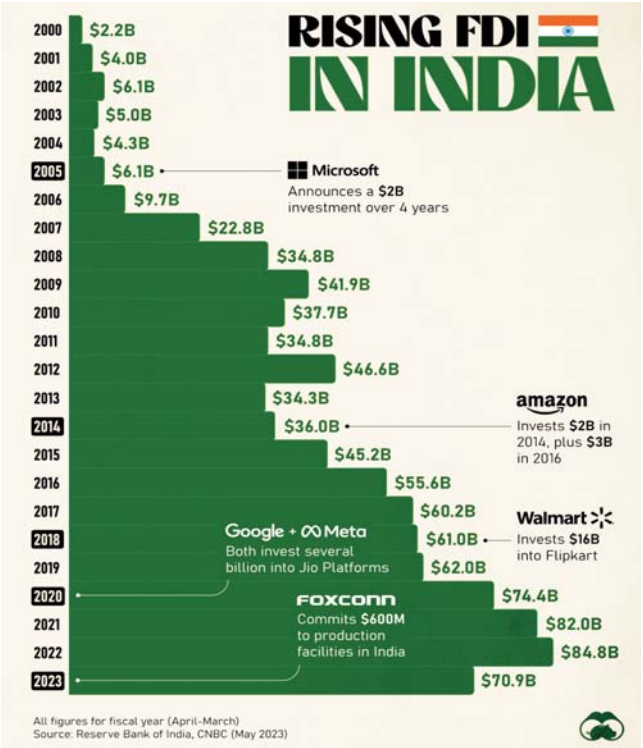

Marcus Lu, Visual capitalist | December 17, 2023

ENHANCING HAZARD IDENTIFICATION, RISK ASSESSMENT, AND SAFETY MANAGEMENT PLANNING BY INTEGRATING REGULATORY REQUIREMENTS WITH ISO 45001:2018 IN MINES

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Abstract

This article offers a comprehensive exploration of mine safety, highlighting the imperative of effective hazard identification, risk assessment, and safety management planning, and how these factors integrate with regulatory requirements in accordance with ISO 45001:2018 in mining operations. It encompasses a detailed examination of regulatory prerequisites, ISO 45001:2018 principles, risk assessment methodologies, and control strategies.

The article underscores the utmost significance of mine safety, given the inherent hazards associated with mining. It stresses the proactive roles of hazard identification, risk assessment, and thorough safety management planning in averting accidents, safeguarding personnel, and ensuring compliance with regulations. The integration of regulatory requisites with ISO 45001:2018 is advocated as a robust framework for augmenting mine safety, aligning legal responsibilities with internationally recognized best practices.

The paper explores risk assessment comprehensively, elucidating methodologies and risk rating scales. It emphasizes the evaluation of both base risk and residual risk. The risk control hierarchy, encompassing elimination, substitution, separation, administration, training, and personal protective equipment, is advocated as an effective strategy for risk management.

The article culminates with a sample high-risk area control plan, underlining the necessity of training team members on risk assessment scales to ensure a shared understanding of hazard prioritization.

Key words: Mine safety, Hazard identification, Risk assessment, Safety management planning, Regulatory requirements, ISO 45001:2018, Risk control hierarchy, Accident prevention, Risk assessment methodologies, Occupational health and safety.

1.0 Why Hazard Identification and Risk Assessment in Mines?

Mining operations involve inherent risks and hazards due to the nature of the work environment, including underground excavations, heavy machinery, hazardous substances, and potential geological instabilities. Therefore, prioritizing mines safety is crucial to protect the well-being of workers and minimize the occurrence of accidents, injuries, and fatalities.

Effective hazard identification, risk assessment, and safety management planning play pivotal roles in ensuring mines safety. By systematically identifying hazards and assessing risks, mining operators can proactively implement control measures to prevent accidents and mitigate potential harm to workers and the environment.

Safety management planning provides a structured approach to managing safety in mines. It involves the development and implementation of comprehensive safety policies, procedures, and protocols tailored to the specific hazards and risks present in mining operations. A well-designed safety management plan encompasses various aspects, including emergency response protocols, worker training and competency programs, regular inspections, incident reporting and investigation procedures, and continuous improvement processes. By integrating these elements, mining companies can establish a culture of safety, foster worker engagement and participation, and ensure regulatory compliance.

2.0 Why Integrating Regulatory Requirements with ISO45001:2018?

Integrating regulatory requirements with ISO 45001:2018 provides a robust framework for mining companies to enhance mines safety and effectively manage occupational health and safety risks. ISO 45001:2018 is an internationally recognized standard that sets out the criteria for establishing, implementing, and continually improving an occupational health and safety management system.

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By integrating regulatory requirements with ISO 45001:2018, mining companies can align their safety practices with both legal obligations and internationally accepted best practices. This integration ensures that mines comply with specific regulatory requirements imposed by relevant authorities, while also benefitting from the comprehensive framework provided by ISO 45001.

ISO 45001:2018 emphasizes a proactive approach to managing health and safety, focusing on hazard identification, risk assessment, and the implementation of effective controls. It encourages the involvement of workers, promoting their participation and engagement in safety initiatives. The standard also emphasizes the importance of leadership commitment and continual improvement, fostering a culture of safety within the organization.

By integrating regulatory requirements into the ISO 45001 framework, mining companies can streamline their safety management processes, eliminate redundancies, and create a unified approach to mines safety. This integration ensures that regulatory obligations are met while leveraging the benefits of ISO 45001, such as a systematic approach to hazard identification, risk assessment, and safety management planning.

3.0 Key Points from Key Regulatory Requirements

3.1 12th Safety Conference held on 28-29 January 2020 recommendations

- Strategies for Disaster Prevention in Coal Mines: KEY POINTS
- SMP shall give adequate priority on developing “Principal Hazard Management Plan (PHMP)” This shall be in Auditable mode as described in Cir 3 of 2019
- SMP shall include Emergency withdrawal and re-entry protocol based on Triggered Action Response Plan (TARP) for all Principal Hazards having potential to cause multiple fatalities
- Near Miss Cases Management:
- Encourage Reporting of Near Miss Cases
- Enquiring into them
- Communicating to all mines of own organisation and to others
- SMP to include actions to avoid recurrences

3.2 Tech Circular 4 of 2020, 24 February 2020. Prevention of “Inflammable Gas Hazards in belowground Coal Mines

Gas Hazard SMP**:** In all 2nd & 3rd degree mines SMP to include the following:

- Emergency Response
- Gas emission assessment and determine gas content threshold limits
- Gas Monitoring
- Mine Ventilation Planning
- Methane Drainage ie pre and post drainage plans
- Outburst management
- Prevention of Gas Ignition
- Spontaneous combustion etc

3.3 Tech Cir 03/ 2019 key Points related to Risk Assessment

- Since 9th Safety Conference in 2000 Self-regulation in mines by promoting risk assessment to formulate and implement SMP started.
- CMR 2017 brought it under statutory berth/ requirement
- Tech Cir 5 of 2016 brought formulation of SMP in large private & public sector mines with guidance of Directorate
- All efforts were on development on SMP, Quality of SMPs is upward.
- But implementation is not effective (it’s on paper) without auditable documentation on mitigation of identified principal hazards
- In some mines it was just to fulfil statutory compliance
- Control plans were vague without specific responsibility
- Risk ranking downgraded without objective assessment of existing controls
- Audit and review loosely used
- No visible sign of any training Implementation of SMP on an Auditable Mode
- SMP is on acceptable scale with various principal hazards identified by stakeholders of mine with assistance of experts
- Different mechanisms to be addressed in control plan for control of identified principal hazards
- Clear responsibility
- Target date
- Unique numbering
- Approved in writing
- Bound copy to be given to stakeholders

Major Steps in implementation:

- Work plan to be created with chronological order of mitigative actions
- Work plan to contain various directions, instructions etc.
- Unique reference numbering to be done with reference to SMP
- Person Responsible and Target date to be mentioned
- Person Responsible to make activities in chronological order and responsibilities identified
- Work plan to be approved by authority
- Similar sets of work plan to be made for all procedures
- Complete internal audit of the SMP. This completes One Cycle. Second Cycle to start.
- Digitization of entire SMP implementation

3.4 Tech Cir 05/ 2016 key Points

Hazard Identification & Risk Assessment

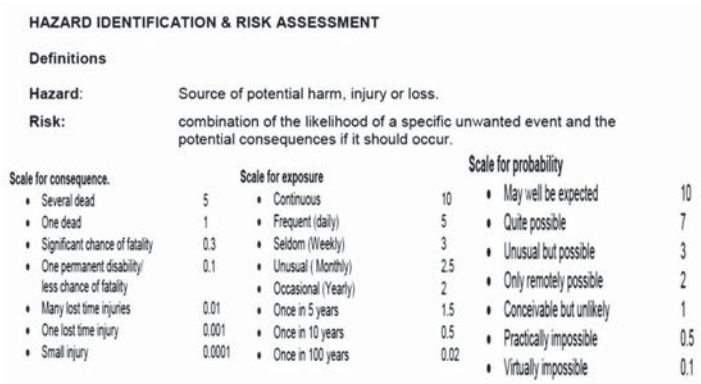
- Team Formation with Mine Manager/ Operations-in-charge as Team Leader
- Arrange Tools for Risk Management like:
- Safety Committee Minutes
- Workmen Inspectors Report
- Violations by Regulators
- Safety Officers Report
- Internal Safety Organisations reports
- If any Previous Risk Assessment Reports
- Near Miss Cases reports etc.
- Hazard Identification shall take into account system failures related to Men, Machines, Materials etc as failure of any of these constituents can lead to failures/ hazards
- While identifying hazards in classified sector, number of workers who may be exposed need to be taken in account to ascertain possible degree of consequences in the event of a mishap in following manner:

Serial No	Percentage of work persons employed	Impact assessment of exposure
1.	>40	Maximum
2.	20-40	High
3.	10-20	Medium
4.	5-10	Low
5.	<5	Very Low

28 Hazards initially identified. Few are given below:

- Existing Mine Fire – Potential for Explosion,
- Roof Fall(Strata Control),
- Mine Gases,
- Water Logged Workings,
- Surface Blasting Vibrations
- Winding Shaft etc.:

3.5 Circular no. 13 of 2002



HAZARD IDENTIFICATION & RISK ASSESSMENT

Definitions

Hazard: Source of potential harm, injury or loss.

Risk: combination of the likelihood of a specific unwanted event and the potential consequences if it should occur.

Scale for consequence.		Scale for exposure		Scale for probability	
• Several dead	5	• Continuous	10	• May well be expected	10
• One dead	1	• Frequent (daily)	5	• Quite possible	7
• Significant chance of fatality	0.3	• Seldom (Weekly)	3	• Unusual but possible	3
• One permanent disability/ less chance of fatality	0.1	• Unusual (Monthly)	2.5	• Only remotely possible	2
		• Occasional (Yearly)	2		
• Many lost time injuries	0.01	• Once in 5 years	1.5	• Conceivable but unlikely	1
• One lost time injury	0.001	• Once in 10 years	0.5	• Practically impossible	0.5
• Small injury	0.0001	• Once in 100 years	0.02	• Virtually impossible	0.1

3.6 9th Safety Conference in 2000

- Risk Management as a Tool or Development of Appropriate Health and Safety Management Systems
- Every mining company should identify one or more mines and should undertake a formal risk assessment process aimed at reducing the likelihood and impact of mishaps of all kinds in mines. Subsequently risk assessment process should be extended to other mines.
- Risk assessment process should aim at effective management of risks, by identifying,
  - o Which risks are most in need of reduction, and the options for achieving that risk reduction,
  - o Which risks need careful on-going management, and the nature of the on-going attention.
- The risk assessment exercise should follow an appropriate process.
- Risk management plan shall be prepared on the basis of risk assessment and implemented in the identified mines.

3.7 Safety Management Plan preparation under regulation 104 of CMR etc.

Coal Mines Regulations, 2017: As per CMR 3. Notice of opening shall be accompanied by- Safety Management Plan prepared under regulation 104. For existing Mines it was one year from 27th November, 2017.

As per 104. Safety management plan-

(1) The owner, agent and manager of every mine shall-
  (a) identify the hazards to health and safety
  (b) assess the risks to health and safety
  (c) record the significant hazards identified and risks assessed;
  (d) make those records available for inspection by the employees; and
  (e) follow an appropriate process for identification of the hazards and assessment of risks.

(2) The owner, agent and manager of every mine, after consulting the safety committee of the mine and Internal Safety Organisation, shall determine all measures necessary to-

(a) eliminate any recorded risk;
(b) control the risk at source;
(c) minimize the risk; and
(d) in so far as the risk remains,
(i) provide for personal protective equipment; and
(ii) institute a program to monitor the risk to which employees may be exposed

(3) Based on the identified hazards and risks, an auditable document called “Safety Management Plan” to be prepared that include:

- organizational structure
- planning
- activities
- responsibilities
- practices
- procedures, processes and resources for developing, implementing, achieving, reviewing and maintaining a safety and health policy of a company

(4) It shall be the duty of the owner, agent and manager to implement the measures determined necessary and contained in the Safety Management Plan

(5) The Safety Management Plan shall contain:
  (a) defined mine safety and health policy of the company
  (b) a plan to implement the policy
  (c) how the mine or mines intend to develop capabilities to achieve the policy
  (d) principal hazard management plans
  (e) standard operating procedures
  (f) ways to measure, monitor and evaluate performance of the safety management plan and to correct matters that do not conform with the safety management plan
  (g) a plan to regularly review and continually improve the safety management plan
  (h) a plan to review the safety management plan if significant changes occur
  (i) details of involvement of mine workers in its development and application

(6) periodically review the hazards identified and risks assessed

(7) submit a copy of the Safety Management Plan to the Regional Inspector

(8) The owner, agent and manager of every mine shall be responsible for effective implementation of the Safety Management Plan

4.0 Key Points from ISO 45001:2018 Standard

1999 OHSAS 18001 published by a group of 13 compatible with ISO 14001 for certification of management systems (Revised in 2007). In 2001 – ILO published its standard ILO-OSH:2001 Guidelines Standard - not for 'certification'. Various countries developed their own Standards - IS 15001 India, ANSI/AIHA Z-10 America, BS 8800 UK etc.

In 2018, ISO published its standard ISO 45001. It's replacing OHSAS18001 BSI Specification. ISO 45001, Occupational Health & Safety (OH&S) management system is the world's first OH&S international standard which will help thousands of organizations to provide a safe and healthy workplace for their workers and other people, prevent deaths, work-related injury and ill-health and to continually improve their OH&S performance.

The OH&S management system approach applied in ISO45001 is founded on the concept of Plan-Do- Check-Act (PDCA). The PDCA concept is an iterative process used by organizations to achieve continual improvement. It can be applied to a management system and to each of its individual elements, as follows:

4.1 Plan

- determine and assess OH&S risks
- OH&S opportunities and other risks and other opportunities
- establish OH&S objectives and processes necessary to deliver results in accordance with the organization's OH&S policy

4.2 Do

- Implement the processes as planned

4.3 Check

- Monitor and measure activities and processes with regard to the OH&S policy and OH&S objectives, and report the results

4.4 Act

- Take actions to continually improve the OH&S performance to achieve the intended outcomes
- PDCA concept into a new framework is shown in the Figure 1 below.

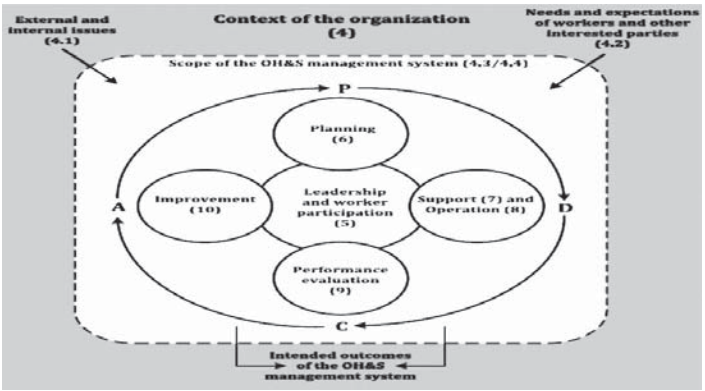


Figure 1: PDCA concept

4.5 In brief ISO45001 key requirements

a) Needs and Expectations of Different Stakeholders
b) Risks & Opportunities to be identified based on above
c) OHS Policy & Objectives

d) Hazard Identification, Risk Assessment and Control Plans for all activities
e) SOPs/ OCPs based on Present and Proposed Controls
f) Workers Participation in EHS/ Consultation and participation of workers
g) SMPs/ OAPs based on Hierarchy of controls
h) Legal/ Regulatory and other Requirements Listing and Monitoring
i) Roles, Responsibilities, Competency and Training
j) Occupational Health Monitoring
k) Emergency preparedness and response/ Mock Drills
l) Internal Audits
m) Incident, nonconformity and corrective action
n) Performance Evaluation/ Performance Monitoring
o) Management Reviews
p) Continual improvement

5.0 Few Important Definitions as per ISO45001

5.1 Injury and ill health

Adverse effect on the physical, mental or cognitive condition of a person

Note 1 to entry: These adverse effects include occupational disease, illness and death

Note 2 to entry: The term "injury and ill health" implies the presence of injury or ill health, either on their own or in combination.

5.2 hazard

Source with a potential to cause *injury and ill health.*

Note 1 to entry: Hazards can include sources with the potential to cause harm or hazardous situations, or circumstances with the potential for exposure leading to injury and ill health.

5.3 risk

Effect of uncertainty.

Note 1 to entry: An effect is a deviation from the expected — positive or negative.

Note 2 to entry: Uncertainty is the state, even partial, of deficiency of information related to, understanding or knowledge of, an event, its consequence, or likelihood.

Note 3 to entry: Risk is often characterized by reference to potential "events" or a combination of these.

Note 4 to entry: Risk is often expressed in terms of a combination of the consequences of an event (including changes in circumstances) and the associated "likelihood" of occurrence.

5.4 incident

Occurrence arising out of, or in the course of, work that could or does result in injury and ill health.

Note 1 to entry: An incident where injury and ill health occurs is sometimes referred to as an "accident".

Note 2 to entry: An incident where no injury and ill health occurs, but has the potential to do so, may be referred to as a "near-miss", "near-hit" or "close call".

Note 3 to entry: Although there can be one or more *nonconformities* (3.34) related to an incident, an incident can also occur where there is no nonconformity

6.0 ISO45001:2018 Relevant Clauses and Key points for Hazard Identification and Risk Assessment

- OH&S policy : Top management shall establish, implement and maintain an OH&S policy
- Organizational roles, responsibilities and authorities: responsibilities and authorities for relevant roles within the OH&S management system are assigned and communicated at all levels
- Consultation and participation of workers: consultation and participation of workers at all applicable levels and functions, and, where they exist, workers' representatives, in the development, planning, implementation, performance evaluation and actions for improvement of the OH&S management system.
- Provide mechanisms, time, training and resources necessary for consultation and participation. Emphasize the consultation of non-managerial workers

6.1 Actions to address risks and opportunities

The organization, in its planning process(es), shall determine and assess the risks and opportunities that are relevant to the intended outcomes of the OH&S management system associated with changes in the organization, its processes or the OH&S management system.

6.2 Hazard identification and assessment of risks and opportunities

Establish, implement and maintain a process(es) for hazard identification that is ongoing and proactive.

6.2.1 Hazard identification

The process(es) shall take into account, but not be limited to:

a) how work is organized, social factors (including workload, work hours, victimization, harassment and bullying), leadership and the culture in the organization
b) routine and non-routine activities and situations, including hazards arising from:
   1) infrastructure, equipment, materials, substances and the physical conditions of the workplace
   2) product and service design, research, development, testing, production, assembly, construction, service delivery, maintenance and disposal

3) human factors
4) how the work is performed

c) past relevant incidents, internal or external to the organization, including emergencies, and their causes
d) potential emergency situations
e) people, including consideration of:
- those with access to the workplace and their activities, including workers, contractors, visitors and other persons
- those in the vicinity of the workplace who can be affected by the activities of the organization
- workers at a location not under the direct control of the organization

f) other issues, including consideration of:
- the design of work areas, processes, installations, machinery/equipment, operating procedures and work organization, including their adaptation to the needs and capabilities of the workers involved
- situations occurring in the vicinity of the workplace caused by work-related activities under the control of the organization
- situations not controlled by the organization and occurring in the vicinity of the workplace that can cause injury and ill health to persons in the workplace

g) actual or proposed changes in organization, operations, processes, activities and the OH&S management system
h) changes in knowledge of, and information about, hazards

6.2.2 Assessment of OH&S risks and other risks to the OH&S management system Establish, implement and maintain a process(es) to:

a) assess OH&S risks from the identified hazards, while taking into account the effectiveness of existing controls;
b) determine and assess the other risks related to the establishment, implementation, operation and maintenance of the OH&S management system.

The organization's methodology(ies) and criteria for the assessment of OH&S risks shall be defined with respect to their scope, nature and timing to ensure they are proactive rather than reactive and are used in a systematic way.

6.2.3 Eliminating hazards and reducing OH&S risks

The organization shall establish, implement and maintain a process(es) for the elimination of hazards and reduction of OH&S risks using the following hierarchy of controls:

a) eliminate the hazard;
b) substitute with less hazardous processes, operations, materials or equipment;
c) use engineering controls and reorganization of work;
d) use administrative controls, including training;
e) use adequate personal protective equipment.

NOTE: In many countries, legal requirements and other requirements include the requirement that personal protective equipment (PPE) is provided at no cost to workers.

6.2.3 Emergency preparedness and response

The organization shall establish, implement and maintain a process(es) needed to prepare for and respond to potential emergency situations,

6.2.4 Internal audit programme

6.2.5 Management review

6.2.6 Incident, nonconformity and corrective action

6.2.6 Continual improvement

The organization shall continually improve the suitability, adequacy and effectiveness of the OH&S management system,

7.0 Integrated Approach

A simplified Flowchart of Integrated Approach is shown in Figure 2 below:

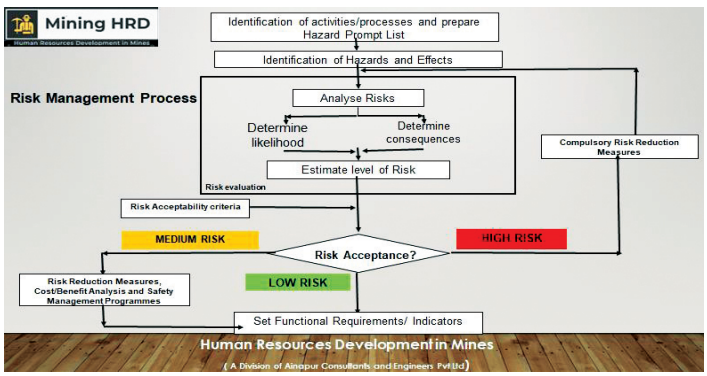


Figure 2 Simplified Flowchart of Integrated Approach

7.1 First Step of identifying activities in mines should address all activities which are Routine and non-routine in nature. Also activities performed by others like contractors/ suppliers/ outsourced and the activities performed in nearby areas which have impact on our employees' Health & Safety. A sample list is given below:

Sample List of Activities in Mines

Routine Activities		Non-Routine Activities
Drilling	Nallah chipping	Bad roof supporting
Blasting	Tub repairing	Hauler & Pump Erection
Supporting	Blacksmith works	Rope changing
Coal Loading	Stowing	Old working Inspection
Tramming	Pipe Laying	Rescue Operation
Lorry Transporting	Support Withdrawing	Tunnelling
Pumping	Surveying	Ventilation Survey
Wall Construction	Maintenance & Repair (In pit/ Outside)	Visitors
House Keeping	Transport of men & Material	Sub-station installation & Maintenance
Stone Dusting	Explosive Storage	Installation of Pumps/Equipment/ Conveyor
Welding	Bit Grinding	Shifting of Machineries
Linemen Works	Surface Fan Operation	Installation of Fan/ Aux. Fan
Lamp Room Operation	Cooking in Canteen	Tail end shifting
Supervision	Carpentry	Auxiliary fan duct extension
LHD operation	Tub Repairing	Rope Splicing
Coal Cutting by Shearer	Diesel Filling	Pulley Shifting
Scavenging	Analysis/ Lab activities	Bore Hole Drilling
Pipe erections	PME	Belt Jointing/ Extension
Accident Enquiry		Track Laying
		Calibration of Ventilation Equipment
Performed by Others	Performed in nearby area	
Machine maintenance by Service engineers Studies by Scientific bodies	Blasting in nearby mines CHP Operation Power plant Operation Coking Coal Plant Dam Construction Brick Plant	

7.2 Second Step is to identify potential hazards. For this, we have to list steps involved in each activity and use following questions:

What can go wrong? → Hazard identification
How often does it happen? → Frequency analysis
How severe is it? → Consequence analysis

Few Hazards are listed below, as sample:

- Slips/falls on the level :
- Fall of persons from heights:
- Fall of tools, materials, etc, from heights:
- Inadequate headroom
- Hazards associated with manual lifting/handling of tools, material, etc; (ergonomical factors)
- Hazards from plant and machinery associated with assembly, commissioning, operation, maintenance, modification, repair and dismantling;
- Vehicle hazards, covering both site transport and travel by road:
- Fire and explosion:
- Violence to staff;
- Substance that may be inhaled;
- Substances or agents that may damage the eye (dust/ smoke/oil leakages etc.)
- Substances that may cause harm by coming into contact with, or being absorbed through the skin;
- Substances that may cause harm by being ingested (for example, entering the body via the mouth); (diesel sucking, acids pipeting, acid fumes at lab)
- Harmful energies (for example electricity, radiation, noise, vibration);
- Work-related upper limb disorders resulting from frequently repeated tasks; (loading the ore in to the trucks, etc.)
- Thermal environment for example too hot;
- Lighting levels; (working at night with less light.) etc..
- Slippery, uneven ground/surfaces; (rainy session / sprinkling water, oil spillage etc.,)
- Inadequate guardrails or hand rails on stairs; (near plants/gen sets / conveyors etc.)
- Flying stones (blasting / shoveling / unloading etc.,)
- Misfires
- Blasting fumes/ gases
- Bench side/slope failure or fall of boulders etc., from sides
- Inundation
- Spontaneous combustion
- Fall from bench etc..

Base risk assessment ignores existing controls and therefore evaluates the inherent risk associated with an activity or situation.

- Base risk assessment is used to identify whether an activity or situation has a sufficient level of associated risk to merit its management through the OH&SMS (i.e. responsibilities allocated, performance monitored and audited, performance recorded, training given etc.)
- Residual risk assessment

Residual risk assessment takes into account the level of risk while the activity is under the control of the organization

- Residual risk is therefore used to measure how well an activity or situation is managed
- Where the level of residual risk is unacceptable high controls need to be modified or the risk eliminated in some way
- This type of risk assessment is often used to identify objectives for system improvement

7.3 Calculating Risk

Risk Score = Likelihood X consequence

Risk= Probability X exposure X consequence

8.0 Different Risk Assessment Scales

There are different types of Risk Scoring Scales/ Assessment methos, but we have to take following steps before selecting any scale:

- Select any scales/ scoring guidelines
- Check it's suitability by assessing 2 or 3 commonly know Hazards in your mines
- If it is inline with your normal perceptions, accept it
- Train All the team members on that scale
- It is important to have same level of understanding on ranking of hazards as we are going to compare Mine Level Hazards
- Every department should use same scales as we have to select High Risk Hazards in our Mine (not within departments as Highest Risky activity in a department may be the Lowest risk activity in our Mine)

8.1 Few more sample scales are given in Figures 3,4,5 below.

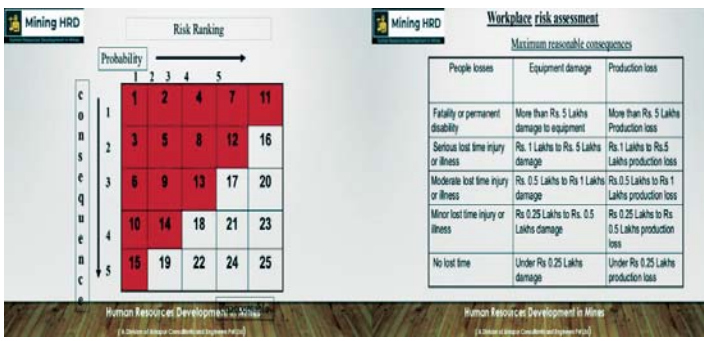


Figure 3: Example of sample scale

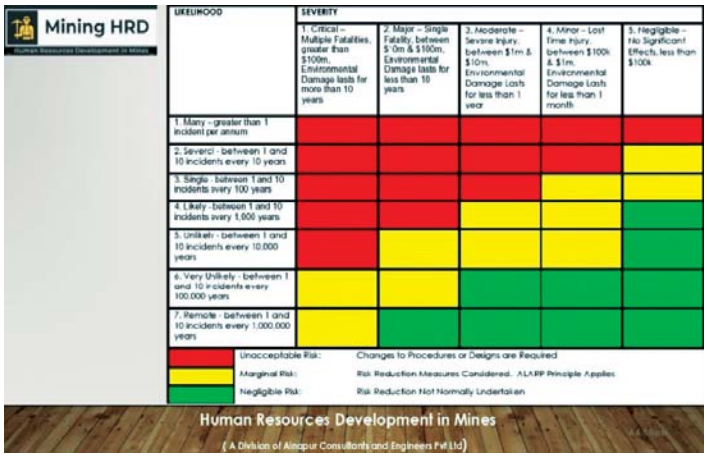


Figure 4: Example of sample scale

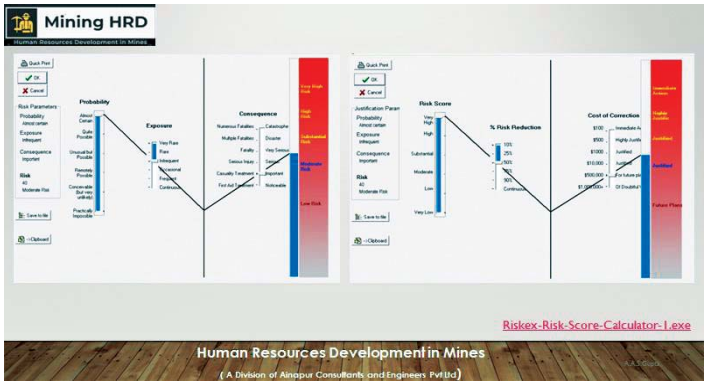


Figure 5: Example of sample scale

9.0 Sample Risk-Based Control Plan

Risk level- (1)	Action and Time Scale- (2)
TRIVIAL	No action is required and no documentary record needs to be kept.
TOLERABLE	No additional controls are required. Consideration may be given to a more cost-effective solution or improvement that imposes no additional cost burden. Monitoring is required to ensure that the controls are maintained.
MODERATE	Efforts should be made to reduce the risk, but the cost of prevention should be carefully measured and limited. Risk reduction measures should be implemented.
SUBSTANTIAL	Work should not be started until the risk has been reduced. Considerable resources may have to be allocated to reduce the risk where the risk involved work in progress, urgent action should be taken.
INTOLERABLE	Work should not be started or continued until the risk has been reduced. If it is not possible to reduce risk even with unlimited resources, work has to remain prohibited.

10.0 RISK CONTROL HIERARCHY

10.1 Elimination- Modification to the process method or material to eliminate the hazard completely (100%).

Examples: removing the hazard; stopping using hazardous chemicals; applying ergonomics approaches when planning new workplaces; eliminating monotonous work or work that causes negative stress; removing fork-lift trucks from an area

10.2 Substitution – Replace the material, substance or process with a less hazardous one (75%).

Examples: replacing the hazardous with less hazardous; changing to answering customer complaints with online guidance; combating OH&S risks at source; adapting to technical progress (e.g. replacing solvent-based paint by water-based paint; changing slippery floor material; lowering voltage requirements for equipment)

10.3 Separation – Isolating the hazard from persons by safeguarding or by space or time separation (50%).

Examples: Engineering controls, reorganization of work, or both: isolating people from hazard; implementing collective protective measures (e.g. isolation, machine guarding, ventilation systems); addressing mechanical handling; reducing noise; protecting against falls from height by using guard rails; reorganizing work to avoid people working alone, unhealthy work hours and workload, or to prevent victimization.

10.4 Administration – Adjusting the time or conditions of risk exposures (30%).

Examples: conducting periodic safety equipment inspections; conducting training to prevent bullying and harassment; managing health and safety coordination with subcontractors' activities; conducting induction training; administrating forklift driving licences; providing instructions on how to report incidents, nonconformities and victimization without fear of retribution; changing the work patterns (e.g. shifts) of workers; managing a health or medical surveillance programme for workers who have been identified as at risk (e.g. related to hearing, hand-arm vibration, respiratory disorders, skin disorders or exposure); giving appropriate instructions to workers (e.g. entry control processes).

10.5 Training – Improving skills therefore making tasks less hazardous to persons involved (20%).

10.6 Personal protective equipment – Using as the last resort, appropriately designed and properly fitted equipment where other controls are not practicable (5%).

Examples: providing adequate PPE, including clothing and instructions for PPE utilization and maintenance (e.g. safety shoes, safety glasses, hearing protection, gloves)

10.7 The action plan should be reviewed before implementation, typically by asking

- Will the revised controls lead to tolerable risk levels?
- Are new hazards created?
- Has the most cost-effective solution been chosen?
- What do people affected think about the need for, and feasibility of, the revised preventive measure?
- Will the revised controls be used in practice and not ignored in the face of for example pressures to get the job done?

11.0 Conclusion

Hazard identification involves identifying potential sources of harm, such as machinery malfunctions, chemical exposures, or unstable ground conditions. Risk assessment entails evaluating the likelihood and severity of identified hazards to determine the level of risk they pose.

Overall, the importance of effective hazard identification, risk assessment, and safety management planning in mining cannot be overstated. These practices help prevent accidents, safeguard the health and well-being of workers, protect the environment, and contribute to the sustainability and long-term success of mining operations.

Training all the team members on the scale used is very important to bring same level of understanding on ranking of hazards as we are going to compare Mine Level Hazards. Every department should use same scales as we have to select High Risk Hazards in our Mine (not within departments as Highest Risky activity in a department may be the Lowest risk activity in our Mine).

12.0 Acknowledgment

I would like to extend my sincere appreciation to the numerous experts, professionals, and institutions who were associated with DGMS in the preparation of Risk Assessment Guidelines/ Circulars and to those who were associated with the preparation of ISO45001:2018 standard. Their contributions have been instrumental in bringing together the critical information and guidance on mine safety, hazard identification, risk assessment, and safety management planning.

13.0 References

1. International Organization for Standardization (ISO) standard ISO 45001:2018 - Occupational Health and Safety Management Systems - Requirements
2. Director General of Mines Safety
3. https://safetyrisk.net/
4. Experiences of Dr Ajaya Gupta. During his employment in Tata Steel (Mines Division), during consultancy to MSPL Iron Ore Mines, Sandvik, KPCL Raichur, Abhijeet Group, Dangote Mines, Training sessions in Singareni Collieries etc.

MEAI NEWS

MEAI HEADQUARTERS

MEAI TECH SERIES – Nov 2023 (MTS–17)

In continuation of the Technical Series, MEAI without break conducted the SEVENTEENTH PRESENTATION of "MTS-17" on 22nd December 2023 (Fri) at 06:30 pm Online on WebEx platform.

The topic presented was MINE SCHEDULING PROCESS and the Speaker was Mr Venkat Ramana Rao Masabtula. Large number of professionals had joined and lauded the disquisition.

The interactive session concluded with a Vote of Thanks proposed by Mr T.R. Rajasekhar, Consultant, to the speaker for having taken pains for the preparation of the wonderful presentation and to all the participants for their kind attention.

BELLARY HOSPET CHAPTER

WORKSHOP On NEW TRENDS IN MINING SOLUTIONS BY PUZZOLONA GROUP

Date: 20th November, 2023. Venue: Hotel Malligi, Hospet

More than 120 members attended the Work shop on – New Trends in Mining solutions by Puzzolana Group at Hotel Malligi, Hospet. Dr. Meda Venkataiah, Executive Director Mines / Nominated Owner, MSPL Limited graced the occasion as the Chief Guest. The Chapter Office-bearers, EC & DC members, Chapter Members and representatives of Trade vision Group attended the workshop.

Workshop started with the welcoming of the dignitaries on to the dais by Sri Sandeep, Manager Mines.

Sri Sandeep welcomed the dignitaries on the dais viz. Dr. Meda Venkataiah, Executive, Chief Guest of the programme, Trade Vision India Dignitaries Sri Nagaraj, Managing Director; Sri DVR Prasad, Vice President; Sri SHM Mallikarjuna, Chapter Chairman; Sri P Venkateswara Rao, Chapter Secretary; and Sri J Srikanth, Chapter Treasurer occupied the dais and started the workshop by watering the plant.

Sri Mallikarjuna SHM presented the welcome address to the August gathering. He said that the Screening and Crushing are some of the most important activities in Mining and requested everyone present to make best use of the opportunity to enlighten their skills and knowledge. He thanked the Dignitaries of Trade vision India for coming over and accepting to present a much-needed workshop on the important subject and also thanked the entire BH Chapter crew for arranging the Workshop.

Sri K V Nagaraj, Managing Director, Trade Vision India, addressed the gathering on this memorable occasion and explained the Business of Puzzolana Group and also showed the videos of various types of crushers and their specifications. He also presented the videos of their manufacturing plants located at Hyderabad and Bangalore. He was happy to announce that his group is holding more than 60% share in the market in Telangana and Bangalore. He also shared that their products are completely indigenous and they have been in use in the Bellary- Hospet sector for more than 25 years. He thanked the Chief Guest and members of the BH Chapter for the opportunity given to them to share

their products and information in front of all the concerned Mining, Mechanical and Electrical Engineers.

Sri D.V.S.R Prasad, Vice President, Tech. Trade Vision India commenced the presentation by providing a clear overview of the subject matter. The structure was well-organized, guiding the audience through a logical sequence of ideas. The presentation seamlessly blended informative content with visually appealing slides, enhancing the overall learning experience. He Explained about Various types of crushers, safety features in crushers, and also recent developments in the technology. And he also noted that their commitment towards the machinery Standards. The Q&A session that followed the presentation allowed participants to seek clarification and delve deeper into specific aspects. Sri D.V.S.R Prasad handled questions adeptly, demonstrating a comprehensive understanding of the subject matter.

Sri K V Nagaraj, Managing Director, Trade vision India, Sri D.V.S.R Prasad, Vice President Tech and other members of their team felicitated the dignitaries on the Dais right from Dr. Meda venkataiah, Sri Mallikarjuna SHM, Sri P Venkateswara Rao and Sri J Srikanth, Chairman, Secretary and Treasurer of the MEAI BH Chapter for their Support in conducting the Workshop.

Dr. Meda Venkataiah commenced the address by expressing gratitude for the invitation and conveyed his warm wishes to the organizers and participants of the event. He expressed that the topic of the workshop was appropriate and need of the hour. He opined that this is the time to rethink and reduce the cost of the screening and crushing as the open market is facing a tough time after the MMDR Amendments. He felt that we all need to focus on the efficiency and cost savings in order to keep the cost under control as the cost of finished goods are almost fixed. He also shared that they might be the first private company in the sector to start screening and crushing those days apart from NMDC. He thanked the Trade Vision team and BH Chapter team for organizing such a wonderful workshop to enlighten the skills of the Mining fraternity.

Sri. P Venkateswara Rao, Secretary BH Chapter proposed vote of thanks to the members present at the Workshop and thanked the Chief Guest, Managing Director & Vice President of Trade Vision India group and their team, BH Chapter members and everyone that attended the Workshop and also thanked the staff of Hotel Malligi, Hospet for extending their support in conducting the function in a grand manner.

This programme was followed by dinner.

HYDERABAD CHAPTER

One Day Workshop for Students on "Industry Institute Interaction"

The workshop was organized by the Chapter on 9-12-2023 at MEAI Auditorium – Hyderabad.

Shri. L. Krishna, Secretary welcomed all the dignitaries on to the dais. Dr. S.K. Sinha, Dy. General Manager, NMDC, Dr M S. Venkataramayya – Vice Chairman, Hyderabad Chapter, Shri. M. Narsaiah – Secretary General, MEAI, Shri. Venkat Ramana Rao Masabattula, Lead Mining Engineer, Stanmore Resources and Dr. N Sri Chandrahas, Assistant Professor, MREC.

Over 100 Students participated from Malla Reddy Engineering College, JB Institute of Technology (JBIT) and Osmania University, Hyderabad.

Keynote address on abroad experience by:
1. Presentation by Dr. S.K. Sinha
2. Presentation by Sri. Venkat Ramana Rao Masabattula
3. Presentation by Dr. N. Sri Chandrahas

Felicitation to the presenters for supporting the Workshop

Group photograph of the attendees and the presenters

(Continued from Page 13)

the areas' habitats, ecosystems, biodiversity and resources, it added.

While it's unclear what materials, if any, can be exploited, the claims come as Washington seeks to boost access to so-called critical minerals that are necessary for electric vehicle batteries and renewable energy projects, industries the Biden administration has tagged as key national security concerns. Meanwhile, there are competing calls to protect the fragile Arctic environment — the fastest warming part of the planet — as climate change opens up the region to potential development.

Resource potential

The US continental shelf contains 50 hard minerals, including lithium and tellurium, and 16 rare earth elements, James Kraska, chair and professor of International Maritime Law at the US Naval War College, wrote in an article this week. The extension "highlights American strategic interests in securing these hard minerals on its seabed and subsoil, lying sometimes hundreds of miles offshore," he wrote.

The most recent assessment by the US Geological Survey, conducted in 2008, estimated that about 90 billion barrels of undiscovered oil and 1,670 trillion cubic feet of gas lie inside the Arctic Circle, along with critical metals needed for electrification. However, most of that estimate is based on land studies and the offshore potential is largely unexplored.

More than half of America's extended continental shelf — 520,400 square kilometers — stretches in a large wedge north of Alaska toward the Arctic Ocean, including an area that overlaps with Canadian claims to the seabed floor, according to the US statement.

Another 176,300 square kilometers lies in the Bering Sea, between Alaska and Russia, but falls on the US side of the maritime boundary between the two countries. Canada and the US don't have a maritime boundary agreement in the Arctic and establishing the US outer limits in the Arctic "will depend on delimitation with Canada," the State Department said in its executive summary.

Canada's Ministry of Foreign Affairs didn't respond to a request for comment.

Law of the Sea

The 1982 United Nations Convention on the Law of the Sea, which the US never ratified, governs maritime zones around countries. Under the law, countries have the right to any resources in the sea or seabed floor

within their so-called exclusive economic zones, which can stretch up to 200 nautical miles off the coast.

But beyond that, they can claim economic rights to resources on or below the seabed floor where their continental shelf extends, although not within the water column. The seas above also remain international waters. Russia, Denmark and Canada have waited years for their overlapping Arctic seabed claims to be reviewed by the Commission on the Limits of the Continental Shelf, a UN supported group, with Russia the first to receive a ruling earlier this year.

The State Department said in its response to questions that the US would need to establish maritime boundaries in the future with Canada, the Bahamas and Japan where their claims overlap. It added that the US uses the same rules to determine its extended continental shelf as in UNCLOS, which it said the Biden administration supports joining.

The decision to unilaterally delineate its continental shelf boundary, rather than to ratify UNCLOS and then submit a claim through the commission, may raise the ire of other countries, said Pincus at the Wilson Center.

"I think a lot of other countries around the world are going to have thoughts about how the US has done this," she said. It also may reduce the likelihood of the US ever ratifying the law since a major reason for doing so would have been to make a CLCS claim, she said.

Bloomberg News | December 22, 2023

MEAI PROFESSIONAL DEVELOPMENT PROGRAM – MPDP-IV

MEAI PROFESSIONAL DEVELOPMENT PROGRAM (MPDP - IV)

TOPICS FOR 4th COURSE OF MPDP

TOPICS	FACULTIES
Hyperspectral Remote Sensing & It's Applications	Prof Anup Prasad IIT(ISM)
(a) MMDR 1957 ; (b) MCDR 2017 ; (c) Environment Clearance of Mining Projects (d) Mineral Laws & Environmental Clearance	Mr AR Vijay Singh, BE (Mining), FCC (IC), FCA, Chartered Accountant
Mining Legislation and Management of Mines	Mr Susheel Kumar, Director, Govt of Telangana, Hyderabad
Advances in Drilling & Blasting Technology - Few Case Studies	Dr More Ramulu, Chief Scientist, CIMFR
Geostatistics in Mineral Industry	Prof Bhabesh C. Sarkar IIT (ISM), Dhanbad
Future Trends towards Zero Emission Technology in Excavators & Dumpers	Mr Suresh Nair, VP, Tata Hitachi Sales & Marketing, Bangalore
Mineral Auction	Mr Sabyasachi Nayak, Director Mine Magma, Bhubaneswar
(a) Safety Management Plan; (b) AI & IoT in Mine Safety; (c)Spectacular RESQ & Adventures;(d) Innovative Technologies in Opencast Mining; (e) Cost Parameters in Mineral Industry	Mr Deepak Vidyarthi, Consultant Mining, Assessor NABET -QCI, Bangalore
Mineral Resources & Reserves - Classification & Reporting	Dr Abani R Samal, Principal, Geo Global LLC, USA
Building High Performing Teams to Navigate Business Challenges	Dr Debabrat Dash, VP - HR & Admin, MSPL Limited, Hosepet
Strategic and Tactical Mine Planning for Opencast Mines	Mr Suryanshu Choudhury, Head, Mine Planning, GMDC, Ahmedabad
Mine Waste Utilization	Dr Ram Chandar Karra, Asstt Prof & Former HOD, Mining Engg, NITK, Surathkal
FC Act – Evolution of SEZ – impact of SC Decisions	Mr KAV Prasad, VP Legal, MSPL Limited, Hosepet
Recent Changes in Mining Plan Submission & FMCP	Mr T.R.Rajasekhar, Consultant, Bangalore
Forest Clearance of Mining Projects	Mr K. Madhusudhana President MEAI, CEO, MSPL Limited, Hosepet
Digitalization for Productivity Enhancement in Mines	Mr Mahesh Kumar, Consultant IT, Minematics, Hyderabad

MEAI PROFESSIONAL DEVELOPMENT PROGRAM (MPDP - IV)

COURSE FEES

MEAI Members	Non MEAI Members
Rs 15,000 +18% GST	Rs 20,000 +18% GST

Interested professionals may please contact Sri M. Narsaiah, Secretary General, MEAI at meai1957@gmail.com / Phone no. 040- 66339623 / 040-23200310, or Sri Deepak Vidyarthi, Chairman, Training, Development & Program Committee of MEAI at vidyarthikm@hotmail.com for more details.

Payment of COURSE FEE may be made at A/c no. 0387810100086016; IFSC: UBIN0803782 ; Bank: UNION Bank of India, Nampally Station Road, Telangana – 500 001

REGISTRATION: For Registration, please click on the following link:
https://forms.gle/ScP8nrFcbAynhyTd8

Members of Training, Development & Program Committee of MEAI

The previous courses were successfully held online on WebEx platform on three consecutive week-ends and were well attended by 26 participants from 08 reputed mining organizations including NMDC, Tata Steel, MSPL, HGML, JSW, besides a few independent consultants. 24 technical sessions were conducted by 16 eminent faculties and industry experts covering 20 relevant subjects. Participants were awarded Certificates of participation. Attendance and Assessment tests are mandatory for all participants to be eligible for the "MPDP Certificate".

WHO SHOULD ATTEND?

The MPDP Course will benefit Mining Professionals, Engineers, Geo-technical Engineers, and Mineral Exploration Geologists working in the mineral industry (mid-level to senior level)
Additional attraction for RCPs: Those who attend the course will get a credit of 40 points!!!

Deepak Vidyarthi,
Chairman, Training, Development & Program Committee

NACRI (NRO) & MEAI (PO) JOINT COMMITTEES FOR THE TERM 2023-2025

(AS REQUIRED BY NACRI CHARTER, 2019)

1. Ethics Committee of MEAI (NACRI Members, Min = 2) - term of office: 2 years
(Members are supposed to be seniors and well respected in the society)

1.	Mr SN Mathur	President- MEAI	Chairman
2.	Mr T Victor	Past President- MEAI	Member
3.	Mr Arun Kothari	Past President- MEAI	Member
4.	Mr Sanjay Pattnaik	Past President- MEAI	Member
5.	Mr K Madhusudhana	Past President- MEAI	Member
6.	Dr PV Rao	Co-Chair NACRI	Member
7.	Dr Abani Samal	NACRI	Member
8.	Secretary General	Secretary General-MEAI	Member Secretary

2. Complaints Committee of MEAI (NACRI Reps, Min = 2) - term of office: 2 years
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3.	Mr Dhananjaya G. Reddy	VP-II MEAI	Member
4.	Mr Laxman Singh Shekhawat	VP-III MEAI	Member
5.	Mr TN Gunaseelan	NACRI	Member
6.	Dr A Srikant	NACRI	Member
7.	Dr AK Sarangi	NACRI	Member
8.	Mr M Narsaiah	Secretary General-MEAI	Member-Secretary

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5.	Mr Shameek Chattopadhyay	NACRI	Member
6.	Dr SK Sinha	NACRI	Member
7.	Mr B Sahoo	Jt Sec. cum Treasurer-MEAI	Member-Secretary

4. Professional Development Program (PDP) Committee - term of office: 2 years
(Professional Training on IMIC and Code of Ethics Conducted by NACRI and Facilitated by MEAI HQs & Chapters)

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3.	Mr Dhananjaya G. Reddy	VP-II MEAI	Member
4.	Mr Laxman Singh Shekhawat	VP-III MEAI	Member
5.	Mr M Narsaiah	Secretary General-MEAI	Member
6.	Dr PV Rao	Co-Chair NACRI	Member
7.	Dr Abani Samal	NACRI	Member
8.	Dr A Srikant	NACRI	Member
9.	Mr TN Gunaseelan	NACRI	Member
10.	Mr Pankaj Satija	NACRI	Member
11.	Mr Shameek Chattopadhyay	NACRI	Member
12.	Mr KS Solanki	NACRI	Member
13.	Dr AK Sarangi	NACRI	Member
14.	Mr Deepak Rathod	NACRI	Member
15.	Mr TR Rajasekar	NACRI	Member-Secretary

(SN Mathur)
President, MEAI &
Co-Chair NACRI

(Dr PV Rao)
Co-Chair NACRI

CONFERENCES, SEMINARS, WORKSHOPS ETC.

INDIA

8-10 Jan 2024: International conference on **"Advanced technology in exploration and exploitation of minerals"**. Organized by MEAI Rajasthan Chapter-Jodhpur at Hotel Shri Ram International, Jodhpur, Rajasthan, India. For details contact: meai_jodhpur@yahoo.co.in. website: www.meai.org

18-20 Jan 2024: **ICGEID 2024. 2nd International Conference on Geotechnical Issues in energy, infrastructure, and disaster management**. Venue: Auditorium complex, IIT Patna. Organized by Department of civil and environmental engineering. For details contact: Dr Amit kumar verma at infoicgeid24@iitp.ac.in or +91 7781012407

16-17 Feb 2024: National conference on **"Advanced iron ore beneficiation & Sustainable low-grade utilization"**. Organized by MEAI Hyderabad Chapter & NMDC Limited at Hyderabad, Telangana, India. For details contact: meai1957@gmail.com or sinhask@nmdc.co.in. Website: www.meai.org

ABROAD

10-11 Jan 2024: **Future Minerals Forum (FMF 24)-Conference and Exhibition**. VENUE KING ABDULAZIZ INTERNATIONAL CONFERENCE, CENTER, RIYADH, SAUDI ARABIA. For Speaking Enquiries speaker@futuremineralsforum.com.

11-12 Jan 2024: **International Conference on Mineral Processing and Mining ICMPM 2024**. Singapore. Organised by World Academy of Science, Engineering and Technology. Website URL: https://waset.org/mineral-processing-and-mining-conference-in-january-2024-in-singapore

8-9 Feb 2024: **International Conference on Web Mining, Information and Knowledge Extraction (ICWMIKE 2024)**. Lisbon, Portugal. Website URL: https://waset.org/web-mining-information-and-knowledge-extraction-conference-in-february-2024-in-lisbon; Contact URL: https://waset.org

18-19 Feb 2024: **International Conference on Bauxite Mining and Alumina Refining ICBMAR 2024**. Jeddah, Saudi Arabia. Website URL: https://waset.org/bauxite-mining-and-alumina-refining-conference-in-february-2024-in-jeddah

4-5 Mar 2024: **Carbon Capture Summit 2024**. Dubai 12345, United Arab Emirates. Web site: https://www.middleeast.carbon-capture-conference.com/booking

4-5 Mar 2024: **International Conference on Mining Intelligence ICMI 2024**. Rio de Janeiro, Brazil. Website URL: https://waset.org/mining-intelligence-conference-in-march-2024-in-rio-de-janeiro

4-8 Mar 2024: **The 17th ACM International Conference on Web Search and Data Mining (WSDM)**. Event Location: Mérida, Yucatán. Contact wsdm-2024-general-chairs@googlegroups.com

10-13 Mar 2024: EnviroTech Lisbon, 2024 - cement conference. Hotel Cascai Miragem Health & Spa, Av. Marginal 8554, 2754-536 Cascais, Lisbon, Portugal. Contact details: 15 South Street, Farnham, Surrey, GU9 7QU, United Kingdom, Tel: +44 (0)1252 718 999, Email: enquiries@globalminingreview.com

11-12 Mar 2024: **Australia Carbon Capture Summit 2024**. Perth, Western Australia 6000. Website: https://www.australia.carbon-capture-conference.com/booking

17-18 Apr 2024: **Deep Sea Mining Summit**. London, UK, London, WC1 United Kingdom. Website: https://www.deepsea-mining-summit.com/index

22-23 Apr 2024: **International Conference on Recent Developments in Mining Technologies ICRDMT 2024**. London, United Kingdom. Website URL: https://waset.org/recent-developments-in-mining-technologies-conference-in-april-2024-in-london

23-25 Apr 2024: Exhibition Mining World Russia. 28th exhibition of machines and equipment for mining, processing and transportation of minerals. Moscow, Crocus Expo, pavilion For details contact: Ms. Natalia Medvedeva, Portfolio Director, ITE Group, Email: natalia.medvedeva@ite.group. Web link: https://miningworld.ru/en/media/news/2023/august/17/equipment-for-mining-industry-in-russia.

7-8 May 2024: **International Mining Geology Conference 2024 (IMG 2024)**. Perth Convention and Exhibition Centre, Perth, Australia. For details contact conference@ausimm.com

17-18 May 2024: **International Conference on Surface Mining and Land Reclamation ICSMLR 2024**. Sydney, Australia. Website URL: https://waset.org/surface-mining-and-land-reclamation-conference-in-may-2024-in-sydney

21-23 May 2024: **Discoveries 2024 Mining Conference.** Mazatlan International Center, Av. del Delfin 6303, Marina Mazatlán, 82103 Mazatlán, Sinaloa, Mexico. Website https://www.discoveriesconference.com/

17-19 Jun 2024: **Molten 2024**. Brisbane, Australia and Online. Contact AusIMM. T: 1800 657 985 or +61 3 9658 6100 (if overseas)

18-19 Jun 2024: **Direct Lithium Extraction Summit 2024**. Denham Grove Hotel, Tilehouse Ln, Denham, Uxbridge, UB9 5DG United Kingdom. Website:http://energy.apexevents.cn/

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