Summary of Workshop-2
on
Technology Roadmap
for
Coal Sector Organized by
Coal India Limited

Volume-II (Part B)

Table of Contents

Workshop on Technology Roadmap for Coal Sector
Organized by Coal India Limited under the aegis of Ministry of Coal
Date: 15th March 2022
Venue: CIL, Kolkata and through Weblink.

1. Inaugural Session

Chairman, Coal India Limited along with Director (Marketing), Director (Technical), CVO, Sr. Advisor (Finance), CIL and Advisor (Project), MOC inaugurated the workshop on Technology Roadmap at Auditorium, CIL and virtually.

Director(Technical) in his address welcomed all the dignitaries, delegates and all the speakers, authors. In his address, he drew the attention towards the fact that in the coming decade opencastable coal of all shallower depth shall be exhausted & in order to maintain production level of 1 Billion Tonne, it is imperative that more & more of production is to be from highwall mining and other reliable method. The revival of growth of high capacity UG mines shall be the top priority.

Advisor (Project), MoC in his address, informed the audience that this is the 2nd workshop is being organised in the series on Technology Roadmap in coal sector. The 1st workshop was held in January 2022 at CMPDI, Ranchi and the subject covered viz. exploration, underground coal mining technology, Transportation, Surveying and remote sensing, communication, opencast mining technologies, environment, new technologies and R&D, mine planning & scheduling, information technologies, artificial intelligence. He talked about the relevance of the workshop on Technology Roadmap on present mining scenario.

Chairman, CIL in his Keynote address emphasised mainly on three important aspects. He emphasised on resilience of an organisation, mainly technical, financial & environmental. He further stressed that digitization shall play a crucial role in growth and sustenance of the company in the future. He also concurred with D(T), CIL and reiterated that in view of environmental & social compulsions underground mining has to be taken up on priority.

Total ten papers were presented in the whole day workshop from 10.00am to 5.30pm. Around 130 nos. delegates were joined physically and virtually from India, Australia and UK.

2. Technical Session IA

Insights shared by Dr.Rao on applicability of Highwall Mining in India with special reference to the design guidelines of Highwall mining index (HMI) and the odd parameters that are to be considered prior to selection of highwall mining, special mention of applicability of Punch Longwall can be explored by subsidiaries of CIL for higher extraction of coal.

Experience sharing on Highwall coal mining case study by Sharda Project highlighted the challenges and lessons learnt from the project.

3. Technical Session IB

1st presentation was made by Mr. Subhankar Bhattacharya & Mr. Rajat Chakraborty from Larsen & Toubro. Through this presentation they had enlighted about different conditions where we can adopt of Surface miner and Ripper successfully. From their valuable inputs we have learned that removal of OB is also feasible through surface miner.

2nd speaker Dr. Bhattacharya highlighted about Sustainable Mining in coal with Environmental Sustainability in wake of climate change narrative. We are committed to responsible coal production through smart, safe and sustainable mining with coal as primary driver of energy in the nation. The valuable inputs of Dr. Bhattacharya on different aspects of underground coal mining would be surely taken into consideration by the attendees.

3rd speaker Mr. Jonas Stahlbage, MD, STM Construction Equipment Pvt. Ltd. gave a blast free open cast mining operation option, i.e. Xcentric Ripper. This gave ensure our commitment towards safety while keeping the economics under consideration. Our subsidiary company SECL has already adopted this kind of OBR technique.

4. Technical Session II

Sri Jayanth Bhattacharya presented on behalf of Gainwell Commosales Pvt. Ltd. on Highwall Mining potential in India. He presented that Highwall Miners have potential for mining seams from 1m to 5m to a depth of 300 meters. Production rates vary from 40,000 Tonnes to 100,000 Tonnes per month depending on thickness of seam. Machines are being manufactured in India from their plant near Asansol under license from Caterpillar USA.

Sri Ajay Kumar Sharma, GM Jhanjra Area presented case studies on Jhanjjra Coal Mine of ECL. He presented that longwall are suitable at standard heights whereas Continuous Miners may be used for low heights. This UG mine has highest production in CIL. It is poised to achieve highest production in 2021-22 of 3.6 Million Tonnes. Panel length needs to be increased from present length of 700m to 1500m so as to increase production and productivity. For greater productivity & viability, panel lengths upto 1.5 kms are crucial.

5. Technical Session III

Shri N V K Srinivas, GM, SCCL presented case studies on Adriyala Project. The best practices shared by SCCL Adriyala Project needs to be replicated, specially how SCCL integrated learning from previous LW projects and incorporated the best technical advice on Length of LW face, Width of LW face, Modernization of Equipment, face automation.

Shri Manish Mishra, GM, West Bokaro, TATA steel shared the best practices on optimizing the coal beneficiation using the best available resources, digital and technological upgradation, infrastructure for eco-friendly transport and strict quality assurance along with customer centric approach.

Such case studies help cross learning across the industry and helps in introspect on what can be done to improve safety, productivity and upgrade the technology.

Sri Debashri Mitra on behalf of M/s Eimco Elecon, presented on Mining Machineries product. He covered on Technical & Operational details of mining machineries viz. Mechanised Loading and Drilling Machine, Side Discharge Loader(SDL), Load Haul Dumper(LHD), Universal Drilling Machine, Continuous Miner(CM) package,CM-3000, TRS-Roof Bolter,10 Te Shuttle Car.

Participation by the manufactures/vendors like Gainwell, L&T, Emico Elecon, STM Construction Equipment pvt. Ltd. helped the stakeholders to get aligned on the technological options available in the Highwall and Blast free mining while keeping the economics under consideration.

Annexure - A

Workshop on Technology Roadmap in Coal Sector
Organised by Coal India Limited in association with Ministry of Coal
CIL, Kolkata, on 15th March 2022
Programme

Time	Session		Presenting Organisation
10.00 – 10.45 hrs.	**Inaugural session**		
10.45 – 11.15 hrs.	**Technical Session IA** **TS 1A - Technology Roadmap**	(1) (2)	Dr.Rao Balusu, Reasearch team leader(Mining), CSIRO(Australia) Prof. R M Bhattacharya, IIT(ISM), Dhanbad
11.15 – 11.30 hrs	Tea Break		
11.30 – 13.00 hrs	**Technical Session IB** **TS 1B - Blast free technology**	(1) (2) (3)	Mr. Partha Mookherjee, Head(BD), Larsen & Toubro Mr. Rajendra Khoda, CGM, Puzzolana Machinery Fabricators Mr. Jonas Stahlbage, MD, STM Construction Equipment (I) Pvt. Ltd
13.00 – 14.00 hrs.	Lunch Break		
14.00 – 15.30 hrs.	**Technical Session II** **TS 2 - Highwall Mining – Prospect in India**	(1) (2) (3)	Mr. John Priddle, MD,ADDCAR Highwall Mining System Mr.Dipankar Banerjee, COO,Gainwell Commosales Pvt. Ltd. Mr. Biswanath Pan, Advisor, CBL (Cuprum Bagrodia Limited)
15.30 – 15.45 hrs.	Tea Break		
15.45 – 17.15 hrs.	**Technical Session III** **Case Studies / Continuous Miners/SDL/ LHD**	(1) (2) (3) (4) (5)	Mr. Ajay Kumar Sharma, GM Jhanjra Project Shri M K Prasad, DT(OP), SECL - Sharda Project Mr. N V K Srinivas, GM, Adriyala Project, SCCL GM, West Bokaro, TATA Steel Mr.Mukil Dwivedi, ED,Emico Elecon (India) Ltd
17.15 – 17.30 hrs.	**Valedictory**		

Annexure- 1

Prospects for Highwall Mining in India

Rao Balusu

CSIRO MINERALS
www.csiro.au

15 March 2022

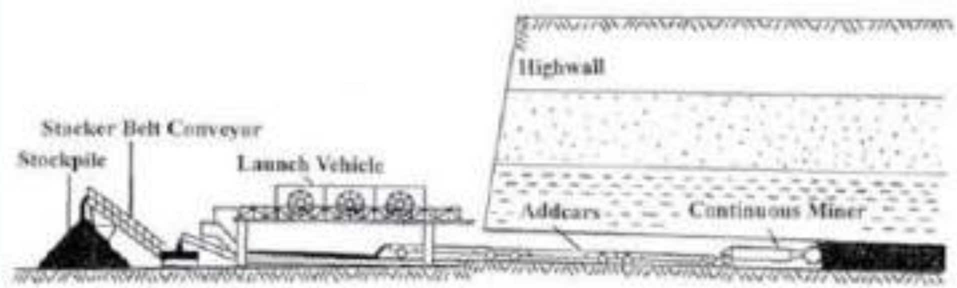
Presentation to Coal India Ltd (CIL)

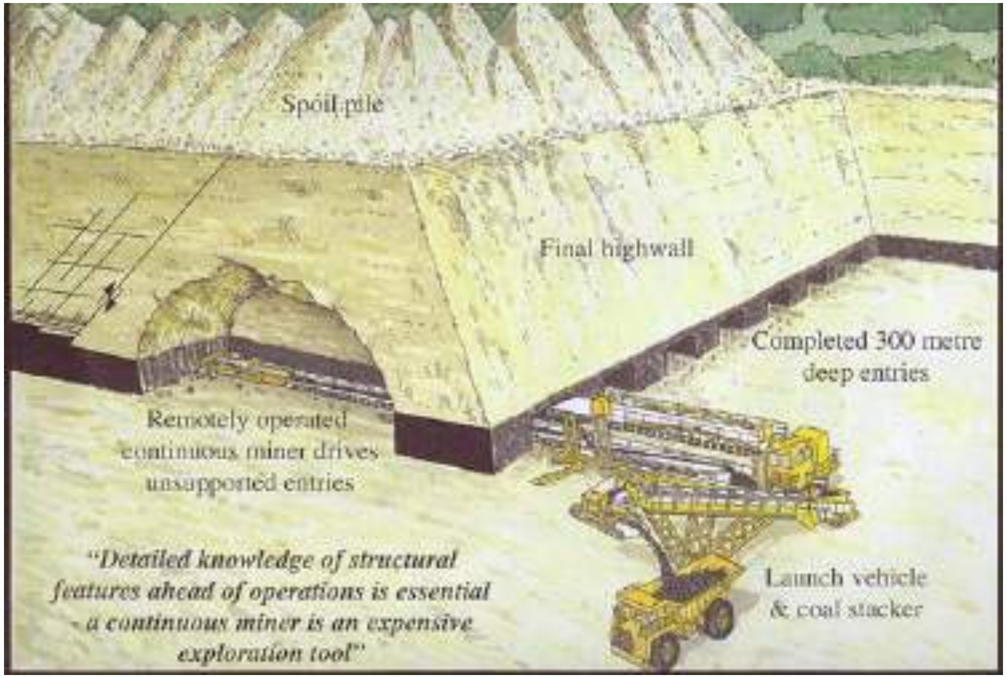
Presentation Outline

- Introduction – Highwall mining
- Highwall mining systems
- Geotechnical issues & rating
- Guidance Control
- Failures and causes
- Design guidelines
- Summary

Introduction - Highwall Mining

- Developed in 1980's.
- Widely used in Australia in 1990's
- Driving parallel roadways into highwall/ coal seam using remote controlled mining machinery (Continuous Miner)
- 200 - 500 m long entries
- Feasible to extract reserves that are not suitable for further opencut mining or longwall
- Low capital cost and short lead time
- Can achieve 0.5 to 1.0 MT/year
- High productivity





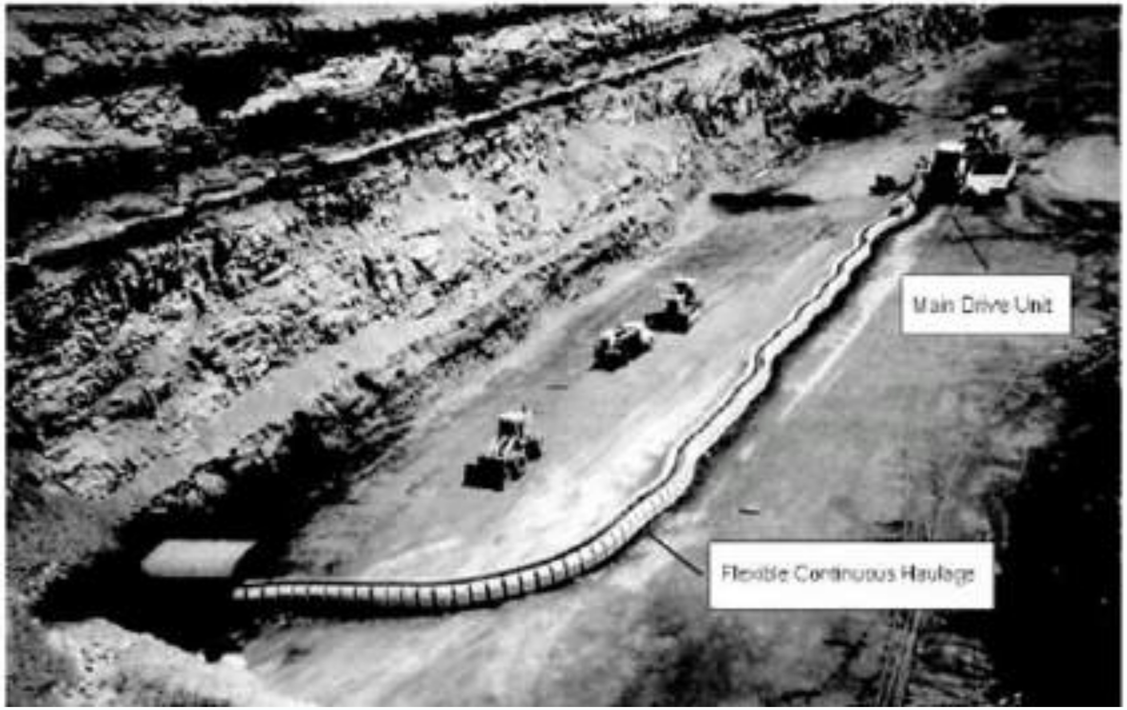
Highwall Mining Systems

- **Auger highwall mining system**

- Single or Twin augers
- Diameter up to 1.9m
- Penetration depth ~ 200 m
- Productivity ~ 50,000 t/month

Highwall Mining Systems

- **Continuous Highwall Miner (CHM)**
- **Archveyor system – Flexible continuous haulage system behind Miner**



Highwall Mining Systems/ Methods

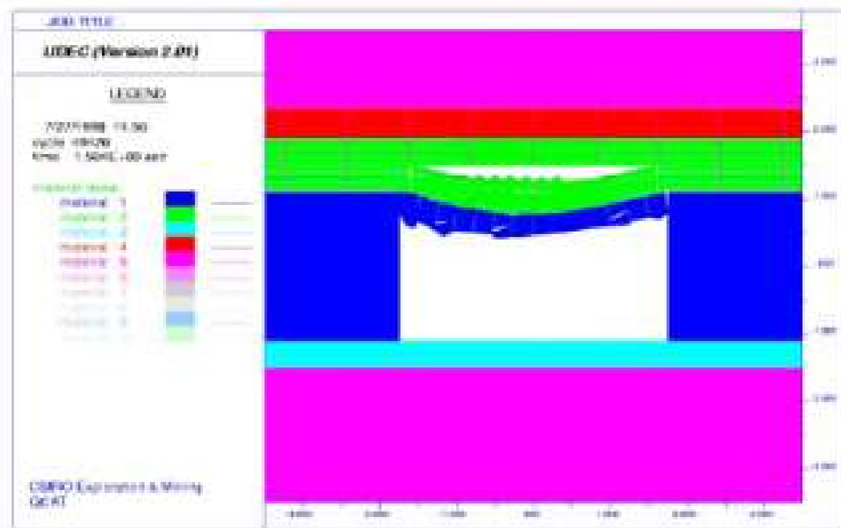
- **Addcar highwall mining system**
  - ➢ Launch vehicle
  - ➢ Conveyor cars (7.5m long)
  - ➢ Cars added progressively
- Roadway width ~ 3.5m
- Penetration depth ~ 500m
- Productivity ~ 100,000 T/month

Geotechnical, Design & Guidance

- Unsupported span stability
- Pillar stability
- Panel stability
- Failures - case studies
- Design guidelines
- Guidance control

Unsupported span stability

- Typical failure mechanism – delamination & snap-through
- Simple analytical – based on thickness of roof plate
- Probabilistic approach
- Numerical modelling techniques



Pillar stability

Mechanisms

- Pillars fail from excessive compressive stress
- Coal strength governed by a Hoek-Brown yield criterion
- Pillars stable if there is an elastic core (yield in ribs)
- Once the yield zones coalesce, the pillar stress-carrying capability reduces
- With further applied stress the pillar strength decreases rapidly to its residual value

SUMMARY OF TOOLS

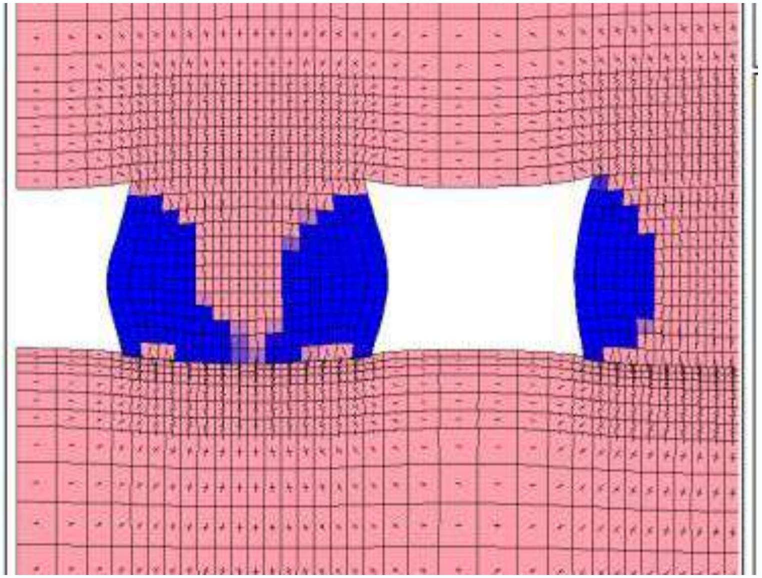
Any one of the following three codes may be used for the CSIRO pillar design technique:

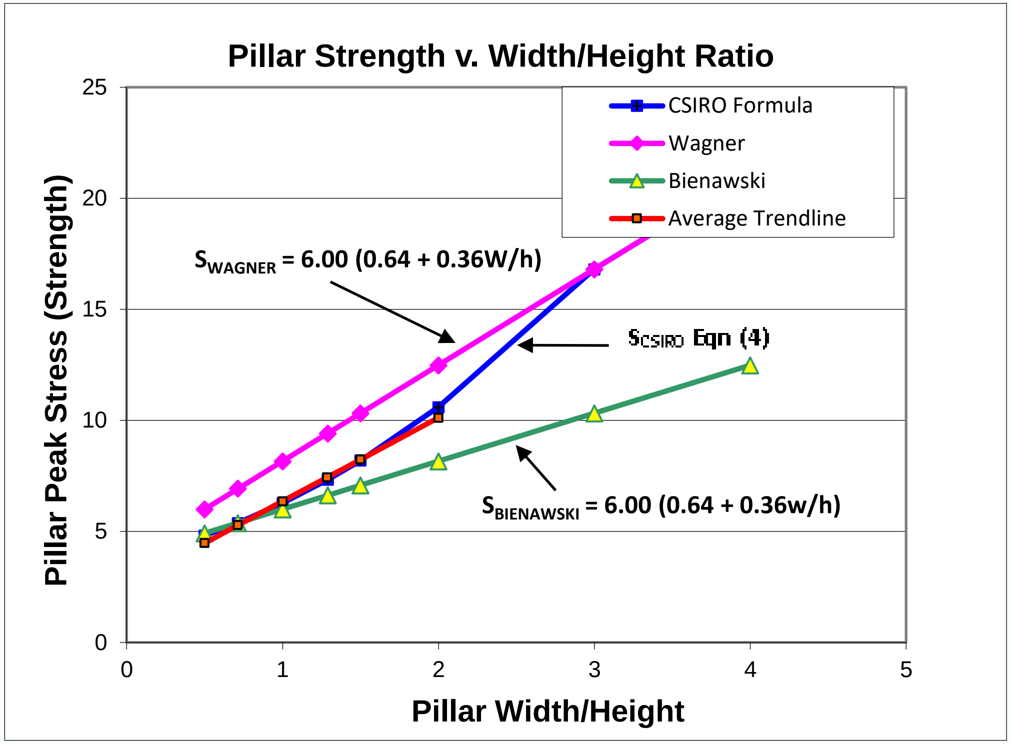
1. FESOFT, a CSIRO Finite Element Code
   (Duncan Fama et al., 1993)
2. FLAC, a Finite Difference Code
   (ITASCA 1995)
3. UDEC, a Discrete Element Code
   (ITASCA 1995)

1. **Emphasise that it is the layout design of the panels that is important – Panel Stability**
2. **However, in the context of underground pillar design it has always been found useful to look at empirical pillar strength relationships**

Pillar stability

- Coal strength – lab studies
- **Empirical Pillar Strength**
- **Pillar Stability Modelling**





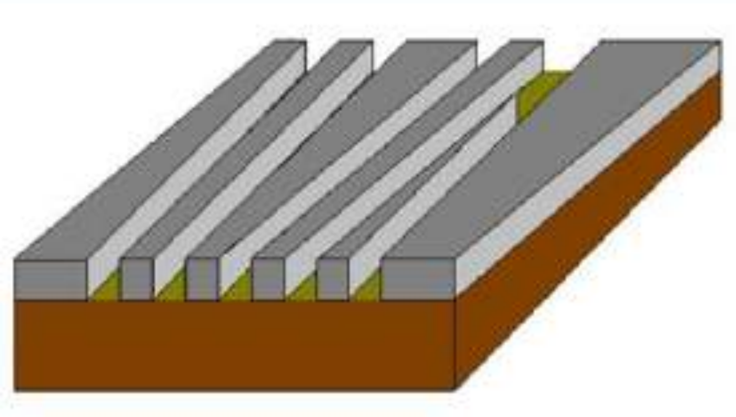
In Wagner strength formula, W = 2w for very long rectangular pillars

$$S_{csiro} = 6.00 * (0.64 + 0.36(0.69 + 0.44\frac{w}{h})\frac{w}{h} \qquad [0.5 \le \frac{w}{h} \le 3.0] \qquad \textbf{Eqn 4}$$

HWM Pillars – very long and narrow – Average coal strength (mass cube strength 6MPa, mass UCS 4.8MPa)

Panel stability

- Panel stability depends on local mine stiffness
- Factor of safety – for whole panel
- One pillar failure may lead to total panel failure
- Roadways to be driven in perfect parallel



Factors contributing to Pillar/ Panel failure

- Lack of site investigations
- Lack of knowledge on insitu stresses
- Poor knowledge on span stability
- Inadequate pillar design
- Inadequate panel width design
- Poor guidance control of the miner
- No monitoring and feedback

Panel Failures

Highwall before failure

Highwall after failure

Panel Failures

Panel failure – Mine A

Panel failure – Mine B

Design guidelines – No go conditions

- *Limited mining reserve*

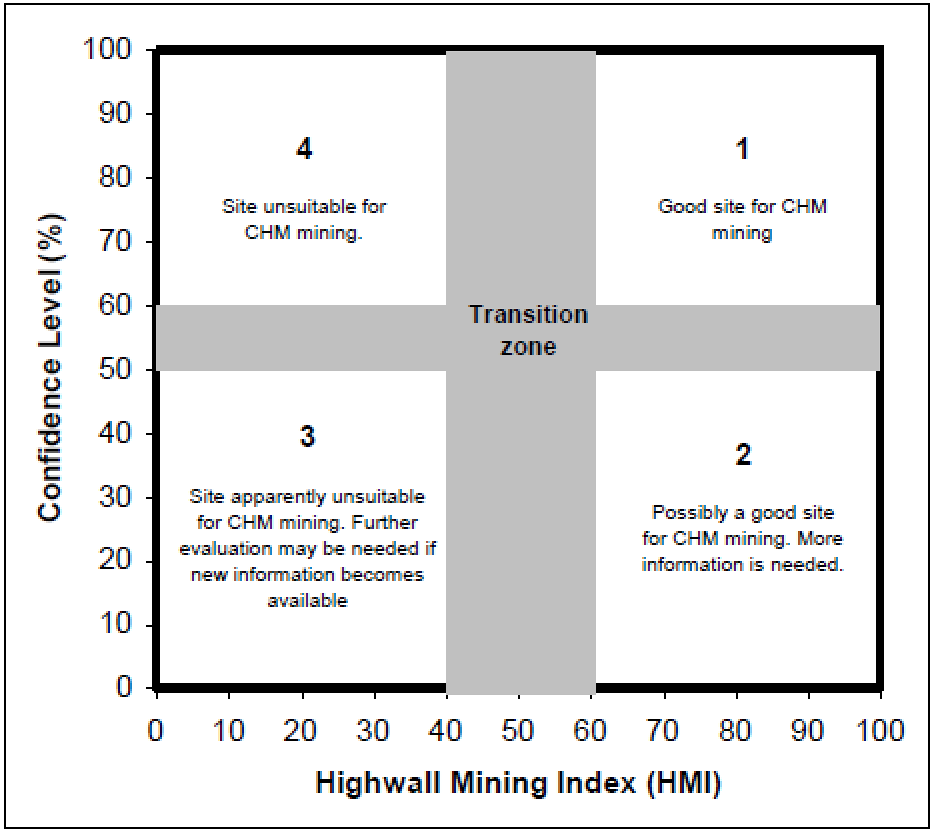
  (<250m – new site; <100m existing site)
- *Poor roof conditions*

  (Extremely weak roof, heavily jointed, weathered)
- *Seam dip >20°*

  (>10° -15° for CHM, >18° for Archveyor, >20° for Auger)
- *Seam methane content > 10 m^3/tonne*
- *Unstable highwall and/or lowwall*
- *Seam thickness <1.0 m*
- *Pit width <30 m*
- *Stone bands in coal seam (Auger)*

Design guidelines – Highwall Mining Index developed

- 15 key factors – Rating guidelines are given in the Tables
- Key factors are weighed differently in HMI
- Uncertainty on judgement is incorporated
- A given site has two index values: HMI rating & Confidence level



Design guidelines – HMI

Rank	Parameter	Condition				
		Excellent (100≥rating>80)	Good (80≥rating>60)	Fair (60≥rating>40)	Poor (40≥rating>0)	No-go (rating=0)
A	Roof condition	Strong to very strong roof rocks; thickly bedded; joints with wide spacing. No alternation and weathering.	Moderately strong roof rock; medium bedded; joints with moderate spacing. Slight alternation and weathering.	Moderately weak roof rocks; thinly bedded; joints with close spacing. Alternation and weathering.	Weak roof rocks; very thinly bedded; joints with very close spacing. Strong alternation and weathering.	Extremely weak to very weak rock; laminated; joints with very close spacing. Severe weathering.
B1	Mineable Reserves	>1500 m highwall	500 m to 1500 m highwall	250 m to 500 m highwall	100 m to 250 m highwall	<100 m highwall
B2	Seam gas (methane)	Very low methane content (<0.1m^3/t). No concern to mining	Low methane content in general. (0.1-1m^3/t). Higher gas only in localised pockets.	Seam methane = 1-5m^3/t. Gas problems could be encountered occasionally in reserve.	Seam gas (5-10m^3/t). Gassy seam and gas problems are expected to be encountered throughout.	Seam methane >10m^3/t
B3	Seam Dip	+0° to -4°	+0° to +1°, or -4° to -7°	+1° to +2°, or -7° to -10°	+2° to +4°, or -10° to -15°	>+4°, <-15°,
B4	Highwall /lowwall stability	Smooth highwall wall. No hanging blocks. No major joint sets or faults. No risk of large scale lowwall instability	Localised loose rock blocks. Slight weathering. Minor joints/cracks. No discernible risk of lowwall instability	Common small rock falls. Dense jointing. No risk of large scale highwall instability. Very low risk of lowwall instability. Possible block falls.	Large rock falls. Weathered. Wedges and slabs formed by joints. Some risk of local lowwall instability but manageable.	Grossly unstable highwall. Significant risk of large scale lowwall instability.
C1	Seam continuity	Seam is consistent with no faulting or folds	Structures which slightly reduce seam thickness. Only small faults and undulations	Structures which reduce thickness by up to 50%. Seam changes direction by 5° in folds	Structures which reduce thickness over 50%. Faults and distinct folds are common.	Seam heavily affected by faulting and folding.
C2	Pit condition,	No loose material, dry, no floor work.	<0.5 m loose material. Water puddles. Shave	<2 m loose material. Pumping required. Some	>2 m loose material. Major pumping and mud clean up.	Pit width <30 m.

CSIRO

Design guidelines – HMI

Rank	Parameter	Condition				
		Excellent (100≥rating>80)	Good (80≥rating>60)	Fair (60≥rating>40)	Poor (40≥rating>0)	No-go (rating=0)
	preparation		floor.	mud. Soft floor.	Floor repairs required.	
C3	Seam quality	Medium to hard export coking coal. No in-seam parting or stone bands	Soft coking coal and export steaming coal. 1 or 2 stone bands.	Any unwashed product which is saleable. Many partings and stone bands.	Coal not in previous categories which must be washed for sale. Many stone bands.	
C4	Floor condition	Strong floor rocks. Unaffected by water.	Weak to moderately strong floor rocks. May be wet but not muddy.	Weak floor rocks. Occasionally muddy.	Very weak floor rocks (clay). Wet and muddy throughout.	
C5	Ground water	Dry environment. No water gets into the mining entries.	Seasonal dry and wet environment. Some water into entries but is manageable.	Generally wet environment. Some water problems could be expected at fault zones.	Very wet environment. Water gets into entries from the pit and from the ground. It may flood the entry.	
D1	Coal strength	Lab coal UCS > 30MPa. Limited coal joints with wide spacing.	Lab coal UCS=20-30MPa. Coal joints with moderate spacing.	Lab coal UCS=10-20MPa. Coal joints with close spacing.	Lab coal UCS <10MPa. Heavily cleated. Coal joints with very close spacing.	
D2	Cover depth (overburden + spoil)	Overburden depth <80 m in the reserve	Overburden depth 50 – 100 m.	Overburden depth 60 – 120 m, possible stress concentration near highwall	Overburden depth 80 – 150 m, possible significant stress concentration near highwall	
D3	Subsidence	Surface subsidence not an issue.	Minor subsidence effects but all contained on lease. Minimal rehabilitation efforts.	Some subsidence or water effects off site but controllable. Rehabilitation could be costly.	No subsidence is allowed. Significant water effects off site. Major rehabilitation costs. Subsidence control is critical.	
D4	Seam thickness	>3.5 m	2.5 m- 3.5 m	2.0 m – 2.5 m	1.5 m - 2.0 m	<1.5 m.
D5	Mobilisation and service	Equipment, service capacity and skilled mining crew are available on site.	Equipment, service capacity and skilled mining crew are available in mines nearby.	Equipment, service capacity and skilled mining crew are available interstate.	Equipment and service capacity are available overseas. New mining crews need to be trained.	

CSIRO

Design guidelines – HMI

The geometric mean value of the parameters in each of the four groups is given by:

$$\overline{A} = A$$

$$\overline{B} = (B1 \cdot B2 \cdot B3 \cdot B4)^{1/4}$$

$$\overline{C} = (C1 \cdot C2 \cdot C3 \cdot C4 \cdot C5)^{1/5}$$

$$\overline{D} = (D1 \cdot D2 \cdot D3 \cdot D4 \cdot D5)^{1/5}$$

The HMI is the weighted mean value of the four groups: :

$$HMI = (\overline{A}^{1.6} \cdot \overline{B}^{1.2} \cdot \overline{C}^{0.8} \cdot \overline{D}^{0.4})^{1/4}$$

The weighted geometric mean of the confidence levels of the four groups is given by:

$$C_{\overline{A}} = C_A$$

$$C_{\overline{B}} = (C_{B1} \cdot C_{B2} \cdot C_{B3} \cdot C_{B4})^{1/4}$$

$$C_{\overline{C}} = (C_{C1} \cdot C_{C2} \cdot C_{C3} \cdot C_{C4} \cdot C_{C5})^{1/5}$$

$$C_{\overline{D}} = (C_{D1} \cdot C_{D2} \cdot C_{D3} \cdot C_{D4} \cdot C_{D5})^{1/5}$$

The overall confidence levels of HMI is given by:

$$C_{HMI} = (C_{\overline{A}}^{\ 1.6} \cdot C_{\overline{B}}^{\ 1.2} \cdot C_{\overline{C}}^{\ 0.8} \cdot C_{\overline{D}}^{\ 0.4})^{1/4}$$

Design guidelines – HMI – Example 1

Rating of the 15 key parameters and their confidence level

Rank	Parameter	Judgement Rating	Confidence level (%)
A	Roof condition	70	70
B1	Mineable reserve	80	70
B2	Seam gas	75	80
B3	Seam dip	75	70
B4	Highwall stability	75	70
C1	Seam continuity	90	60
C2	Pit condition (pit preparation)	100	100
C3	Coal quality	90	95
C4	Floor condition	60	50
C5	Ground water	70	70
D1	Coal strength	75	90
D2	Cover depth	80	90
D3	Environmental aspect – subsidence	100	95
D4	Seam thickness	80	70
D5	Mobilisation and services	90	90
Highwall Mining Index (HMI) = 75			
Confidence level of HMI = 73%			

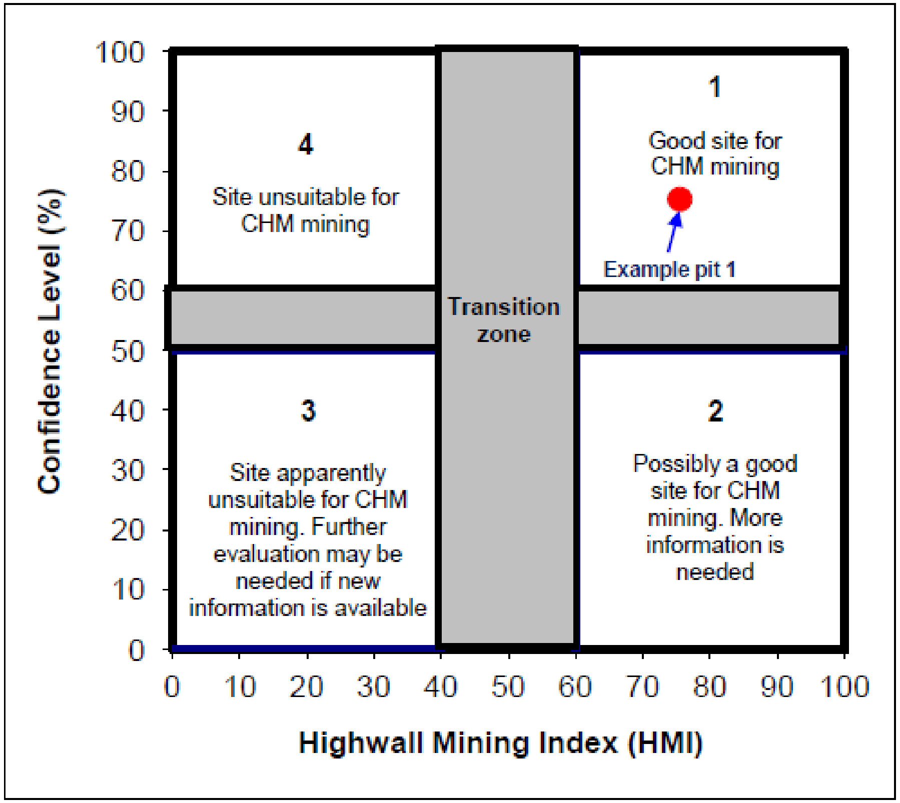
$$\overline{A} = A = 70$$

$$\overline{B} = (B1 \cdot B2 \cdot B3 \cdot B4)^{1/4} = (80 \cdot 75 \cdot 75 \cdot 75)^{1/4} = 76$$

$$\overline{C} = (C1 \cdot C2 \cdot C3 \cdot C4 \cdot C5)^{1/5} = (90 \cdot 100 \cdot 90 \cdot 60 \cdot 70)^{1/5} = 81$$

$$\overline{D} = (D1 \cdot D2 \cdot D3 \cdot D4 \cdot D5)^{1/5} = (75 \cdot 80 \cdot 100 \cdot 80 \cdot 90)^{1/5} = 84$$

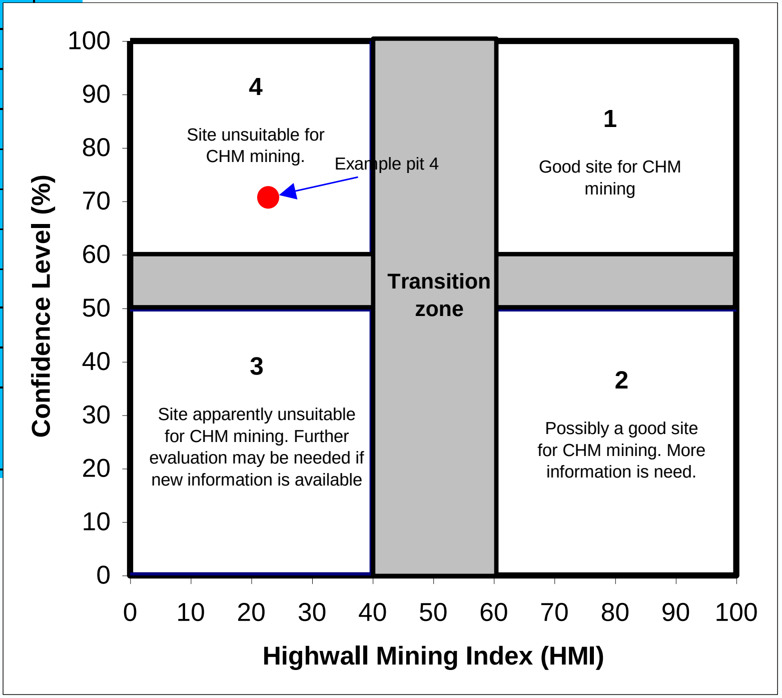
$$HMI = (\overline{A}^{1.6} \cdot \overline{B}^{1.2} \cdot \overline{C}^{0.8} \cdot \overline{D}^{0.4})^{1/4} = (70^{1.6} \cdot 76^{1.2} \cdot 81^{0.8} \cdot 84^{0.4})^{1/4} = 75$$



Design guidelines – HMI – Example 2

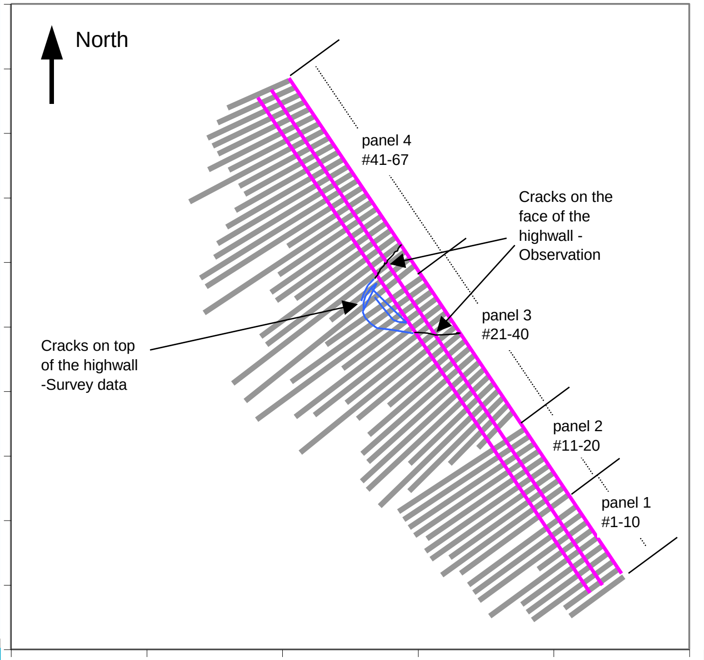
Rating of the 15 key parameters and their confidence level

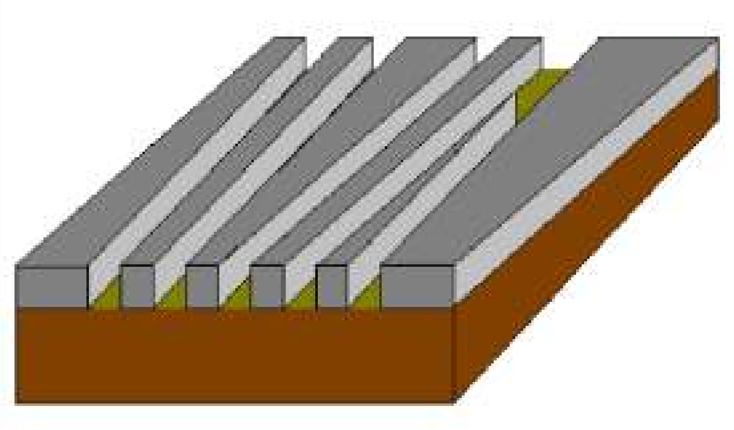
Rank	Parameter	Judgement Rating	Confidence level (%)
A	Roof condition	5	80
B1	Mineable reserve	80	80
B2	Seam gas	60	50
B3	Seam dip	90	60
B4	Highwall stability	70	60
C1	Seam continuity	60	50
C2	Pit condition (pit preparation)	70	80
C3	Coal quality	70	70
C4	Floor condition	10	60
C5	Ground water	80	70
D1	Coal strength	50	60
D2	Cover depth	50	60
D3	Subsidence	90	90
D4	Seam thickness	80	60
D5	Mobilisation and services	60	60
Highwall Mining Index (HMI) = 23 Confidence level of HMI = 70%			



Guidance control – issues to address

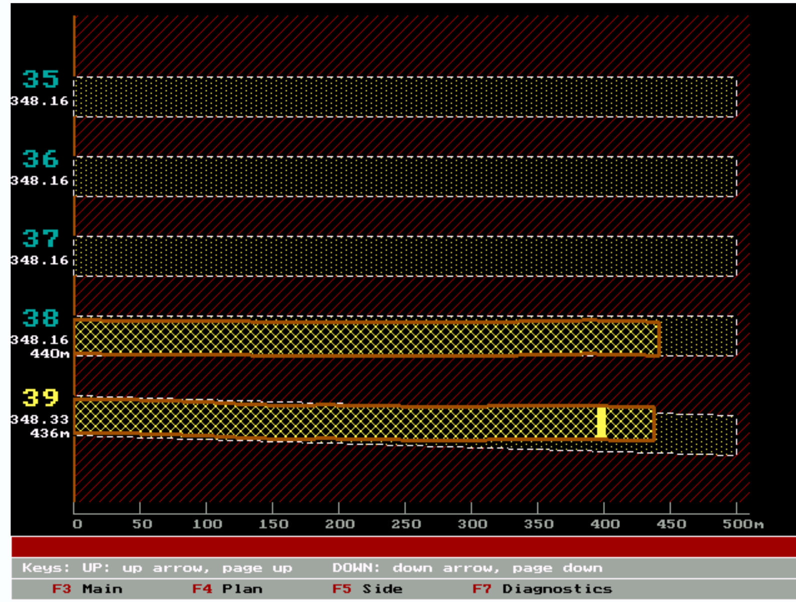
- Driving parallel roadways
  - Remote miner
  - 200m to 500m depth
- Problems
  - Cut-through's connection
  - Pillar failure – frequent roof falls
  - Limited penetration depth





Guidance control

- Problems to solve
  - Uncertainty in pillar size
  - Frequent cut-throughs
  - Reduced penetration depth
  - Pillar/ Panel failure
- Guidance system
  - Military grade Inertial Navigation System
  - Independent odometer
  - Controlling computers
  - Operator display and interface
- Achievements
  - Used in every HWM system
  - No mining equipment lost due to collapse
  - Penetration depths increased to 500m



Summary

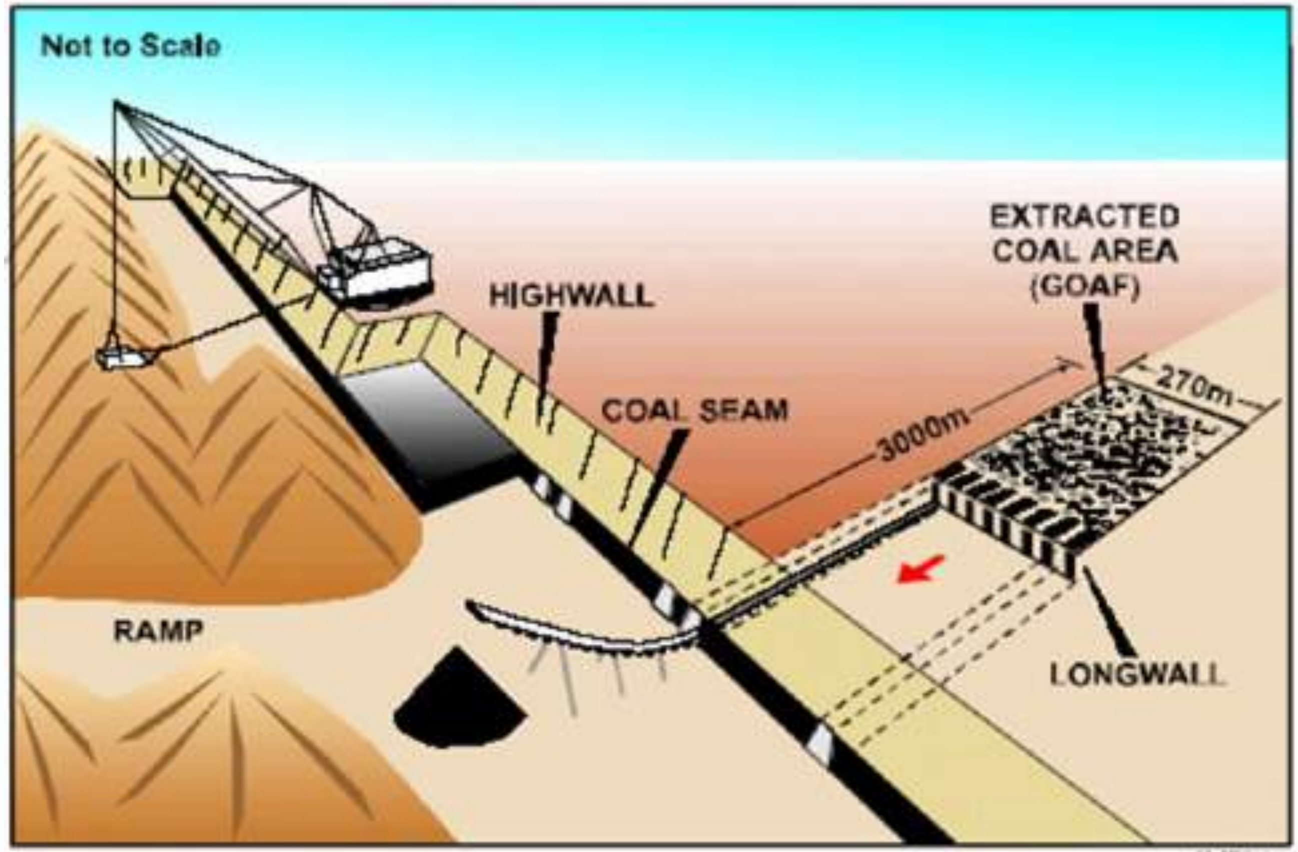
- Low capital cost and short lead time
- High productivity
- Design and Guidance critical for success
- Inadequate design – leads to low % of extraction
- Appropriate for some site-specific blocks
  - Blocks that are not suitable for OC or longwalls

- Punch longwall offers more advantages, if feasible

Punch Longwall

Punch Longwall

- Developing longwall panels directly off highwalls
- All gateroads from highwall

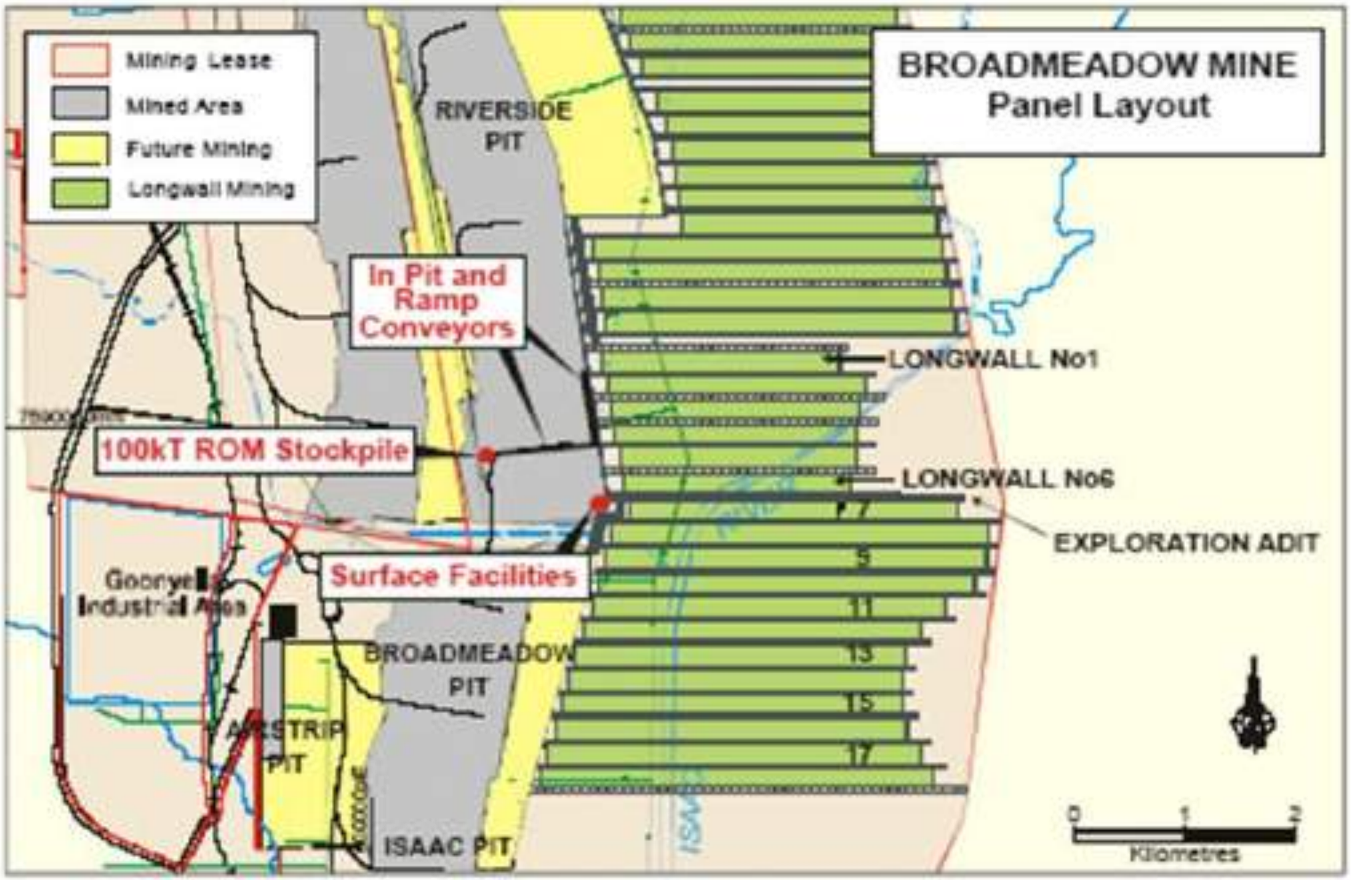


Punch Longwall

- Developing longwall panels directly off highwalls
- All gateroads from highwall
- Case study – Mine A in Australia

Punch Longwall

- Punch longwall panel layout
- After detailed geological and geotechnical investigations



Advantages

- Lower investment (compared to UG longwall)
- High productivity & lower operating cost
- More production capacity + fewer bottlenecks
- Easy logistics – on surface
- Higher gateroad development rates feasible
- Higher and faster return on investment
- Longer term and higher % of reserves extraction (compared to highwall mining methods)

Thank you

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Annexure -2

CASE STUDY ON COAL MINING OPERATION

SHARDA HIGHWALL MINING

SOHAGPUR AREA
SOUTH EASTERN COALFIELDS LIMITED

WECOMES YOU

Content...

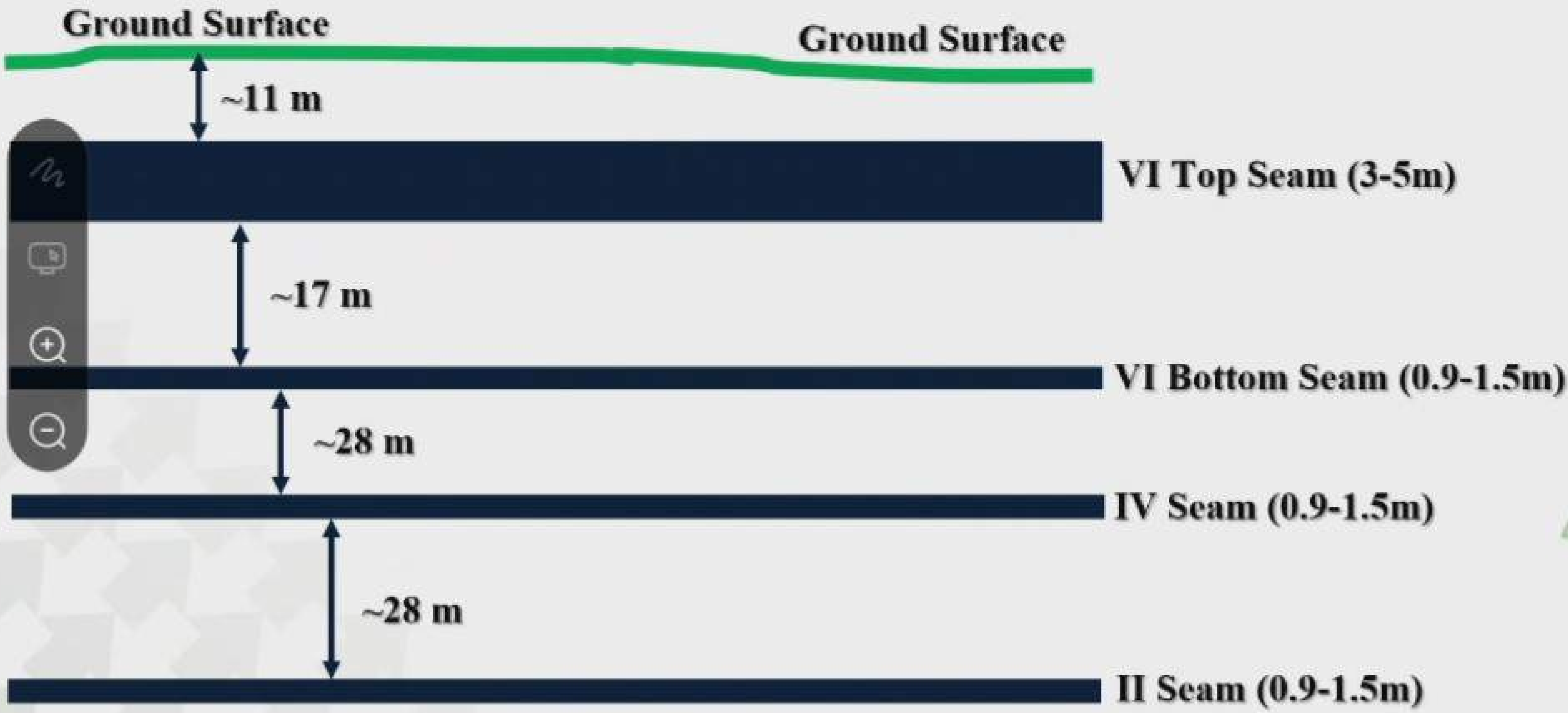
1. Background
2. Introduction
3. Method of Working
4. Highwall Miners
5. Strata Control & Management
6. Advantages
7. Limitations
8. Performance Analysis
9. Summary Evaluation

BACKGROUND

Sharda OCM was Started in 1987 as conventional Open Cast Mine to extract coal from Burhar VI Top seam.

BACKGROUND

Besides Burhar VI Top seam, there were other coal seams like Burhar VI Bottom, IV & II seams.



Due to uneconomic strip ratio

~~Conventional Open Cast~~

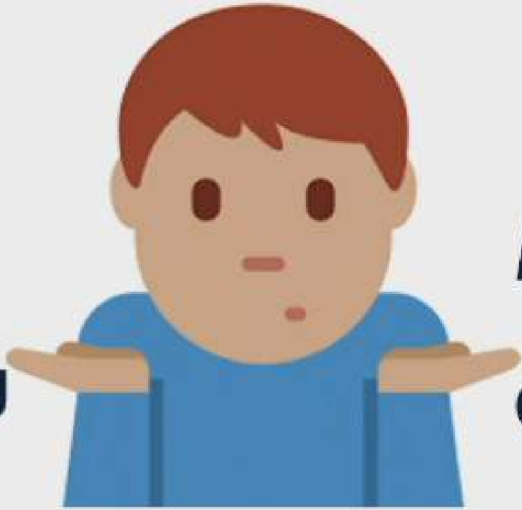
Conventional Underground

Due to low thickness

BACKGROUND

So What's Next?

Leave the coal in-situ forever?



Mine out at any financial cost?

Perhaps, none of these were the right decision!!!

BACKGROUND

After months of brainstorming and analysing Pros-Cons of all available possibilities,

A Pioneer Decision was made

A Paradigm Shift

- First time in the entire COAL INDIA
- A **trailblazer** in the field of Thin seam mining in India

Challenges Apprehended?

FAILURE

- ✓ Economical- Loss
- ✓ Technological- M/c, Strata
- ✓ Social- R&R
- ✓ Environmental- Pollution

Gloomy Future

SUCCESS

- ✓ Economically- $
- ✓ Technological- Conservation
- ✓ Social- Image
- ✓ Environmental- Sustainable

Replication

Introduction

2011 Onwards…….

About Us...

1st **Contract** to extract coal by Highwall mining was awarded to the then **M/s Cuprum Bagrodia Limited** (Now known as ***Minsol Limited***).

M/s **CBL** holds the prestigious position of **First Privately owned company** to successfully introduce Highwall mining in Coal India.

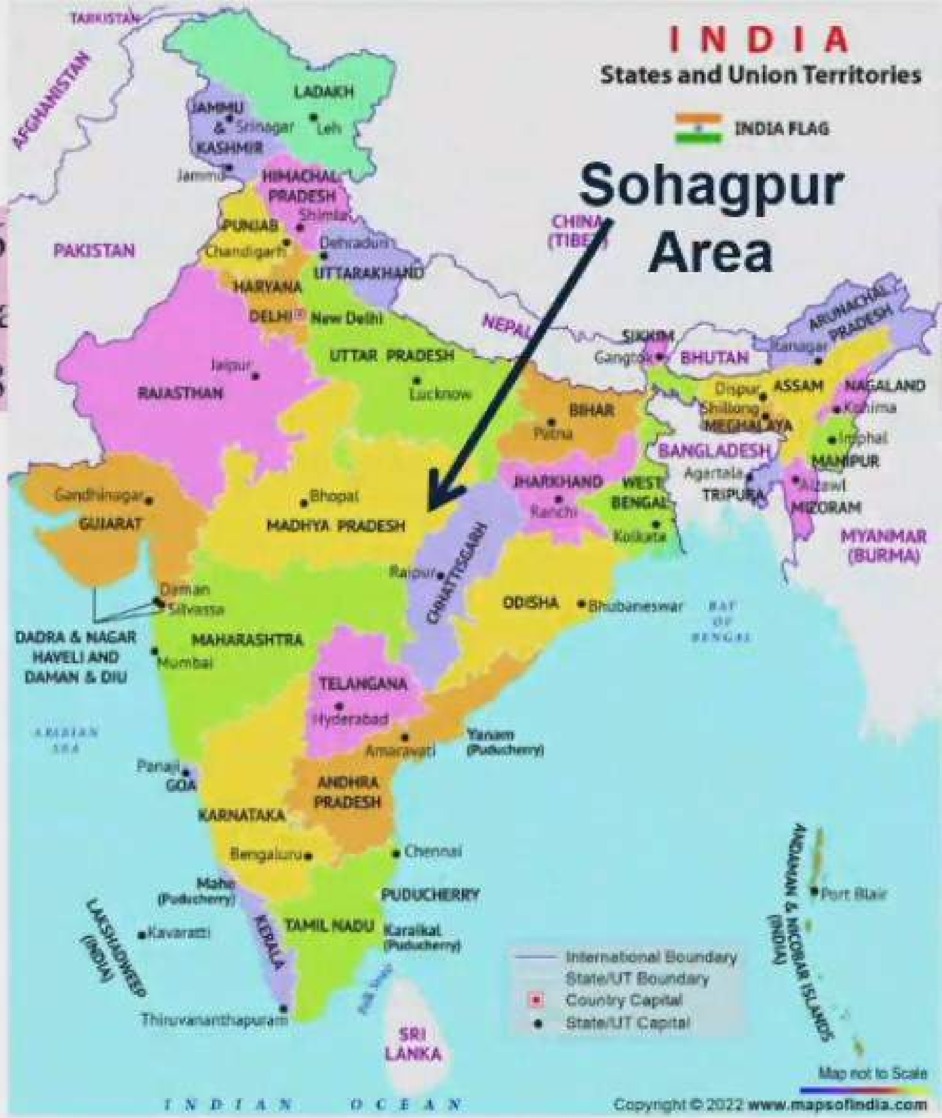
This contract was awarded to extract **6 Million Tonnes** of coal in **9 APPs** which ever is earlier and which lasted till September last year.

About Us...

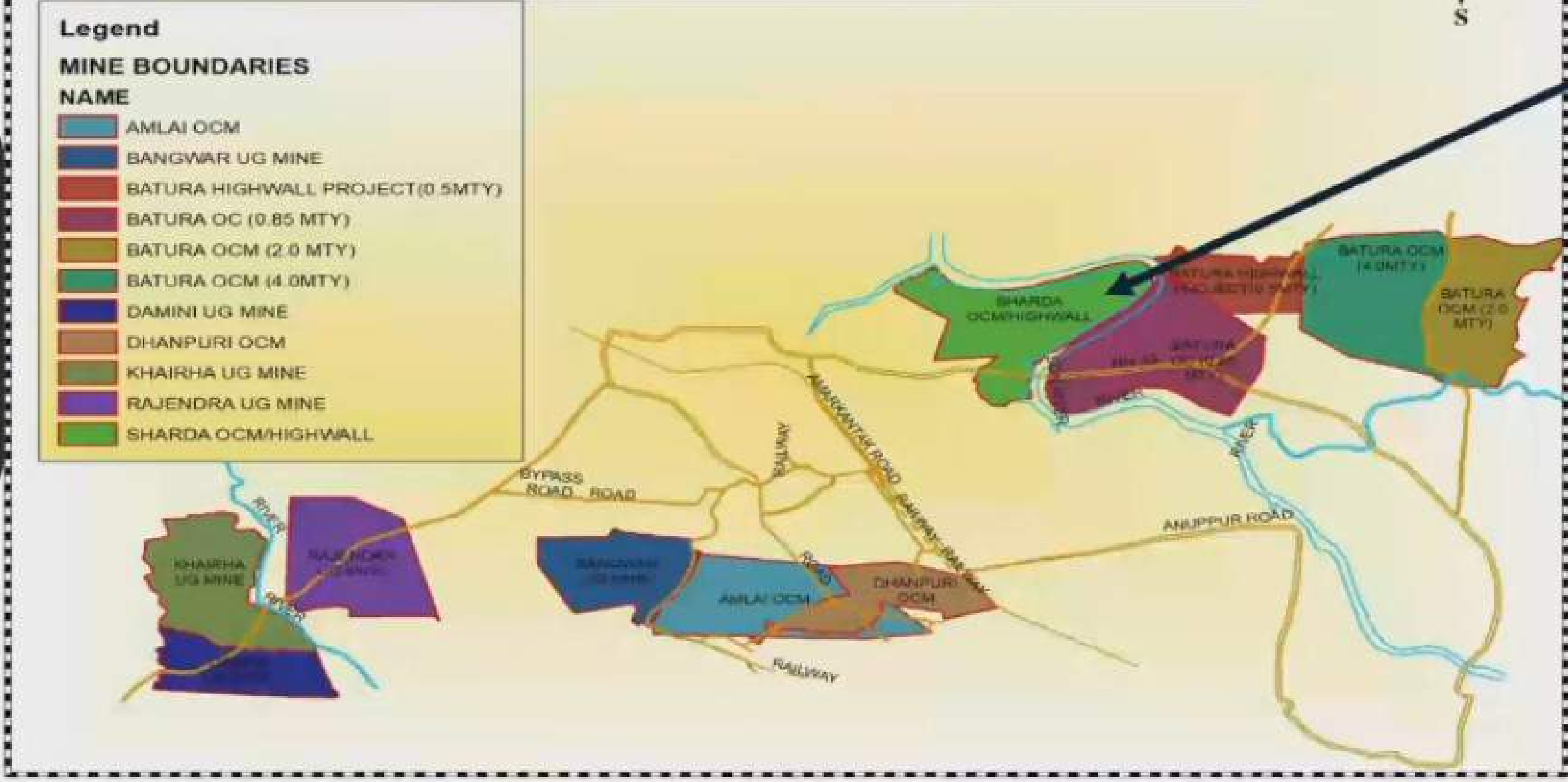
Mine Location

Geographical Info

Coal Evacuation Network



SOHAGPUR AREA



Here We Are!

About Us...

Mine Location	6 km east of Burhar town, Shahdol (M.P.); N-latitude-23'12'10" & 23'13'45", East longitude-81'35"12' & 81'38'08"
Geographical Info	Radial Drainage; Block is free from forest cover; Mine is adjacent to Sone river; elevation ranging from 450-480m MSL
Coal Evacuation Network	Both **Road** *(Near NH-43)* **& Rail** *(Burhar Railway Siding)* **transport;**

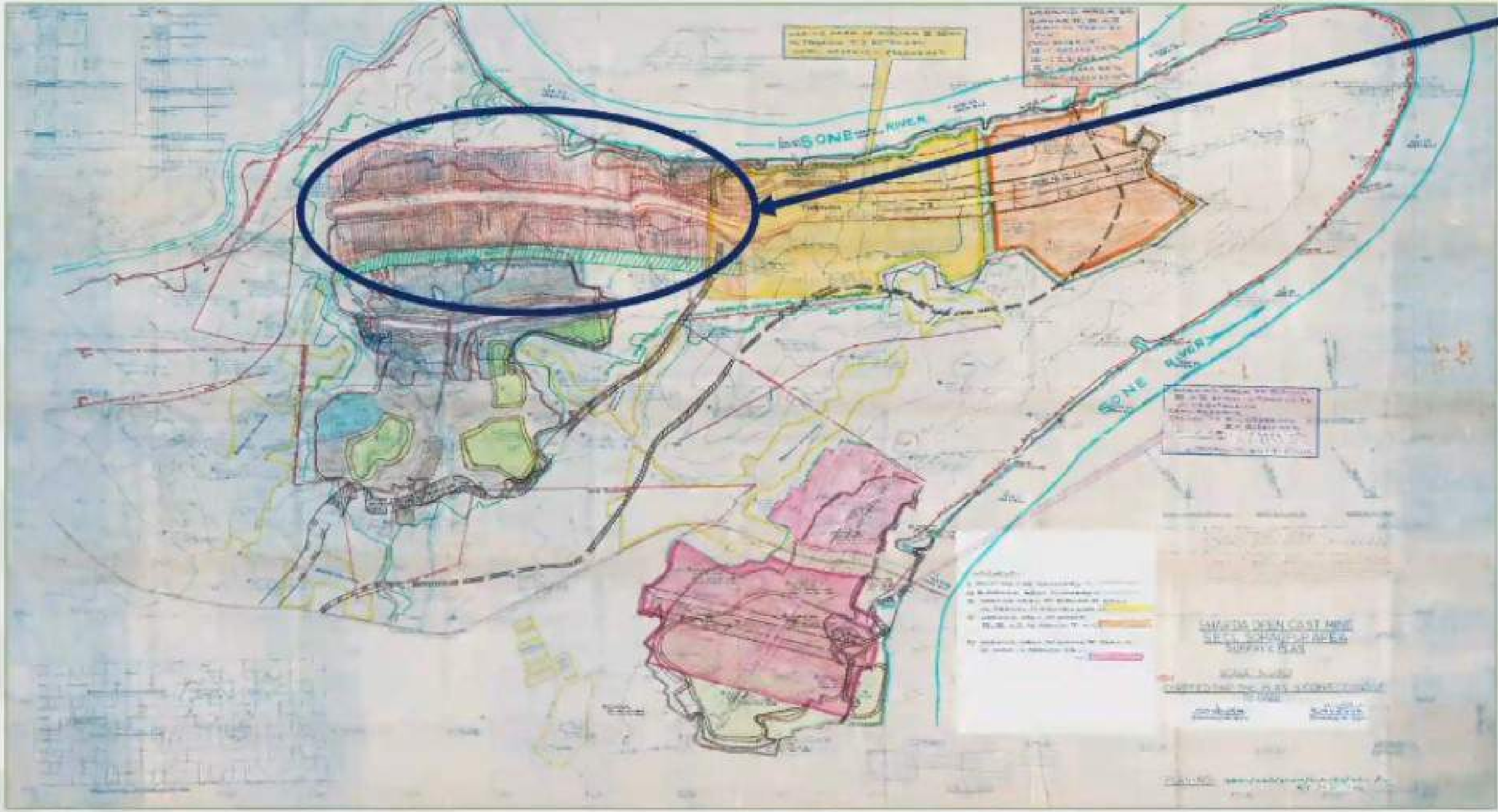
About Us...

Opening Date (HW)	**26-10-2010** (1st APP from 1st April 2011)
EC Capacity	**0.85 MT**
Leasehold Area	**871.205 Ha**
Coal Reserve Left	**5.6 MT** (As on 01.04.2021)
Coal Extracted by	**5.4 MT (By the end of 2021)**
Present Working Location	**Trench T-3 Extension**
Present Contract Status	**2.55 MT/3 Years** (1st APP from 1st Mar 2022)
Present HW Contractor	**Minsol Ltd** (Erstwhile M/s CBL)
No. of HWM at Present	**Two**

Important!

This coal was to be left unmined in the absence of Highwall Mining Technology

Mine Plan



Trench T-3; Seam VIB & IV Worked out

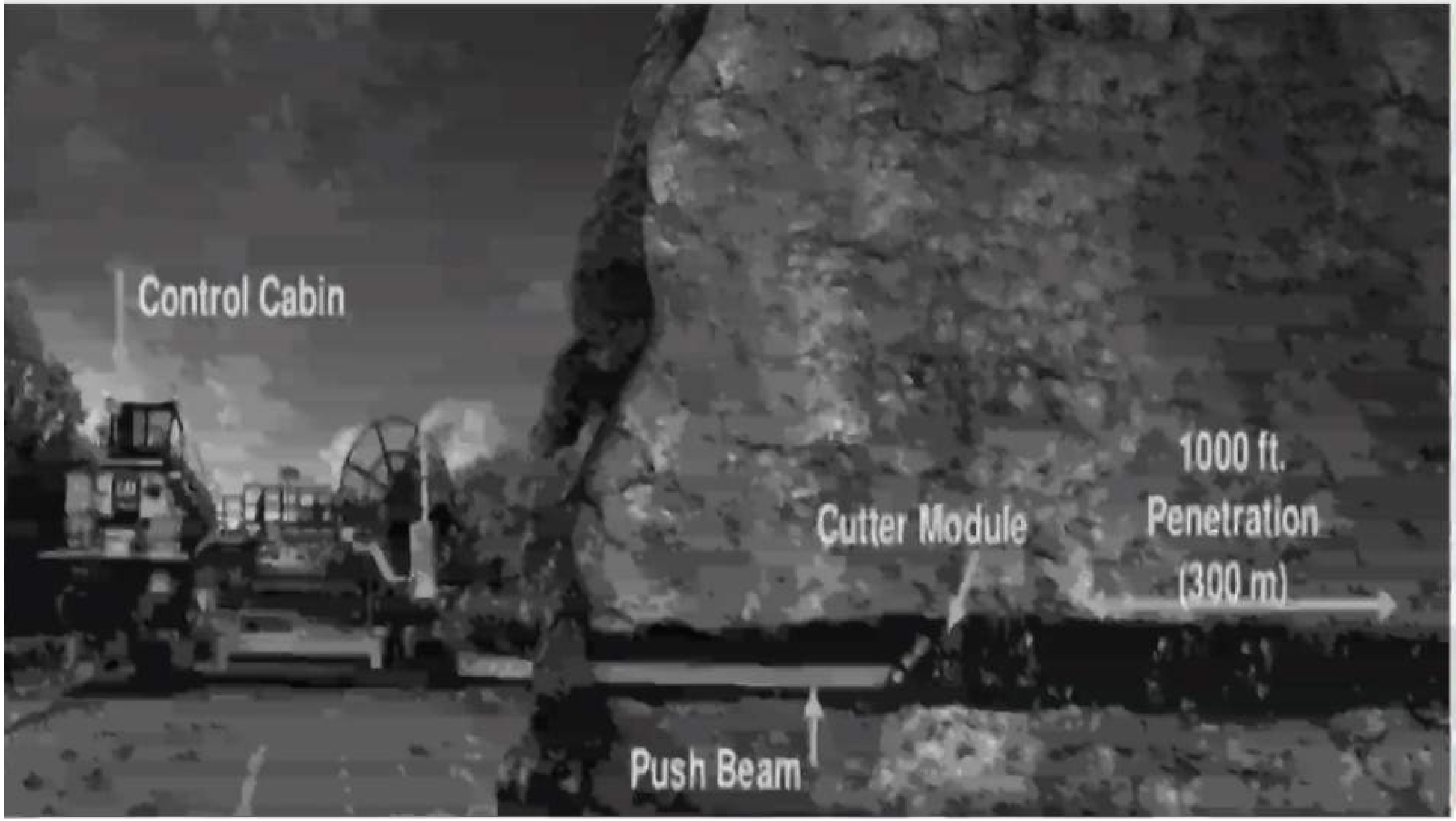
Method of Working

A Closer View of how this Technology Works…..

What Exactly is Highwall Mining?

Definition...?

Illustrative Image



Major Stages...

Trench Preparation

- ✓ Identification & Orientation of proposed trench
- ✓ **Drilling & Blasting**
- ✓ OB removal, Dumping/Backfilling
- ✓ M/C- Drills, Excavators, Dumpers, rock breakers, Dozers, Grader

Major Stages...

HWM Positioning

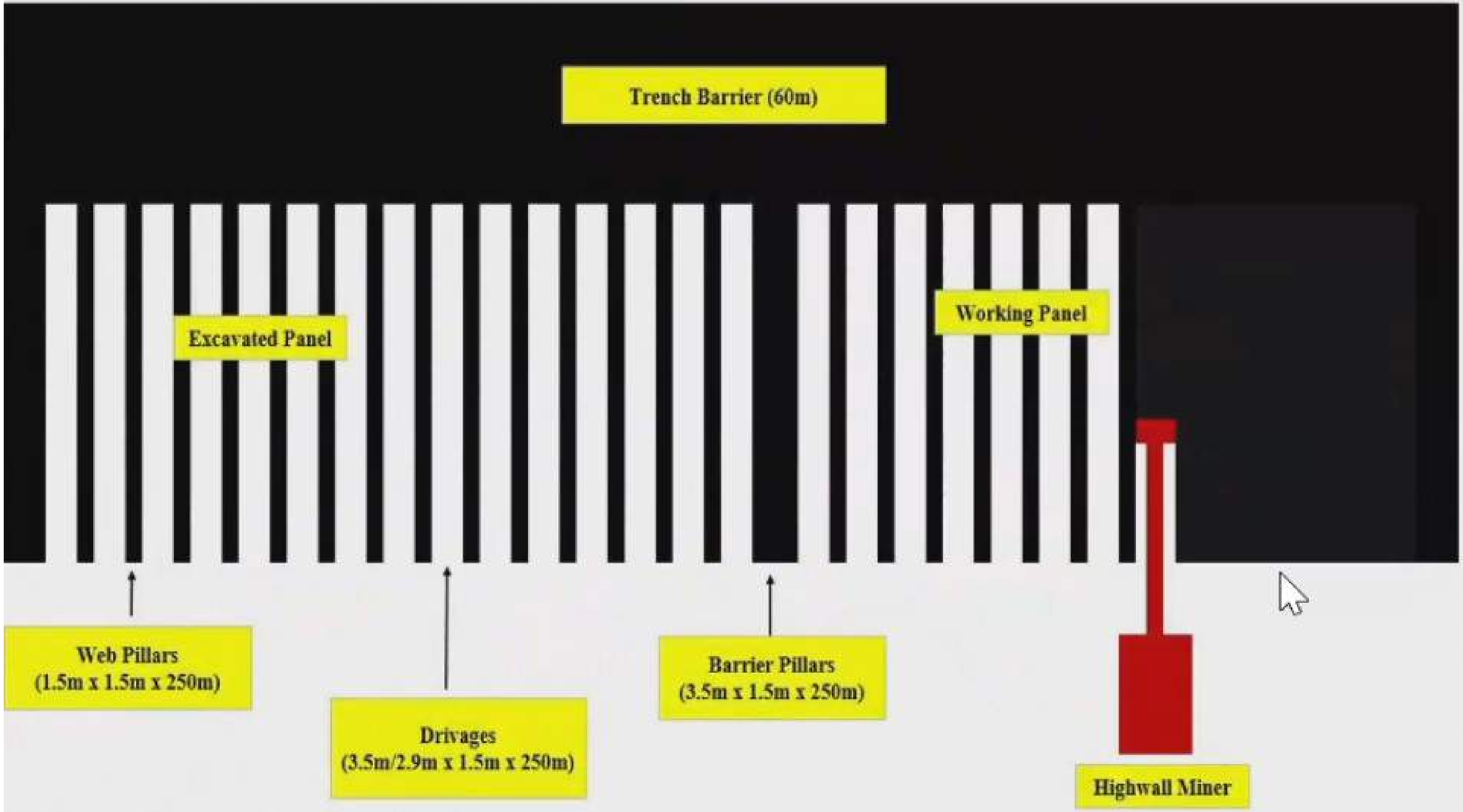
- ✓ Assembling of parts to erect Highwall Miner
- ✓ Extending **Power Lines** and supplying power
- ✓ M/C– Highwall Miners, Front End Loaders with Forks & Buckets

Major Stages...

Coal Cutting

- ✓ Making Parallel **Drivages**
- ✓ Push beams are added sequentially
- ✓ **Penetration** is limited to

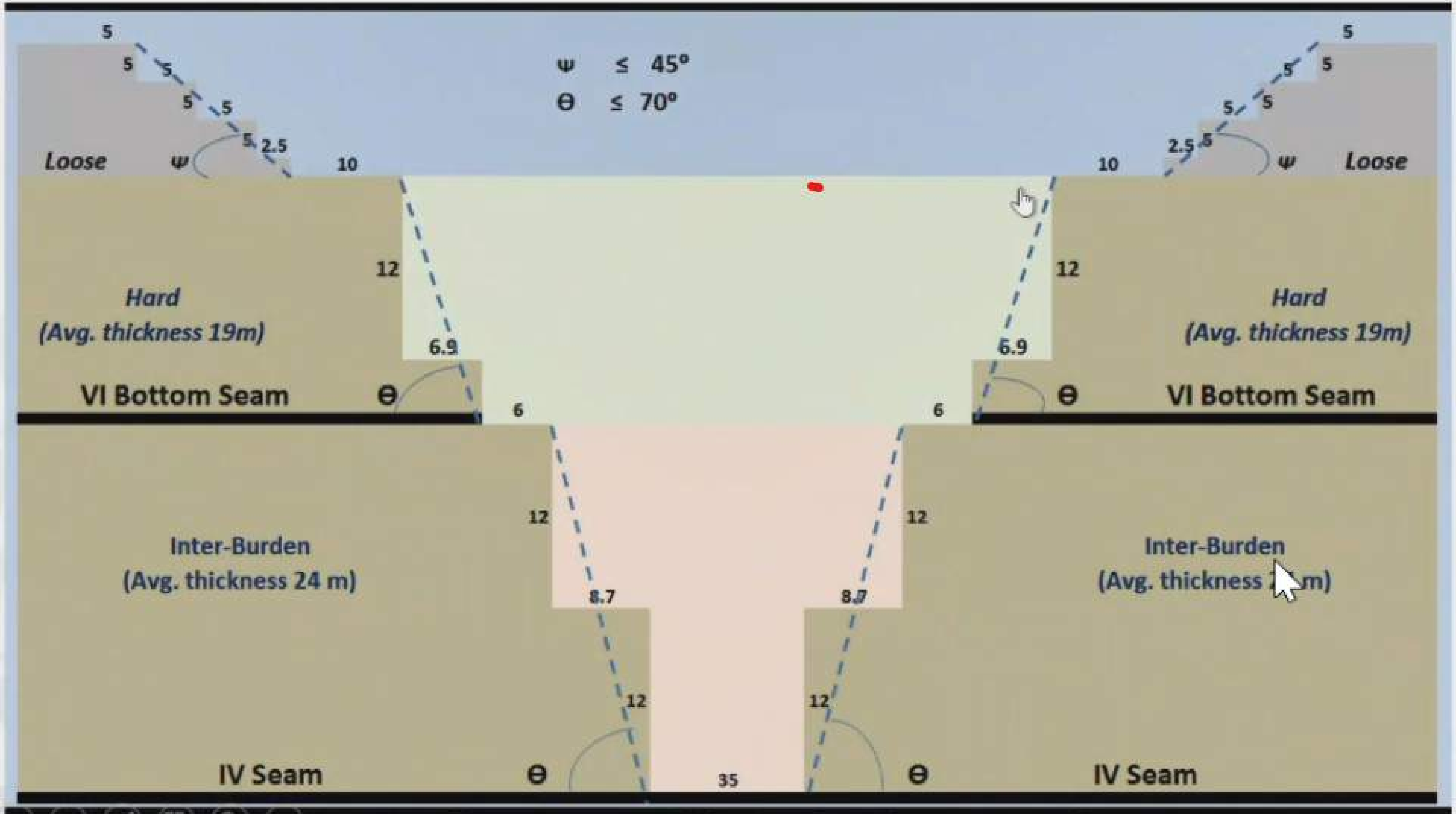
Schematic Diagram...*Panel Layout*

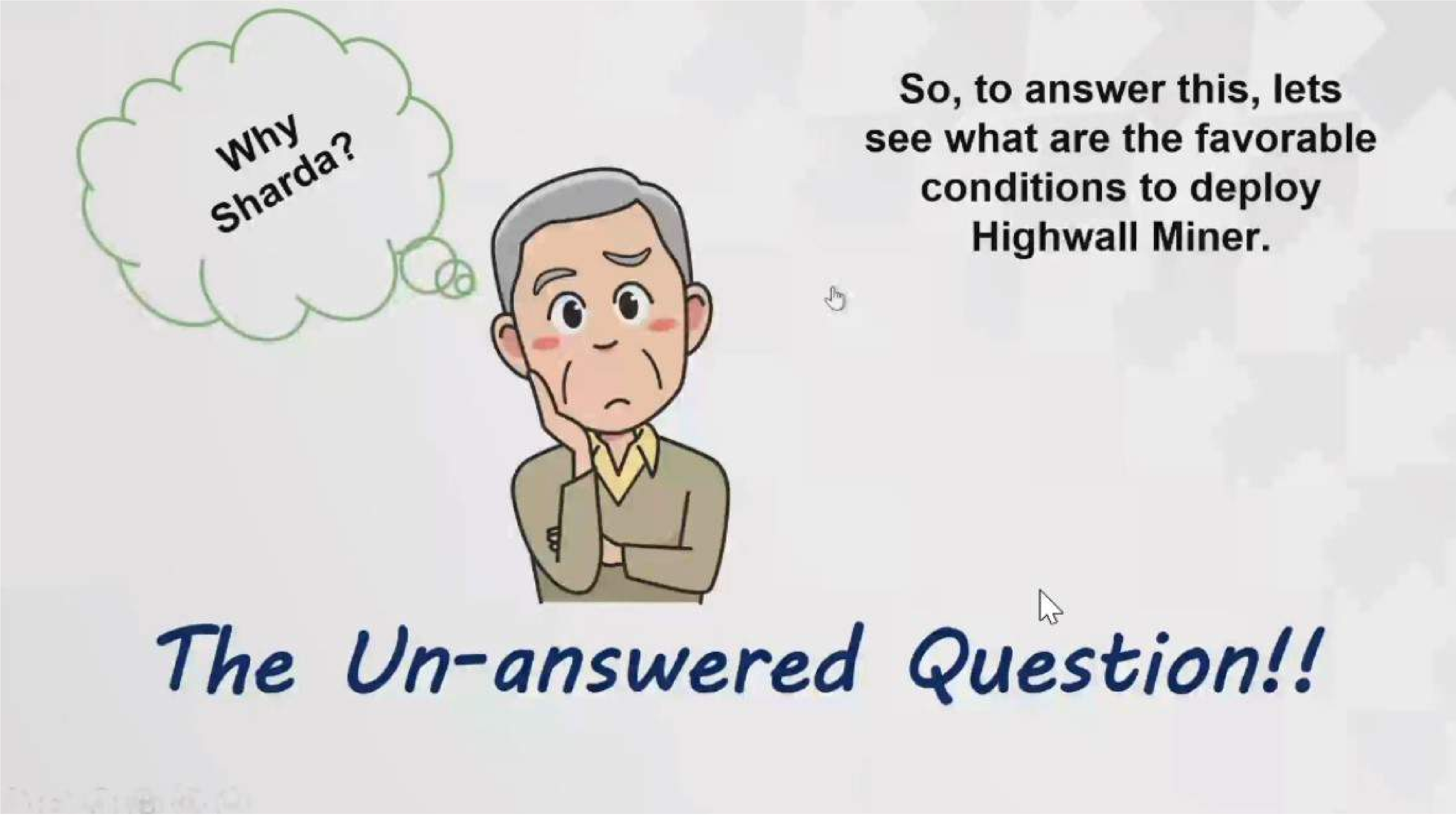


Highwall Mining Operation!

Highwall Mining Operation!

Highwall Mining Operation!




Why Sharda?
So, to answer this, lets see what are the favorable conditions to deploy Highwall Miner.
The Un-answered Question!!

Highwall Mining- A Few Preconditions

Sharda OCM

Highwall mining in the mine started over already worked out area due to which make of water was quite low.

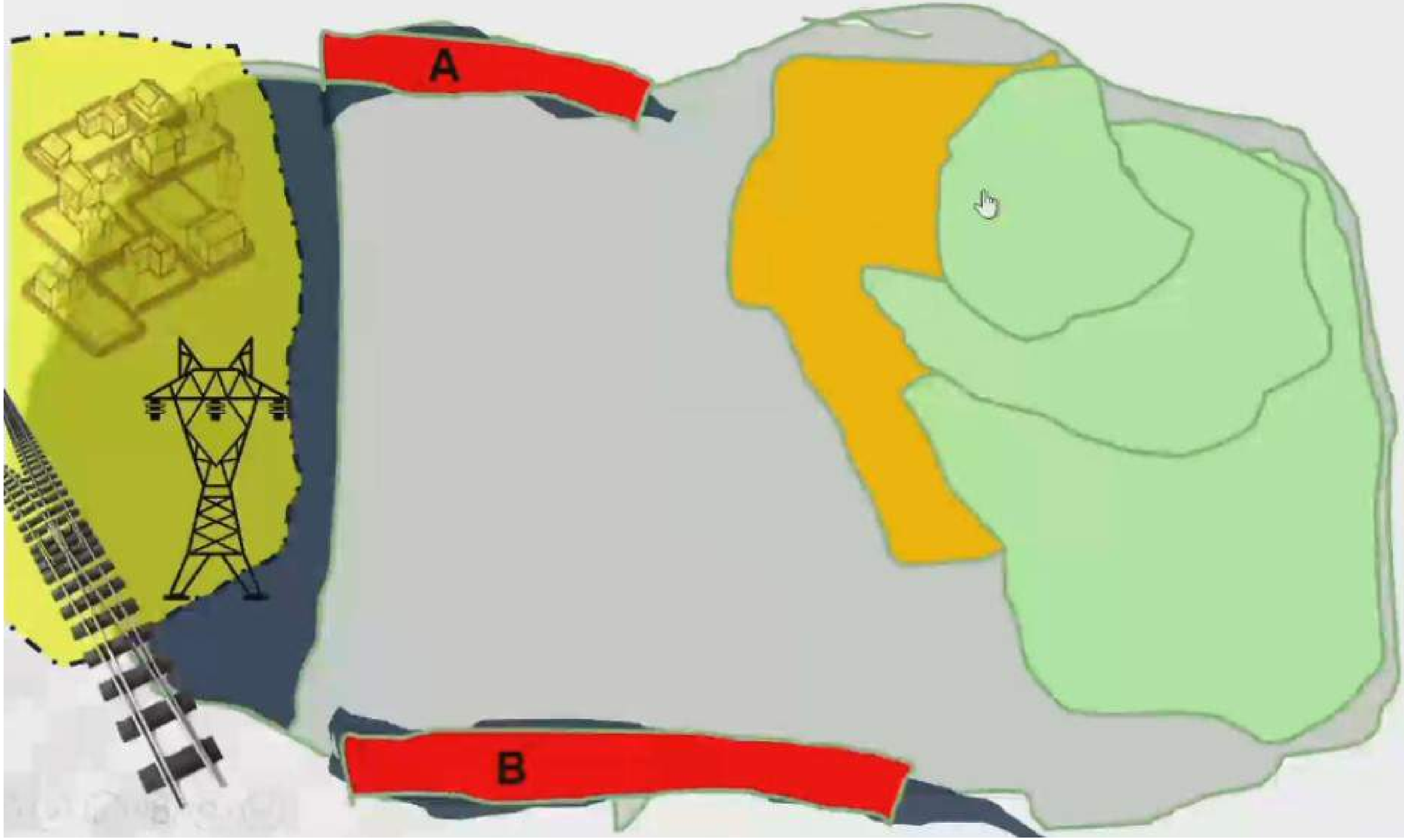
- Make of water
- Strong Roof & Floor
- Beyond Economic Stripping Ratio
- Preferably Flat Seam
- Thin Seams (0.9m-5.5m)

Scope of this Technology

- ⇨ Thin coal seams & beyond Stripping Limit *(as in case of Sharda OCM)*

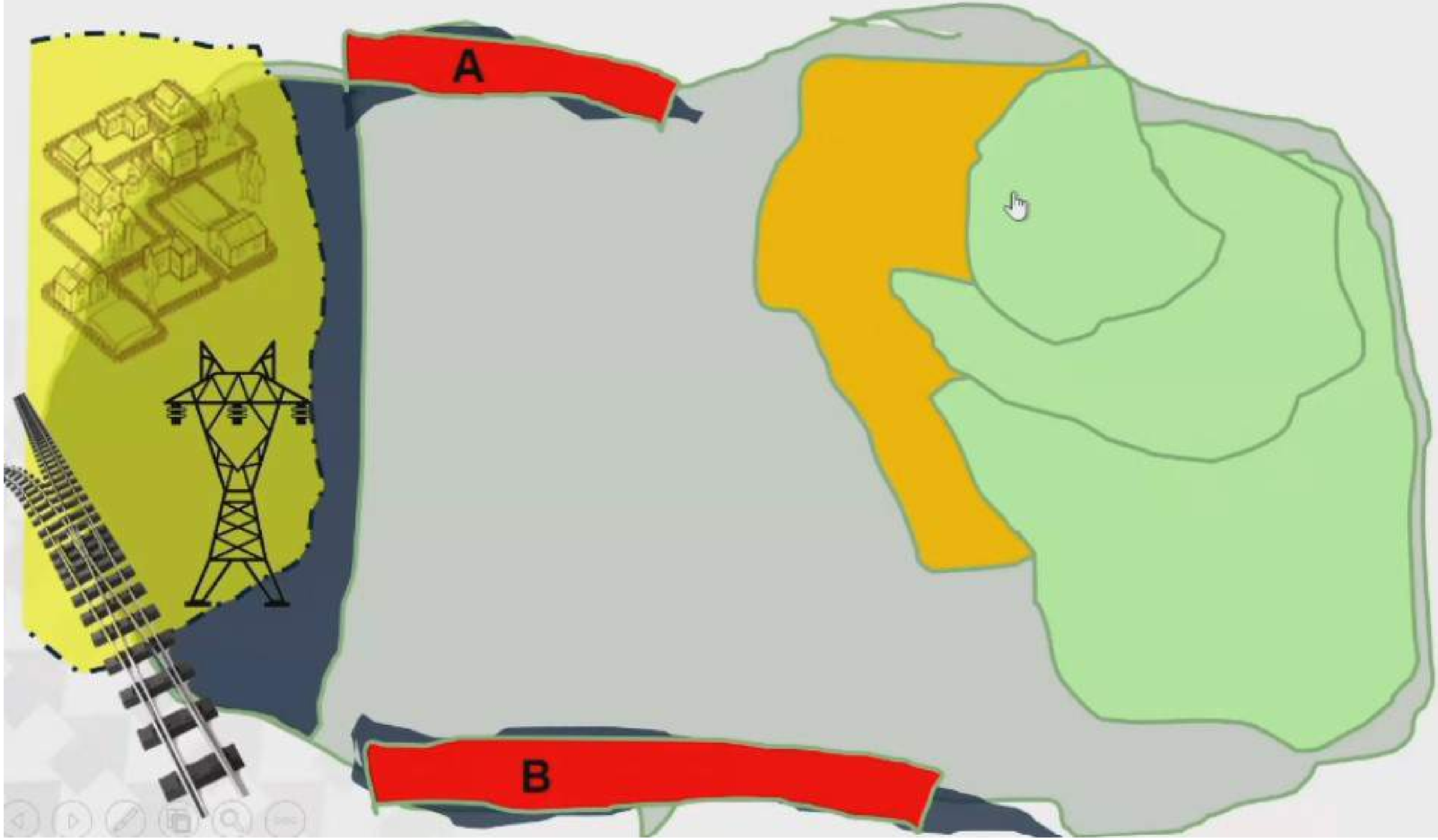
- ⇨ Coal Blocked in Boundaries
  - OB Dumps
  - Structures such as roads, railways, power lines

Scope...*Illustration*



Coal reserve of region A & B are blocked in Mine boundary due to strip limit

Scope...*Illustration*



Thus, say for a seam lying at 100m depth, the blocked coal might be 100m wide strip (assuming 45 degrees slope)

Scope...*Illustration*

So here comes the role of Highwall Mining

Highwall Miner...*Major Sub Systems*

Base Unit/ Advancing Launcher	It houses hydraulic power pack to feed power to push beams and cutter heads.
Reels & Chains	contain Power cable for cutter head, Control cable for cutter head, Methane sensor cable, Hydraulic pressure hose for cutter & cooling water hose for cutter motor.
Controls	Total operation is automatic through programmable logic controller as well as manual through touch screen technology
Push Beams	contains two contra-rotating augurs for transportation of coal from the coal face
Cutter Unit	It can cut coal seam having thickness ranging from 0.96m to 5.5m.

A Comparison...

Content	Highwall Miner No. 1 (Old)	Highwall Miner No. 2 (New)
Date of Commencement	April,2011	March,2019
Make	Caterpillar	Gainwell
Model	SHM 69	GHWM 300
Cutter Drum Diameter (Minimum Cutting Ht.)	28 inches	38 inches
Maximum Cutting Height	65 Inches	118 Inches
Cutter Drum Width	2.9 meters	3.5 meters
Push In & Pull Out Force	130 Tonnes & 270 Tonnes respectively	130 Tonnes & 270 Tonnes respectively
Operating Voltage	995 Volts	995 Volts
Maximum penetration	300 meters	300 meters
Push Beams Length	6.1 meters	6.1 meters
Transformer	2500KVA/50Hz (O/P-995V/480V)	2500KVA/50Hz (O/P-995V/480V)

Stage I - Planning & Design

- Web Pillars & Barrier Pillars_design made by Scientific agency and approved by DGMS

- Trench is designed in such a manner that FoS for Web/Barrier pillars remains more than 2.0, as mandated by DGMS

Stage II- During Mining Operation

- Pre-splitting

ge II- During Mining Operation

're-splitting

Pre-Split: Additional Gain

It has led to huge reduction in OB removal due to increased slope up to 70 degrees (Earlier 45 degrees)

Safety

- Lower Percentage of Trench Area to Coal Extraction area (< 20%)
- Remote Coal Cutting Op
- Safe Positioning of HWM
- Methane Sensor
- Pre-Split Technique
- HWM Auto health monitoring

- Minimal Blast Vibration

Economy

- Coal Conservation- Otherwise Lost
- Cheaper Technology
    - Only 4-persons are needed for machine operation (OMS)

    - No roof suppo... in ...

Environment

- Minimal Land disturbance
- Negligible Noise generation
- Enclosed coal conveying-
  Minimizes the dust emission

Others

- **Flexible & Mobile-** *Easier to recover small blocks of coal*
- **Can extract coal seam of varying thickness**
  - *0.9-5.5m in one cut and even more thick in multiple cuts*
  - *A Thick coal seam was extracted by M/s*

In-situ Conditions

Geological deformations are UNFAVOURABLE- *Faults, Dykes, Folds etc.*

Gradient – *Steep gradient is a challenge for machine stability and cutting/pulling thrust*

Highwall Miner

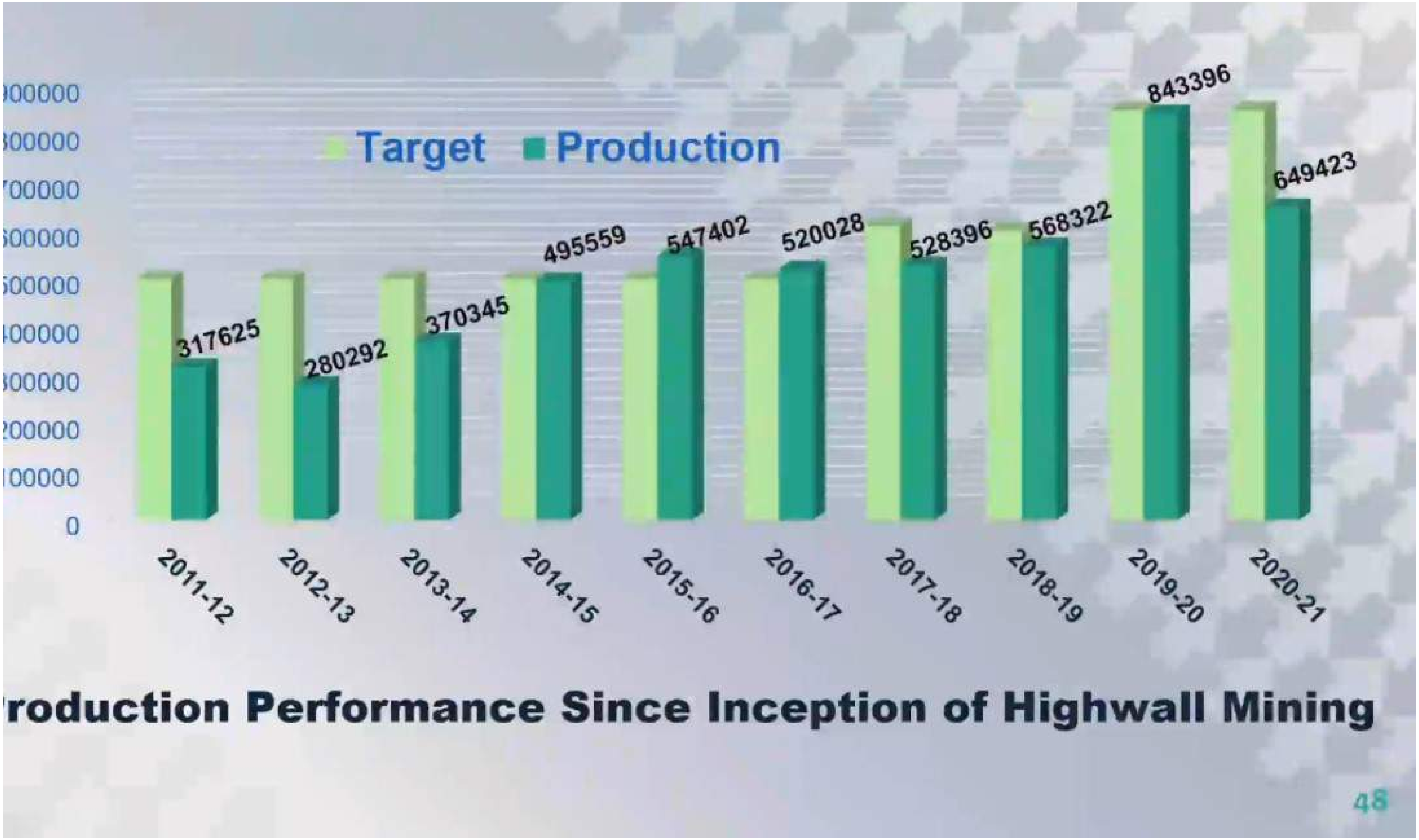
Thick Seam Mining- *In multiple cuts machine stability is a challenge*

Single point production source- *Coal production stops altogether in case of machine breakdown*

Technology Specific

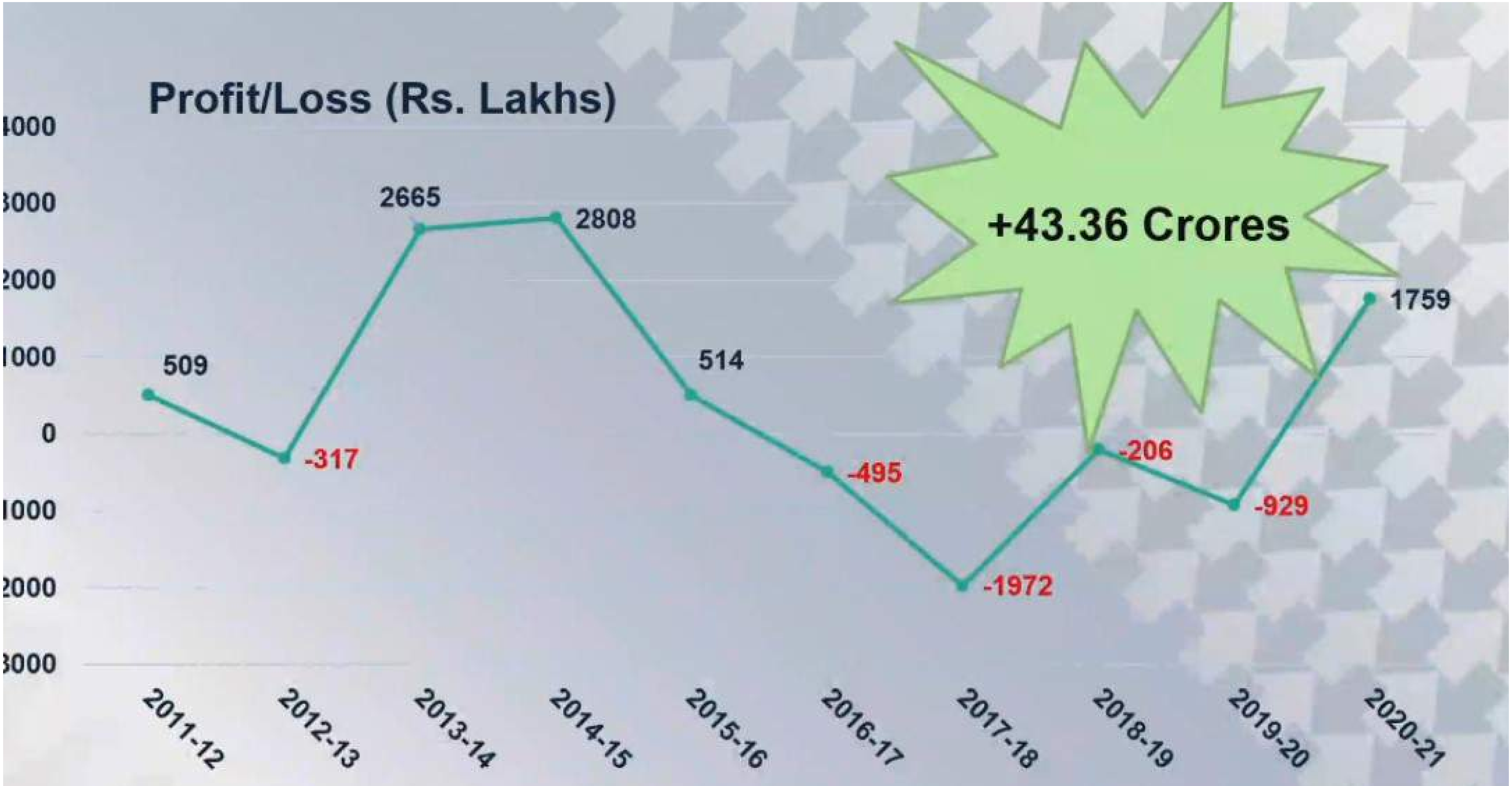
Highly Skilled Manpower- *Since this technology is still in nascent stage in India, training & re-training of manpower for operation & maintenance is an issue*

Lower Extraction % *(as compared to conventional OC method)* - *It is somewhere around 60%*



Target
Production
317625
280292
370345
495559
547402
520028
528396
568322
843396
649423
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
0
roduction Performance Since Inception of Highwall Mining
48

inancial Performance Since Inception of Highwall Mining



inancial Performance Since Inception of Highwall Mining

Summary Evaluation

ighwall Mining Technology is a promising methodology especially for thin
am mining.

is very useful to extract coal that are blocked in safety zones and/or have
ıfavorable stripping ratio.

ı Sharda OCM, highest one day coal production of around 2800 tonnes has
een achieved. However, it has potential to achieve even higher coal production
ıder favorable circumstances.

wing the tag of one of the Safest & cleanest coal cutting technology, it is
onomically attractive too.

'ith the experience gained in Sharda OCM over the past 10 years, confidence
ıs been boosted up to replicate this technology at other favorable places.

Annexure- 3

WORK-SHOP ON TECHNOLOGY ROAD-MAP FOR COAL SECTOR

Focus Area: Blast-free Mining

Presenters:
Subhankar Bhattacharya
Rajat Chakraborty
Dt. 15.03.2022

Content:

Basics of Conventional Mining and Mechanized cutting by surface miner

Influencing factors Surface Miner – Deliberation on applications

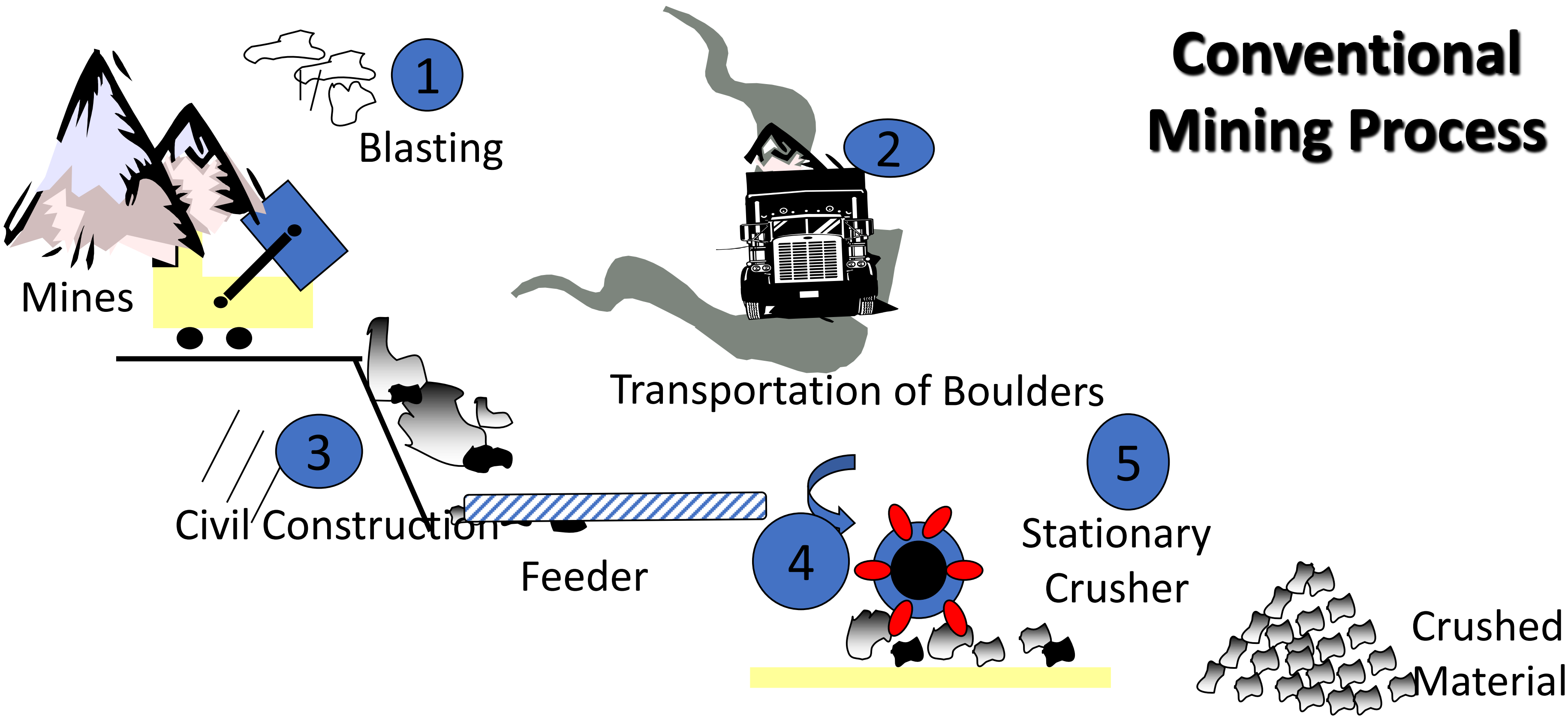
L&T'S foray in developing SURFACE MINER promoting blast-free mining technology

Experience in Coal and Hard Rock Mining

Way forward for LARGE SCALE MINING by SURFACE MINERS

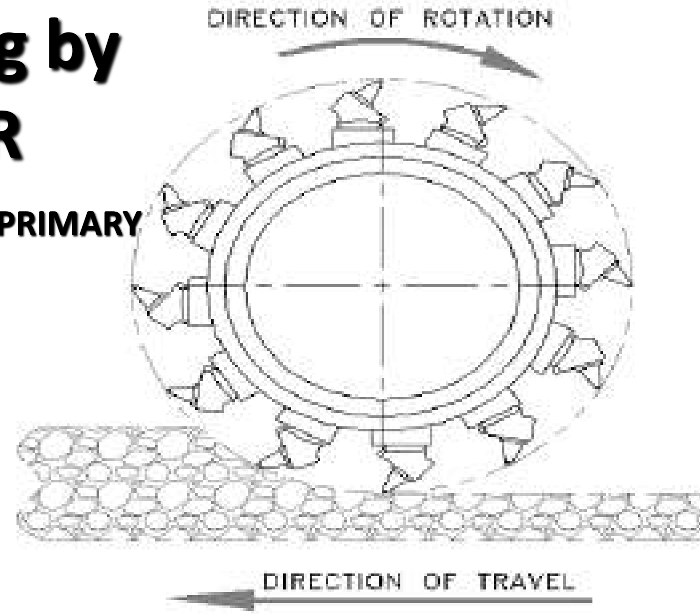
Other Eqp. for MECHINISED MINING –Brief Tech. insights of Ripping

Conventional Mining Process



Mechanized cutting by SURFACE MINER

ELIMINATION OF DRILLING-BLASTING-PRIMARY CRUSHING



Windrowing

Conveyor Discharge

INFLUENCING-FACTORs FOR SELECTION OF SURFACE MINER	
	Uni-Axial Compressive Strength of Rock (MPa)
	Silica Content of Rock
	Nature of Rock deposits (Fractured/massive/layered etc)
	Clay content
	Moisture content
	Area of Mines under consideration
	Gradient of seam & Thickness of seam
	Volume of excavation (TPD)
	Product Output Size requirement

Development of L&T Surface Miner

L&T forayed into development of first Indigenously designed and manufactured Surface Miners in Year 2004. L&T's engineering team worked closely with many users of mining machinery across different mineral applications and launched its first 100 Ton Weight Class - Surface Miner (Model KSM 304) in 2004 with 3m width cutter drum and 1200 HP Engine.

KSM 304 Surface Miner model was an instant success with Indian as well as overseas customers (across coal, limestone and hard rock cutting applications) due to its rugged, heavy-duty design ensuring smooth operations even in toughest mining conditions. Subsequently, over the years, L&T developed and launched different models starting from drum width of 2.2m to 4m to cater to varying needs of different types of mines and applications. The size of mines, hardness of deposits and production requirements determine the suitability of model of machine.

Product Range





Model/Technical Spec.	KSM223	KSM303	KSM403	KSM304/C	KSM404
Cutter Drum width (mm)	2200	3000	4000	3000	4000
Cutting Speed (m/min)	30	30	30	25	25
Max. Cutting Depth (mm)	350	300	350	400/500	400
Engine Power (HP)	800	800	950	1200	1200
Total Weight (Ton) Dry / Operating	48 / 55	50 / 56	54 / 60	100 / 115	105 / 120

L&T Surface Miner

EXPERIENCE IN HARD ROCK CUTTING APPLICATION

L&T Surface Miner

EXPERIENCE IN LARGE SCALE MINING OPERATION




WAY FORWARD FOR LARGE SCALE MINING

- Focus on Technologically more Robust and High-Capacity (100-ton weight class) machines
- Higher Depth of cut & cutting speed will minimize Eqp. fleet
- Combination feet will help optimize on select mines
- Exploring Surface Miner more and more for areas close to habitation
- High-capacity machines are better placed for negotiating hard strata with optimum OPEX.
- Focus on mine plan for development of decent size of face Exposure for higher productive hours of surface miners
- Digitisation initiative for effective Realtime monitoring system
- Quality of Mined coal is an ADD-ON benefit of surface miner

OTHER MINING EQP. FOR MECHANISED CUTING

Methods of Fragmentation of In-situ rock

- Drilling and Blasting
- Use of Surface Miner
- Use of Rock Breaker
- Ripping the in-situ rock using ripper dozer

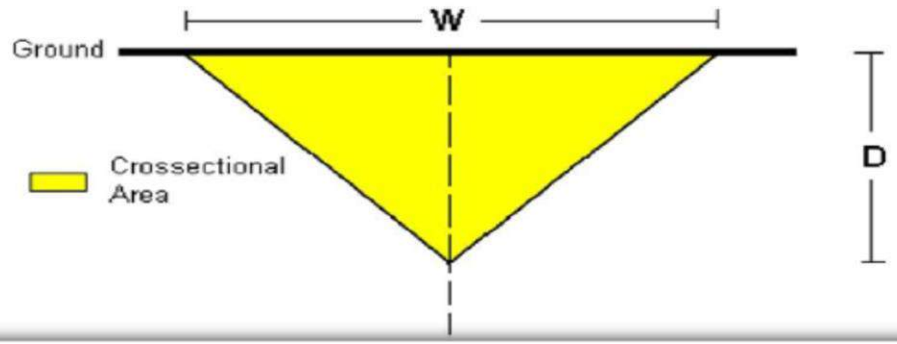
	Dumper	Front End Loader	Excavator
	Drilling and blasting		
	Rock-Breaker		
Surface Miner	Surface Miner		
Ripper - Dozer	Ripping		

KOMATSU

D475A-5E0

860 HP Dozer

Cross sectional area is calculated by using following triangular cut.



Per Cycle Ripped Area(RA) = (DxW)/2

Per Cycle Volume Extracted(VE) in cum = RA x L (Length)

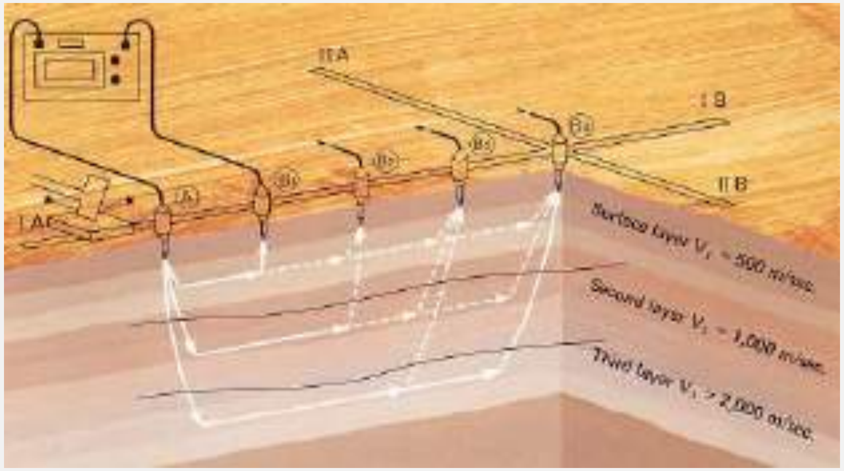
Hence Volume Extraction Per hour(VE/hr) =RA x L x 60 x E/t

Where E is operator Efficiency & t is ripper cycle time

Why Ripping ???

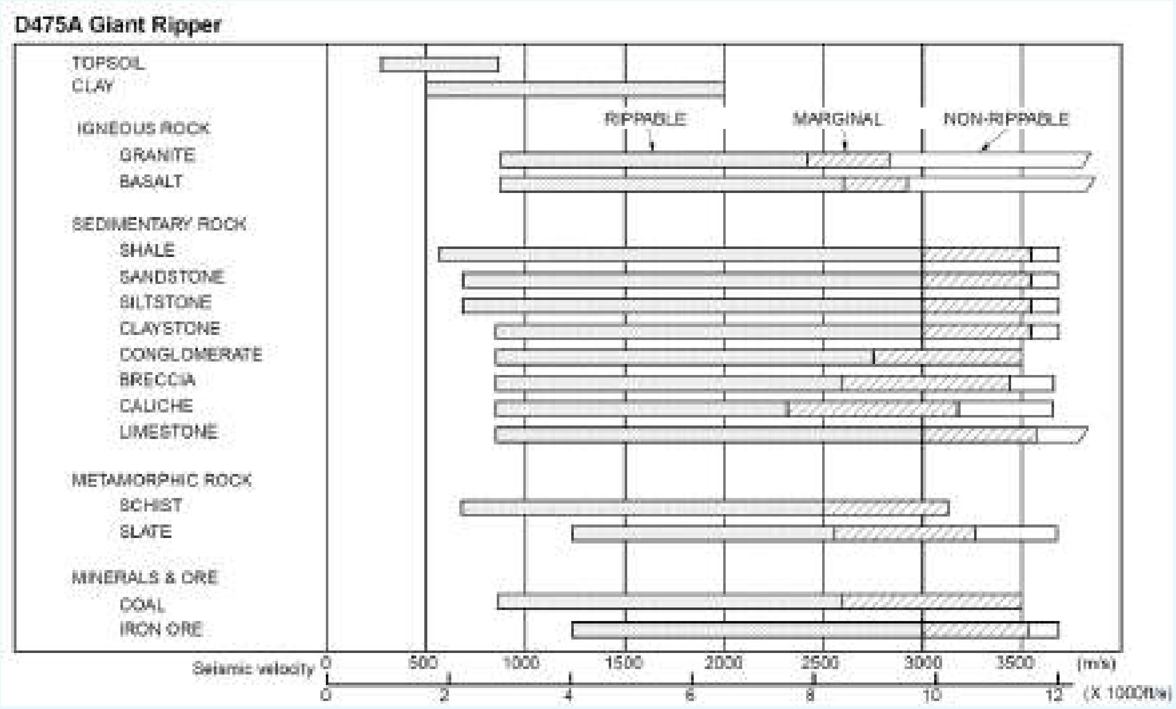
- Mining with reduced vibration, noise and dust pollution
- Energy efficient method of mining
- Mining with less deployment of machinery
- Continuous mining method
- Can do selective mining
- Mining with less variation in extracted rock size

How to identify rippability of Rock



Seismic Velocity Test

- A Ripper meter measures the seismic velocity (m/sec) of the ground
- Higher the speed less rippable is the rock and vice-versa



- Ripper performance based on Seismic Velocity
- Depends on machine class:
  - Weight/Drawbar pull
  - HP
  - Ripper penetration force, etc.

Selection of Ripper

Three primary factors to select the right equipment:

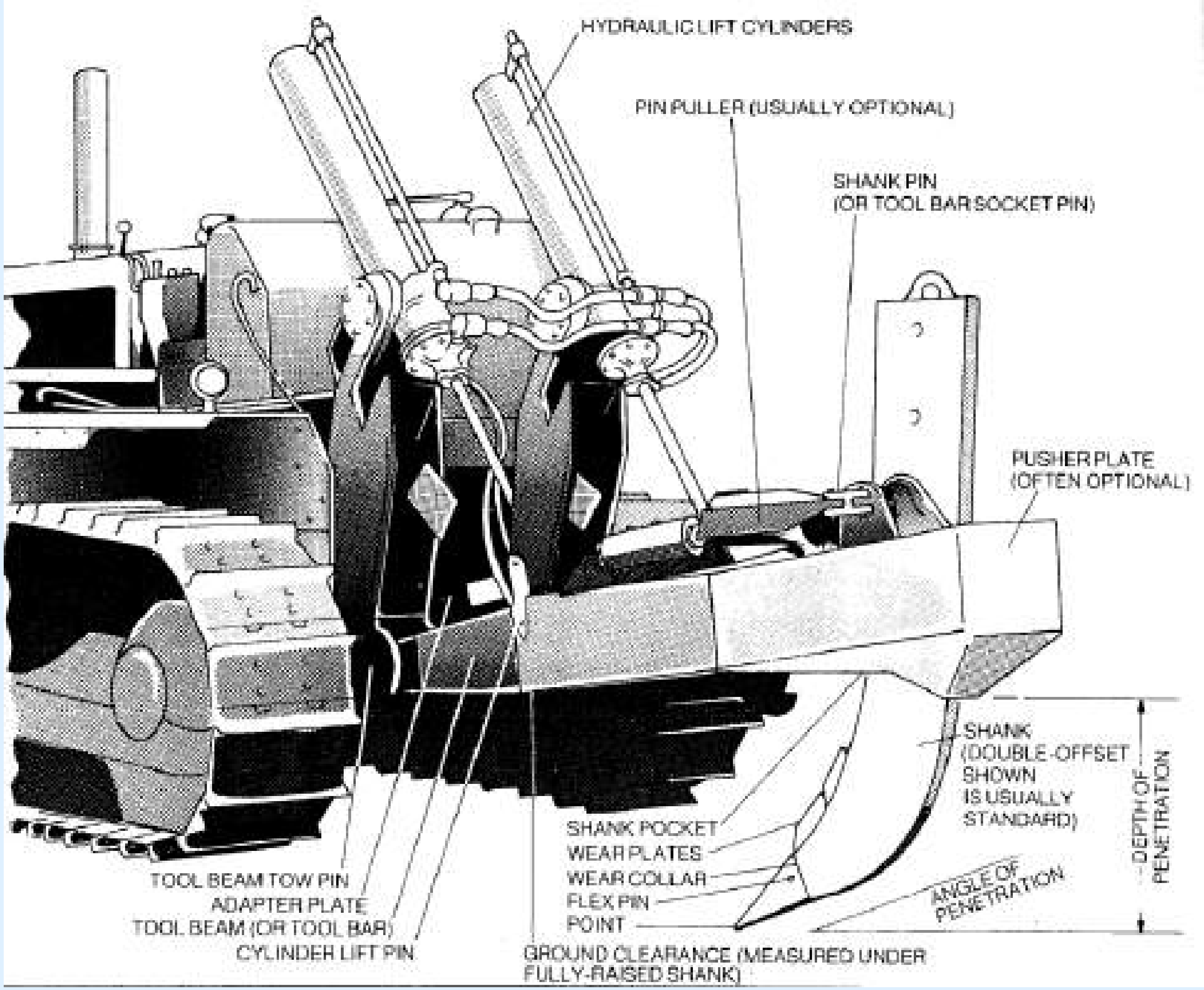
- Down pressure available at the tip, which determines the ripper penetration that can be achieved and maintained.
- Tractor flywheel horsepower, which determines whether the tractor can advance the tip.
- Tractor gross-weight, which determines whether the tractor will have sufficient traction to use the horsepower.
- Ripper Angle

Ripper mounting brackets and hydraulic control mechanisms vary widely among manufacturers. The basic ripper designs are radial, parallelogram and adjustable parallelogram.

Komatsu ripper linkage

Komatsu's D155AX-6

Single Shank Ripper Dozer

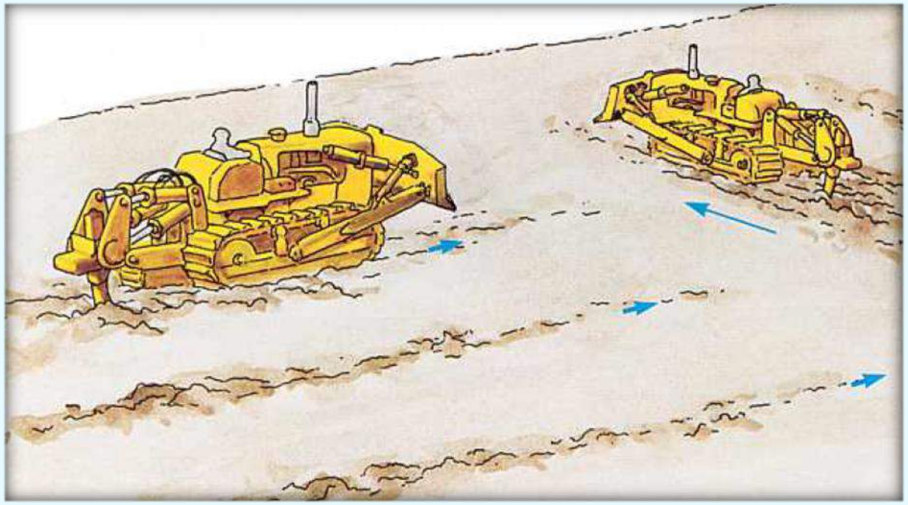


Various Ripping Techniques and Methods

Straight Ripping

Inclined Ripping

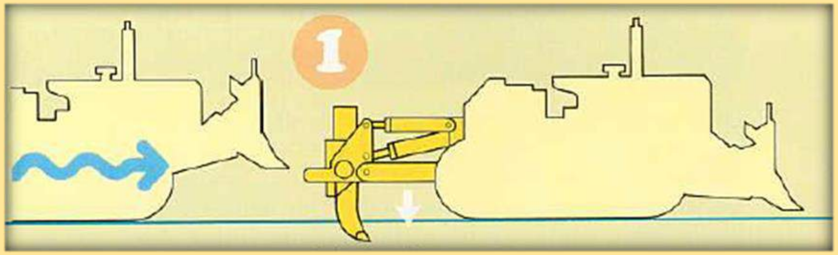
Cross Ripping



Tandem Ripping

When ripping production drops, adding the second tractor almost doubles the costs, but production can be increased by three or four times in some materials.

Single-shank rippers are designed with an integral pushblock for tandem pushing in severe applications.



Ripping Mechanism

Ploughing

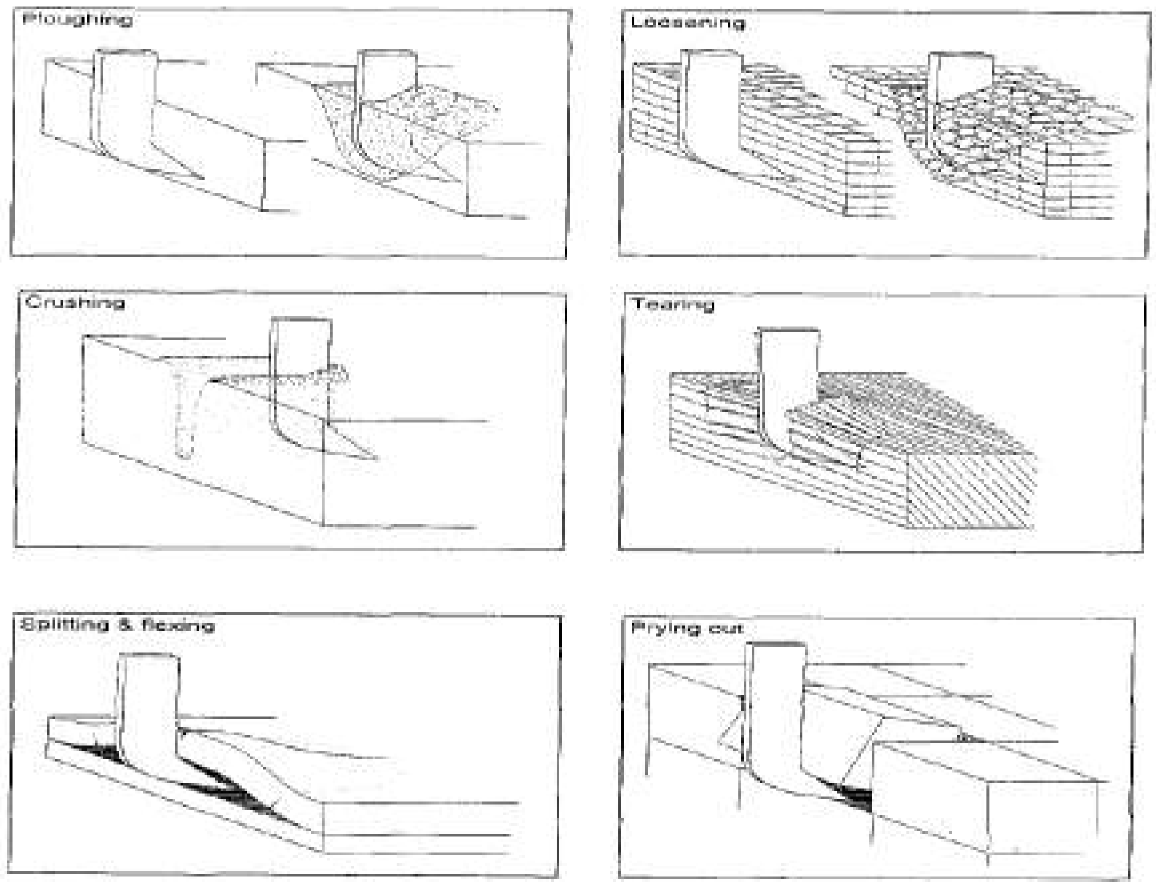
Loosening

Crushing

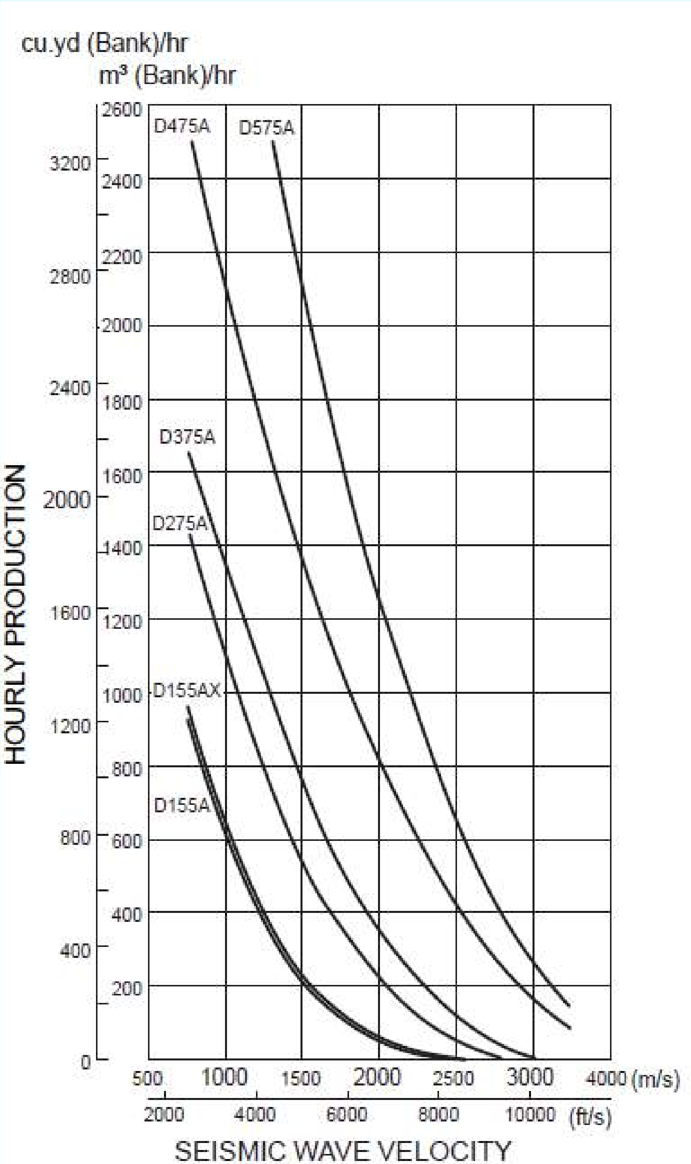
Tearing

Splitting & Flexing

Prying out

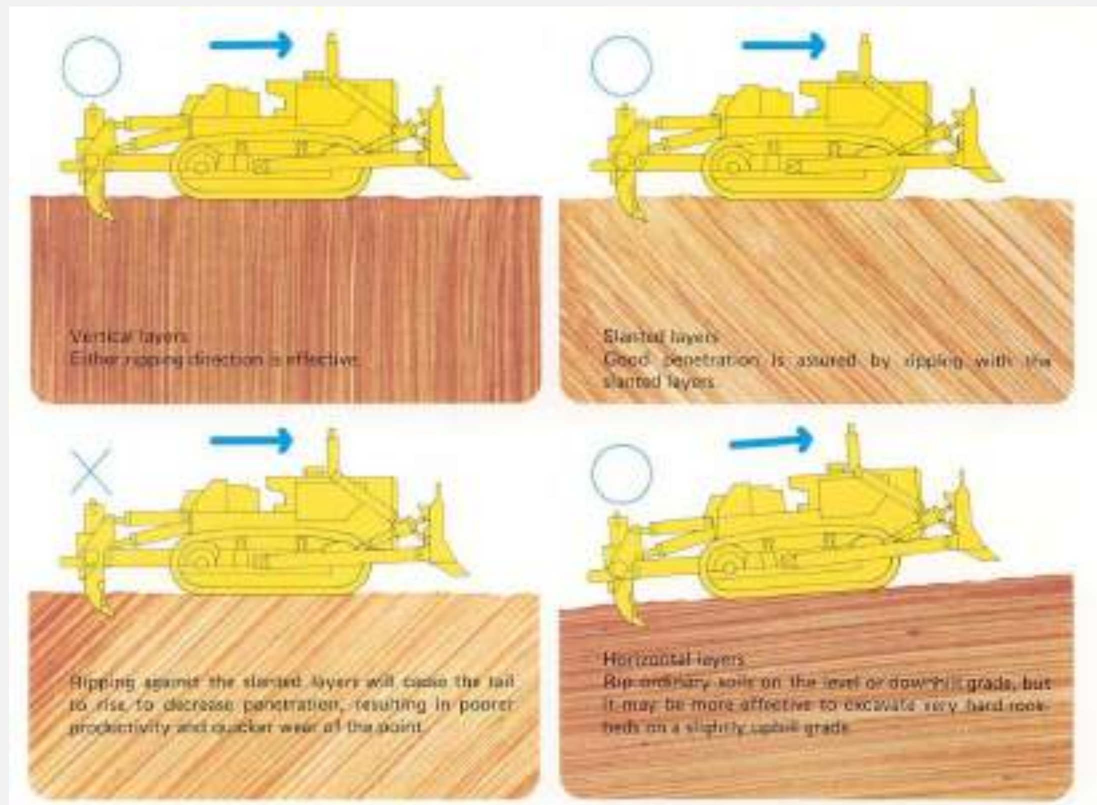


Productivity..

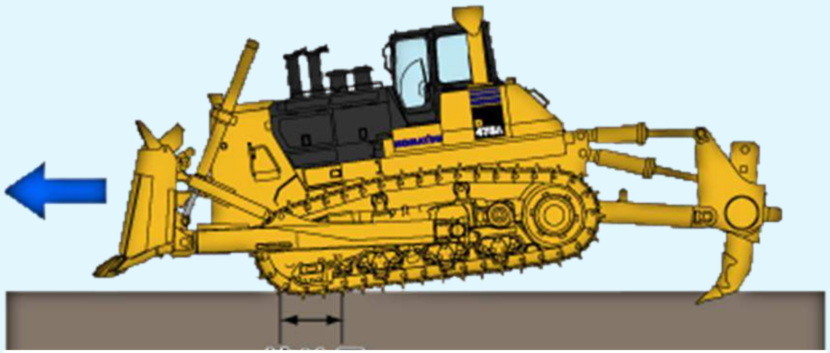


Production can vastly vary based on several factor:

- Knowledge of the geology and material
- Operator skill
- Proper application of Ripping Techniques



Some Good Operating practices..

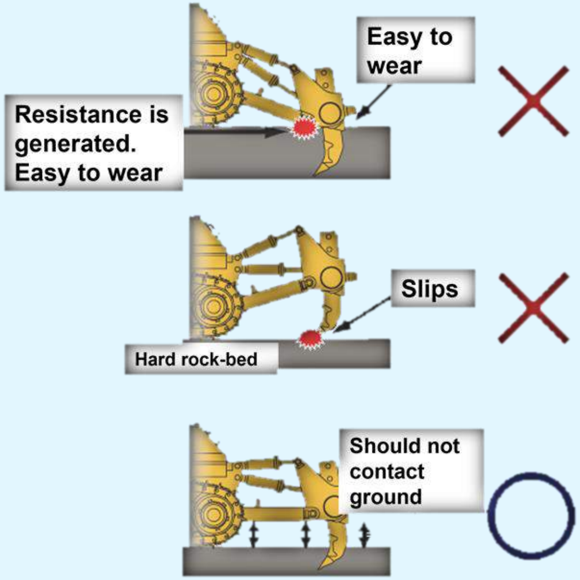


L : Length of track on ground

Maintaining length of track on ground is of paramount importance to get the max drawbar pull

Downhill Ripping for Hard Rock highly recommended : Ripping with machine weight

Always rip in a straight line
Avoid steering during ripping to conserve shank



Maintain Ripper arm parallel to the Ripping surface

Thank You

Annexure -4

Future demand of coal in India vis-à-vis Thrust on UG coal production – agenda for actions

Prof. R.M. Bhattacharjee

Two most critical challenges before the world

Huge impact on mankind

- Covid 19 X
- Global warming & climate change
  - Future of coal ????
    - Future demand of coal in India
      - Challenges before India coal industry to supply coal as per demand
        - How are we going to mitigate the challenges

What are going to discuss today

- Impact of global warming on coal mining?
- Sustainability issues in coal mining
- Challenges before Indian coal industry
- Scenario of coal production technologies in India
- Scenario of coal production from UG workings
- Thrust on UG mining - why
- Strategies for action for improving production from UG coal mining

Impact of coal mining on Global warming & climate change

- Increasing concerns about effect of anthropogenic greenhouse gases on global climate, international society agreed to reduce emissions
- Use of coal – GHG emission
  - Use of coal – Thermal Power & Industrial use
    - Thermal Power –
      - 1.1 gigatonne of CO_2 every year;
      - **2.5 per cent of global GHG** emissions,
      - one-third of India's GHG emissions,
      - and around 50 per cent of India's fuel-related CO_2 emissions

Impact of coal mining on Global warming & climate change

- Environmental footprint due to coal mining
  - Land – Deforestation – Carbon capture – Carbon footprint
  - Water and air pollution
  - Fugitive gas emission from mining of coal
  - Energy consumption to produce coal, process coal and transport of coal – GHG emission & carbon footprint

Arguments against coal

- **Government Policies to create demand for renewables and attract investors -**
  - Larger target of 450 GW renewables set for 2030
  - Green Energy Corridor
  - Solar parks
- **Government policies to help renewables to become cost-competitive**
  - Lower corporate tax
  - Waiver of Inter-State Transmission System (ISTS) charges and losses
  - Capital subsidy
  - 100% foreign direct investment
- **Falling costs of renewables challenge the economics of building new coal plants**
  - solar power tariff nosedived to Rs 2.62/kWh – 20% lower
- **Low calorific value and high ash content (30 to 45%) of Indian coal consume about 0.7 kg/ kWh of coal - United States 0.45 kg /kWh**
- **More stringent emission norms, and water shortages**

Arguments for coal

- Population and growth, urbanisation and continued industrialisation - driving India's energy appetite
- India fourth-largest global energy consumer today, after China, United States and the European Union –
- India's per capita energy consumption increased from 16.3 kWh in 1947 to 1208 kWh in 2019, still very low compared to Canada – 15438, USA – 13098, Saudi Arabia – 10239 kWh
- India's power demand is expected to grow by 80% in ten years
  - CEA projects 2,518TWh of gross electricity generation by FY2029-30
  - Other reports 2,700TWh in 2030, up from 1,500TWh in 2020
- India will account for nearly one-quarter of global energy demand growth from 2019-40 in the Stated Policies Scenario (STEPS), the largest of any country
- Demand for coal will reduce in % of total energy basket but absolute volume will almost be doubled by 2040
- By retiring older plants, the emissions intensity of the grid would improve
- Coal fleet will grow more slowly, but it will be utilized much better
- **We can not stop coal mining or use coal for energy - but Need for responsible mining of coal**

  - **Smart, safe and sustainable**

Coal production scenario of major coal producing countries

	USA	Australia	China	India	Indonesia	Russia
1979/1991	708.63	106.12	635	103.42	0.28	371.90
Maxm. Annual production	1075.88	512.43	3748.53	775.73	616.16	419.09
2019	639.80	503.18	3692.87	769.00	616.16	417.89
Average Annual growth %	-0.1	4.0	4.5	5.1	22.8	0.60
Overall growth	-0.10	3.70	5	6	2200	0.12

Energy Basket of India – at a glance

Fuel	MW	% of Total
Total Thermal	2,34,058	60.9%
Coal	2,02,005	52.6%
Lignite	6,620	1.7%
Gas	24,924	6.5%
Diesel	510	0.1%
Hydro (Renewable)	46,322	12.1%
Nuclear	6,780	1.8%
RES* (MNRE)	96,956	25.2%
Total	384,116	

Source – MoP (30.06.2021)

Most likely demand of coal based electricity and coal for 2030

Parameter	Lower bound	Upper bound
Electricity requirement (TWh)	2200	2400
Coal-based generation (TWh)	1150	1350
Coal for electricity (MT)	800	875
Coal-based capacity (GW)	230	260

Estimates of coal demand projections for 2030

Sector	2030
Utility electricity generation (MT)	800 – 875
Industrial demand (MT)	262- 310
Captive electricity generation (MT)	130 – 140
Total (MT)	**1192-1325**

Coal production scenario

COMPANY WISE PRODUCTION OF RAW COAL DURING LAST TEN YEARS

[Quantity in Million Tonnes]

Company	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20 (Provisional)
CIL	431.32	435.84	452.20	462.41	494.23	538.75	554.14	567.37	606.89	602.13
SCCL	51.33	52.21	53.19	50.47	52.54	60.38	61.34	62.01	64.40	64.04
OTHERS	15.82	15.73	13.87	13.40	9.69	11.27	9.85	8.96	7.53	6.83
CAPTIVE	34.22	36.17	37.14	39.48	52.72	28.82	32.54	37.07	49.90	57.87
Total	532.69	539.95	556.40	565.77	609.18	639.23	657.87	675.40	728.72	730.87

Note: Production of CIL is including Gare Palma IV/1 and IV 2&3 and production of captive is excluding these blocks.

PRODUCTION OF RAW COAL DURING 2010-11 to 2019-20

Annual growth is fluctuating 2 % to 7 %

Issues for consideration

- Do we have enough coal?
- Do we have capacity to produce coal at globally competitive price and in a sustainable manner?
- How impact of coal mining and its beneficiation on global warming may be mitigated?
- How to optimize cost of coal production, cost of environment, cost of energy, cost of land and cost of GHG emission?
- What are the feasible alternative use of coal?

Supply Road map – Challenges ahead

- Presuming demand of around 1200 - 1300 MTPA, with 30-35% of future energy basket may be around, need to prepare a road map
- Challenges before the industry having significant impact on supply road map
  - Production of coal
    - Mix of technology for coal production
    - Technology of coal production
    - Environmental impact of production technology.
    - Socio-technical and socio-political context.

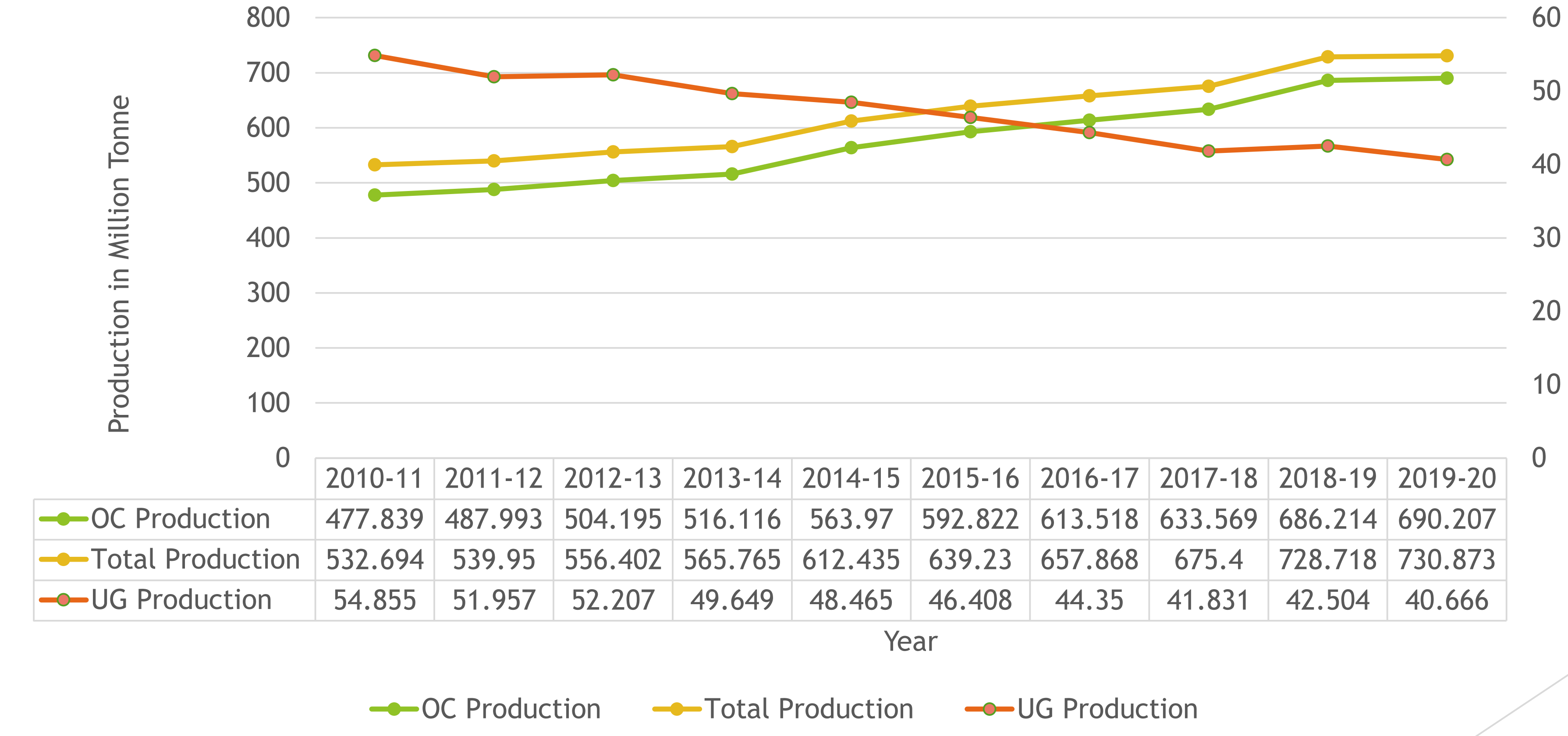
Sustainability and technology of coal production

- Sustainable
  - Environment
  - Economics
  - Conservation
  - Quality
  - Safety

TRENDS OF COAL PRODUCTION IN INDIA FROM OC and UG MINES IN LAST TEN YEARS

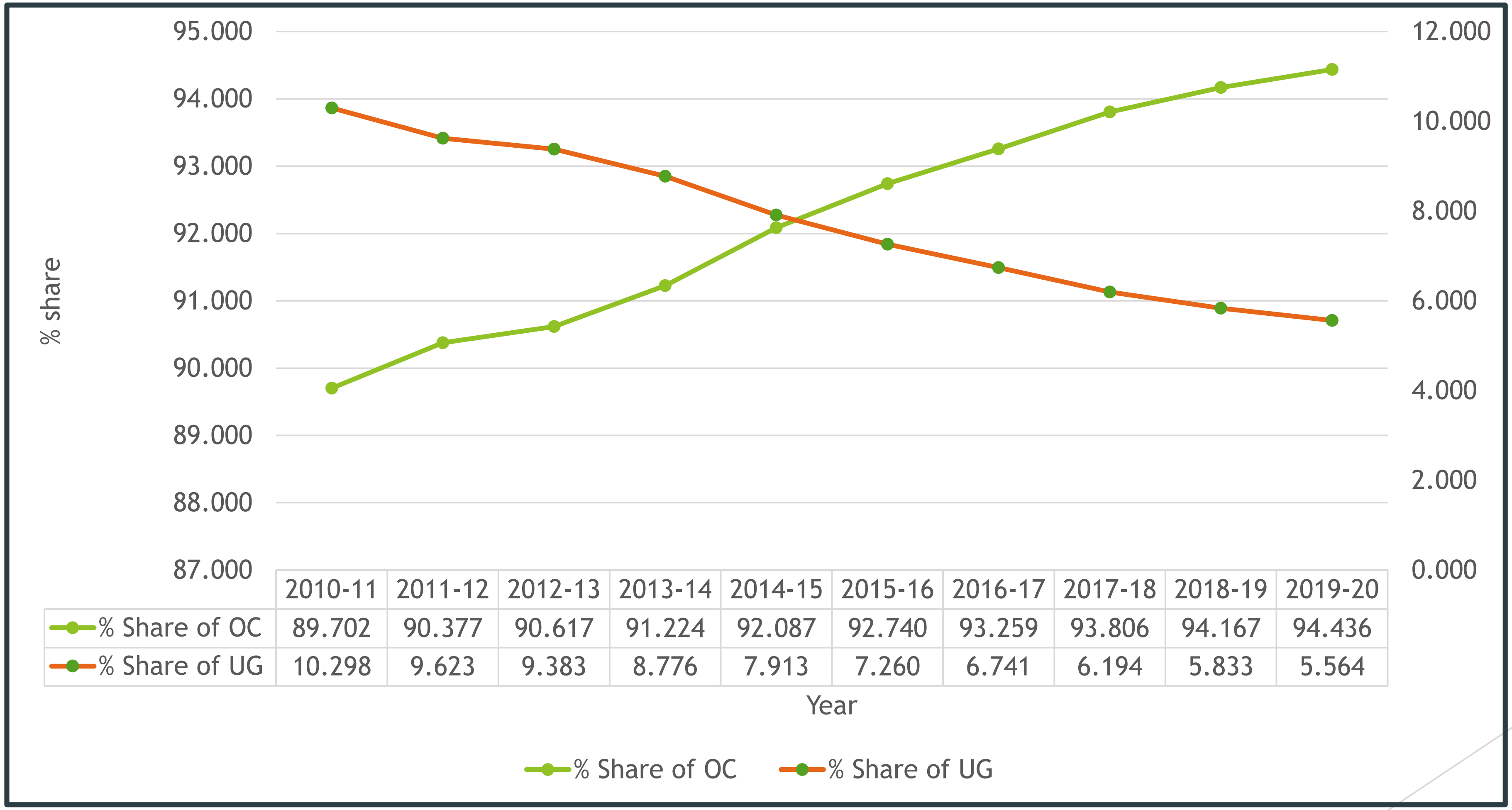
	Opencast		Underground		Total	
	Production	% Share	Production	% Share	Production	% Growth
2010-11	477.839	89.702	54.855	10.298	532.694	0.12
2011-12	487.993	90.377	51.957	9.623	539.95	1.36
2012-13	504.195	90.617	52.207	9.383	556.402	3.05
2013-14	516.116	91.224	49.649	8.776	565.765	1.68
2014-15	563.97	92.087	48.465	7.913	612.435	8.25
2015-16	592.822	92.740	46.408	7.260	639.23	4.38
2016-17	613.518	93.259	44.35	6.741	657.868	2.92
2017-18	633.569	93.806	41.831	6.194	675.4	2.66
2018-19	686.214	94.167	42.504	5.833	728.718	7.89
2019-20	690.207	94.436	40.666	5.564	730.873	0.30

Coal production in last 10 years from Opencast and Underground workings



	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
OC Production	477.839	487.993	504.195	516.116	563.97	592.822	613.518	633.569	686.214	690.207
Total Production	532.694	539.95	556.402	565.765	612.435	639.23	657.868	675.4	728.718	730.873
UG Production	54.855	51.957	52.207	49.649	48.465	46.408	44.35	41.831	42.504	40.666

% of total production from Opencast and Underground workings



	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
% Share of OC	89.702	90.377	90.617	91.224	92.087	92.740	93.259	93.806	94.167	94.436
% Share of UG	10.298	9.623	9.383	8.776	7.913	7.260	6.741	6.194	5.833	5.564

Technology wise of CIL Production in 2019-20 and 2023-24

	Name of the company	Coal Production (M Te) from Underground mines				
		Longwall Technology	Room & Pillar with Continuous Miner	Bord & Pillar with SDL /LHD / Others	Other	Total coal Production from UG
2019-20	CIL	1.96	6.62	20.52	0.1	29.2
	% age of total UG production	6.71	22.67	70.27		
	% age of total production	0.33	1.099	3.41		4.85
2023-24	CIL	4.8	13.81	19.33	0	37.94
	% age of total UG production	12.65	36.40	50.95		
	% age of total production	0.48	1.38	1.93		3.79

Size of UG and OC mines of CIL in 2019-20 and 2023-24

		Production from Underground mines with annual capacity					
		< 0.3 Mte	+0.3 - 0.6 Mte	+0.6 – 1.0 Mte	+1.0 – 4.0 Mte	>4 Mte	Total Production from Underground mines
FY 2019-20	Total Production	12.98	8.17	3.8	5.09	Nil	30.04
	No. of mines	136	21	5	2	0	164
	Average production per mine in M Te	0.095	0.389	0.760	2.545		0.183
	% age of total UG / OC mines	82.93	12.80	3.05	1.22	0.00	
FY 2023-24	Total Production	9.13	11.99	7.06	7.4	4.2	39.79
	No. of mines	88	28	9	4	1	130
	Average production per mine in M Te	0.10	0.43	0.78	1.9	4.20	0.31
	% age of total UG / OC mines	67.69	21.54	6.92	3.08	0.77	

Challenges of Sustainable and Responsible coal mining

- Responsibility of mining sector to implement Mining 4.0 with focus on circular economy and sustainability through
  - smart technologies aiming to develop autonomous mining system for
    - energy-efficient, clean technologies that contribute to
      - bulk production with due care to sustainability by
        - waste minimization and waste re-use in an environmentally responsible manner

- Technology for coal production – less energy intensive
- To reduce environmental impact of production technology

Shift in production technology

Is the technology mix sustainable?

- Environmental foot print of OC is very large compared to UG
- Quality consistency is poor
- Huge land requirement – land scarce commodity
- Rehabilitation, re-settlement is huge social challenge
- Large-scale deforestation huge negative impact on carbon sink
- Energy intensity of OC is very high mainly because of handling OB
- Huge impact on quality of air and water
- 95:5 = OC:UG is not sustainable

What is needed?

- Gradual shifting of production technology
- Increase in share of UG production

Thrust on Underground mining - policy intervention

- ✓ Thrust on UG - Incentivise UG production, 1 mt UG production = X mt OC production, Separate cadre for UG
- ✓ Highlighting reduction in environmental footprint by UG compared to OC mining
- ✓ Discounting Cost of environment for UG Project Feasibility study
- ✓ Mass production – amalgamation of smaller mines, Plan for bigger mines
- ✓ Stop uneconomic semi-mechanized bord & pillar mining,
- ✓ All out mechanization through continuous mining system, underground transport/ conveying of coal, material and men
- ✓ Introduction of global best practices for pilot mines for mass production

Thrust on Underground mining - policy intervention

- Starting new projects in dip-side deeper horizons, independent of existing working
- Thrust on policy change by DGMS for exempting surface land right for UG mining under forest - Study of pilot area under forest to depillaring with caving
- Exploring potential reserves for application of mass production technologies using Bolter miner / CM
- Identification of reserves suitable for mass production mining methods like Room & Pillar / Wongawilli / Longwall
- Extraction of standing pillars by shortwall or short longwall method
- Longwall mining for suitable geo-mining conditions and large reserve
- For Thick seams – Longwall top coal caving method

Thrust on Underground mining - policy intervention

- Partial extraction with stowing for built up areas
- High speed stowing matching with rate of production
- Implementation of mass production technology with matching stowing, dissociating extraction and filling by suitable mining method
- Increasing stowing capacity using paste fill
- Use of multiple stowing range
- Getting raw materials for stowing in underground and mixing near area of stowing
- Decarbonisation not as a cost but overarching business strategy
- No separate team for climate change and sustainability - embedded in operations

Exploration and Planning

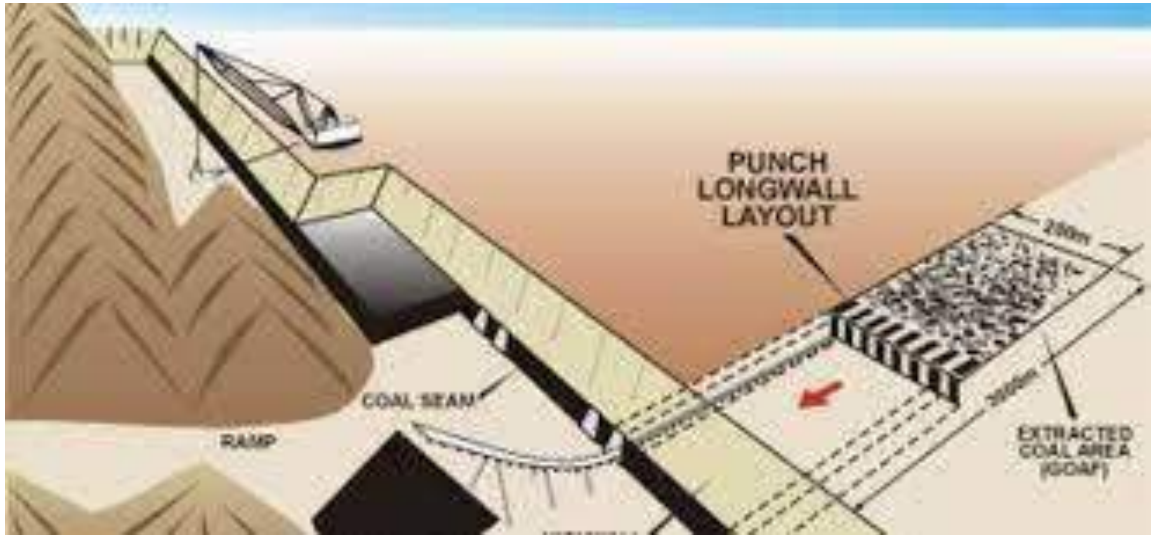
- Detailed exploration of coal seams at deeper horizons to avoid uncertainty
- Use of AI tools in non-invasive detailed exploration by geo-physical methods
- Use of 4D modelling for better understanding of mine geology, variation in geo-mining conditions, effect of geological anomalies,
- Use of mine planning software for long-term and operational planning
- Establishing Tech service cadre including geotechnical engineers for tech support to operation managers
- Provisions for risk assessment due to changes in geo-mining parameters and contingency planning

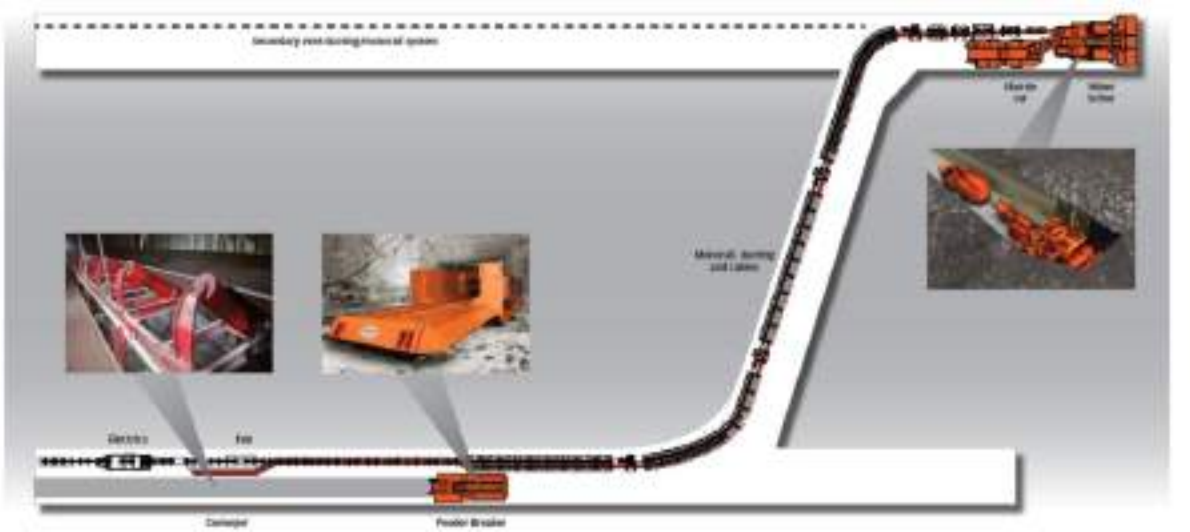
Mine plan

- Larger panels with optimum face transfer
- Adequate reserve for optimum utilization of equipme
- Amalgamation of smaller units
- Proper mine layout considering operational efficiency, coal evacuation, ventilation, stability of structures and safety
- Reducing frequency of major overhaul necessitating equipment transport to surface between face transfer
- Optimise development cost
- Use of mine planning software integrating all the processes – Geological Model to Mine Design to Mine Plan to Production Schedule to Mine Reconciliation
- Gemcom • Minescape • Surpac • Minesight • Vulcan • Minex • Xpac
- Application of Virtual Reality and Augmented Reality in mine planning – assessment of impact of changed geological parameters

UG from bottom of OC

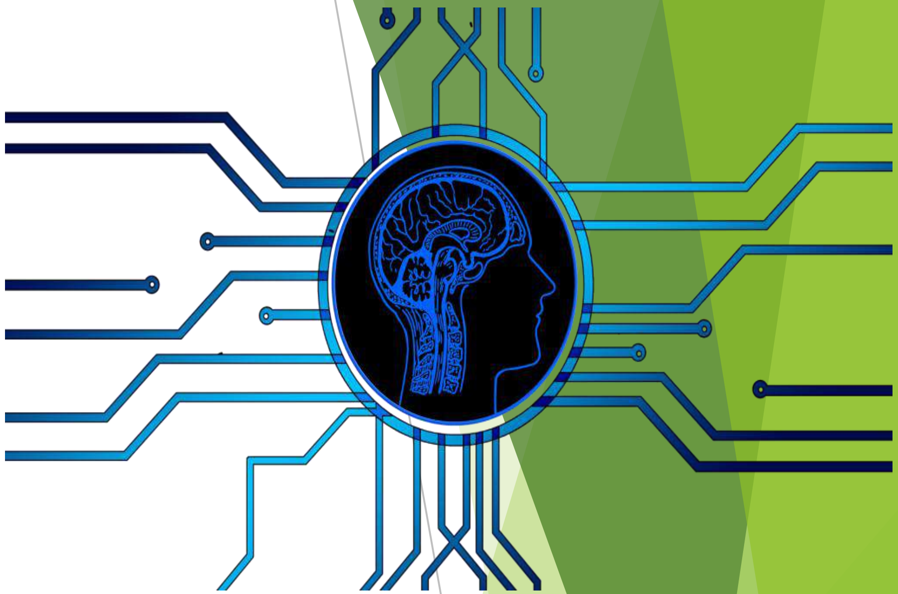
- Punch entry UG mines from bottom of OC mines
- Integrated mine planning – OC to UG
- Punch entry longwall – high capacity, simple circuit
- Highwall mining
- Twin entry development





Mechanization and automation

- Go for all out mechanization of all unit operations with available state of the art technologies
- Systematic AI / ML based preventive maintenance
- Remote and tele-operation wherever possible to reduce exposure tounsafe working conditions
- Automation after mechanization, not the other way round
- Risk assessment before introducing cyber technology and its mitigation



Mass Production Technologies

Face Bolter for bolting at Longwall face before salvaging

Bolter Miner

Longwall

Longwall top coal caving

Coal transport

- Efficient continuous coal conveyance through high capacity outbye conveyor, AFC / BSL, flexible conveyor or shuttle car at face
- Vertical transport through conveyor, as practicable, large capacity automated skips
- Minimum transfer points by proper layout of conveyor, self aligning conveyor
- Underground strata bunker for minimum face stoppage
- Continuous automated monitoring of critical components to prevent breakdown of transport network

Man and material transport

- Man transport through man carrier, mono-rail right upto working faces
- Material transport by mono-rail
- Continuous shifting of heavy installations like energy train, cables, transformers, ventilation duct through mono-rail

Material transport

Multiple Utility Vehicles with attachments like Bucket, Fork, Trailer which can carry a load of 20 tonnes and a basket with a maximum capacity of 1 tonne for transporting heavy materials and Equipment

Longwall support carriers for transporting powered supports of 50-55 te weight

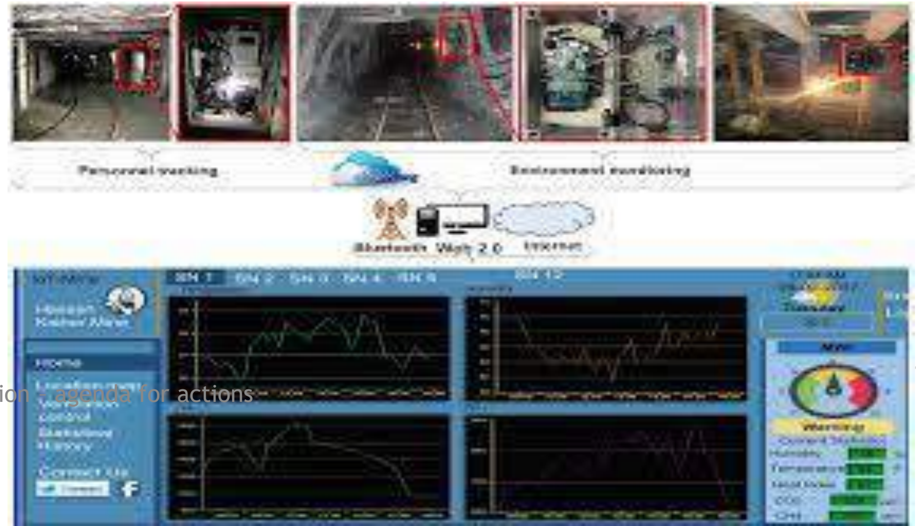
Forklift for squaring of Powered Supports in correct position – upto 60 te

Ventilation Planning

- Use of software like Ventsim / Ventsys etc for designing ventilation system and operational ventilation planning
- Peripheral ventilation
- Multiple heading longwall or CM panels for efficient ventilation
- Automatic closing ventilation doors of air lock
- Guilotine type airlock over conveyor
- Rated seals (5 psi, 20 psi or 50 psi) and their construction
- Construction of hatch doors in isolation stoppings for final sealing
- Ventilation monitoring
- Air chilling

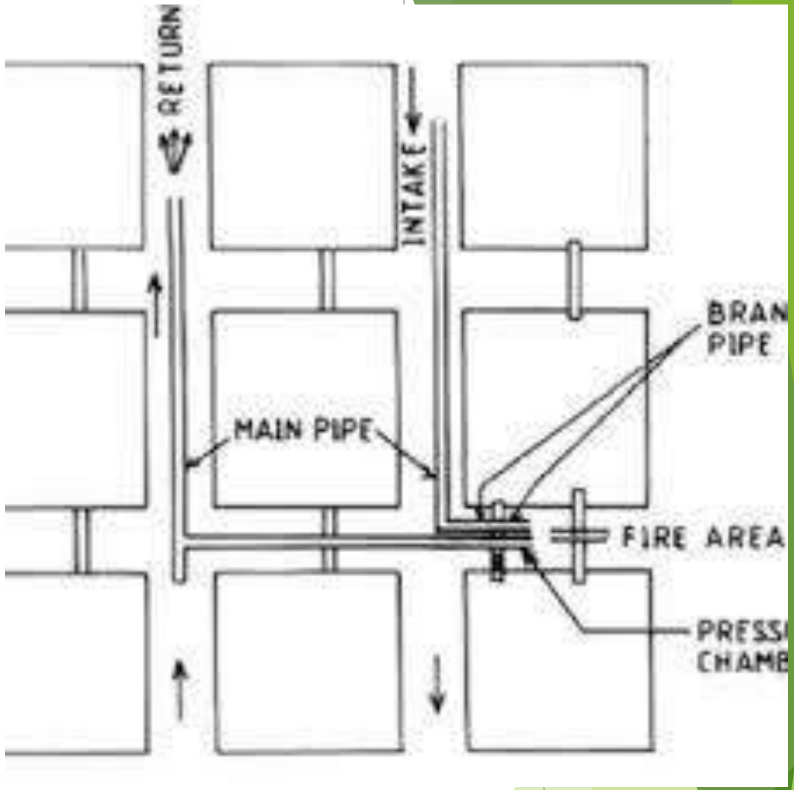
Gas monitoring

- Continuous, reliable and precise monitoring of toxic and inflammable mine gases
- Telemonitoring, Tube-bundle and portable digital gas detectors
- Air analysis by Gas Chromatograph
- TARP based on gas monitoring results and continuous assessment of various gas indicators



Mass Inertization and sealing

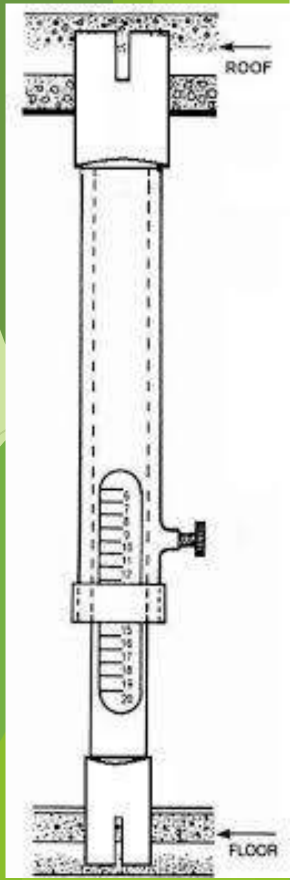
- Arrangements for mass inertization
- Onsite installation of inertization plants of adequate capacity
- Underground pipe network for inert flushing
- Provisions for inert pipes in isolation stoppings
- Simulation based on Computational Fluid Dynamics for effective inertization of goaves
- Risk assessment before sealing panel
- SoP for sealing
- Construction of rated seals



Strata control and strata monitoring

- Insitu stress measurement
- Mapping of geological structures and discontinuities
- Application of numerical modelling in strata control
- Longer roof bolts with resin capsules
- Long cable bolting
- Regeneration of roof rock using chemicals
- Polimeric mesh
- Strata monitoring – tell tale, convergence indicator, load cells
- Strata control TARP
- Longwall powered supports



Stone dusting and dust barrier

- Effective large scale general stone dusting for treating coal dust
- Use of mechanized system of stone dusting using Bulk Duster, Trickle duster, Pod duster
- Dust transport through bore holes and silos
- Use of compressed air for spraying dust continuously with coal production
- Use of large dust bags in returns
- Use of explosimeter for spot analysis of roadway dust
- Use of stone dust bag barrier in place of conventional timber frame
- Scattered and concentrated dust barrier
- Use of aero-dust

Safety management

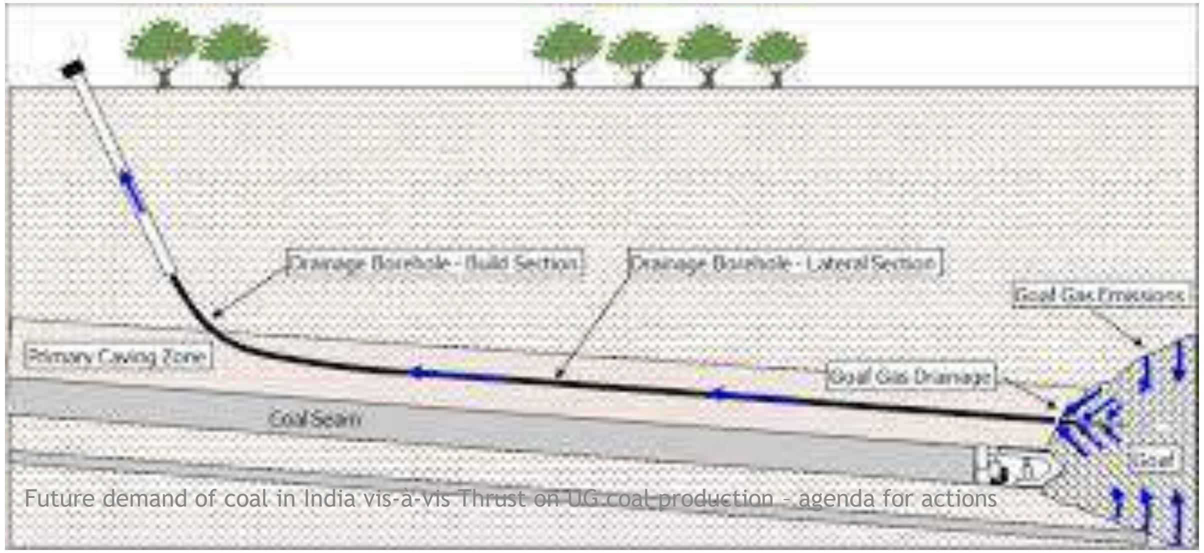
- Risk-based in place of rule based safety management
- Commitment, Consultation, Communication, Coordination
- Risk assessment to develop PHMPs, SOPs
- Use of TARPs
- Risk based Emergency Response Plan
- Root cause analysis based Accident/ Incident Management system

Decarbonising initiatives in mining: shifting from a challenge to opportunity mindset

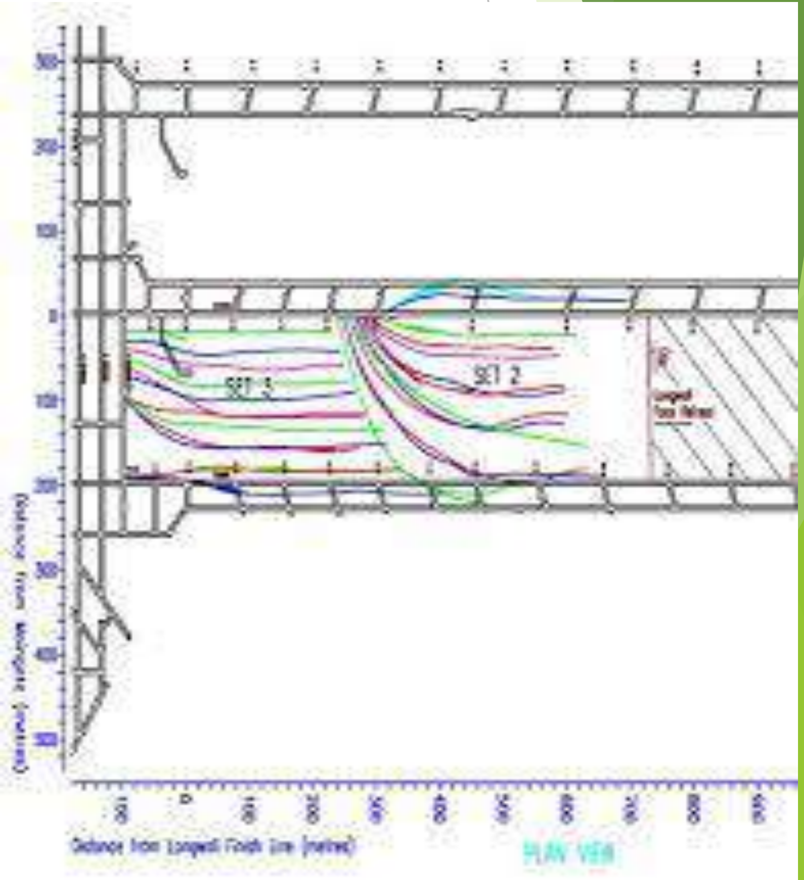
- Mining currently responsible for 4 to 7 percent of greenhouse-gas (GHG) emissions
- Scope 1 and Scope 2 CO_2 emissions from the sector (those incurred through mining operations and power consumption, respectively) amount to 1 percent, and
- Fugitive-methane emissions from coal mining are estimated at 3 to 6 percent ((1.5 to 4.6 gigatons) (McKinsey Study)
- A significant share of global emissions—28 percent—would be considered Scope 3 (indirect) emissions, including the combustion of coal

CBM extraction , Methane drainage and VAM Abatement

- Fugitive methane is a major source of Scope 2
- Pre-drainage of methane in coal seams having insitu gas content of more than 2-3 meter per tonne
- Surface to inseam for virgin blocks, inseam drainage for working mines to reduce gas content to below 2-3 M3 / Te to prevent disruption of operation and reducing risk due to explosion
- CBM extraction before mining
- VAM abatement program



Future demand of coal in India vis-a-vis Thrust on UG coal production - agenda for actions



Remanufacturing initiatives to reduce carbon footprint

- Remanufacturing components from major mining equipment can help mining companies reduce costs while also lowering their environmental footprint
- Remanufacturing - a smart move to drive down waste and improve circularity in businesses while reducing operational costs
- Remanufacturing is “a comprehensive and rigorous industrial process by which a previously sold, worn, or non-functional product or component is returned to a ‘like-new’ or ‘better-than-new’ condition and warranted in performance level and quality.”
- Savings from remanufacturing when compared to new can be more than 50%.
- In addition, there can be a 70% or more reduction in carbon emitted in the remanufacturing process compared to the production of a new component

Conclusions

- Increase share of UG for sustainable mining
- Energy efficiency through automation, cyber technology
- Go for all out mechanization – MPT is the only answer for economic mining
- Not only production technology – state of the art technologies for auxiliary operations / systems like strata control, ventilation, man & material transport, fire & explosion prevention, methane drainage
- Initiatives on decarbonisation to reduce carbon foot print and GHG emissions and Re-manufacturing to save energy and cost
- Implementation of Risk-based safety management – PHMP / HMP, SOPs, TARPs, ERP, AIMS

THANKS FOR LENDING YOUR EARS

__Annexure - 5__

XCENTRIC RIPPER- BLAST FREE OPEN CAST MINING OPERATIONS: Safety and Economic considerations

XR50 at Gevra project in SECL

INTRODUCTIONS

Xcentric Ripper is developed, patented and manufactured by M/s Xcentric Ripper International, S.L. in Spain

We, STM Construction Equipment, are representing Xcentric Ripper in South and Southeast Asia, including India

Jonas Stahlbage - Managing Director (+44 7413126116)
Jagdish Rawat - Country Manager (India): (9920608238)
Gopal Dudani - Asst Country Manager (India) (9831312087)

Xcentric Ripper in Spain

- Founded in 1990 manufacturing buckets and quick-couplers
- First Xcentric Ripper delivered in 2009
- Current manufacturing volume: 300 units per year
- Germany, Finland, Spain, Canada, India were the biggest markets in 2021
- Current max capacity: 500 units per year

STM Construction Equipment
XCENTRIC RIPPER

Xcentric Ripper in India

- First unit supplied in 2012
- Rippers deployed all over the country, incl. J&K, TN, Rajasthan, Orissa, Maharashtra, and Assam
- Head office in Navi Mumbai and staff in West Bengal, Jharkhand, Tamil Nadu and Telangana
- A total of 70 rippers are working in India
  - 30 rippers in limestone
  - 10 rippers in coal mines
  - 08 rippers in iron ore mines
  - Remaining rippers in civil and other works
- Biggest client, Ramco Cement, 12 rippers, has gradually been phasing out Drill & Blast since 2013

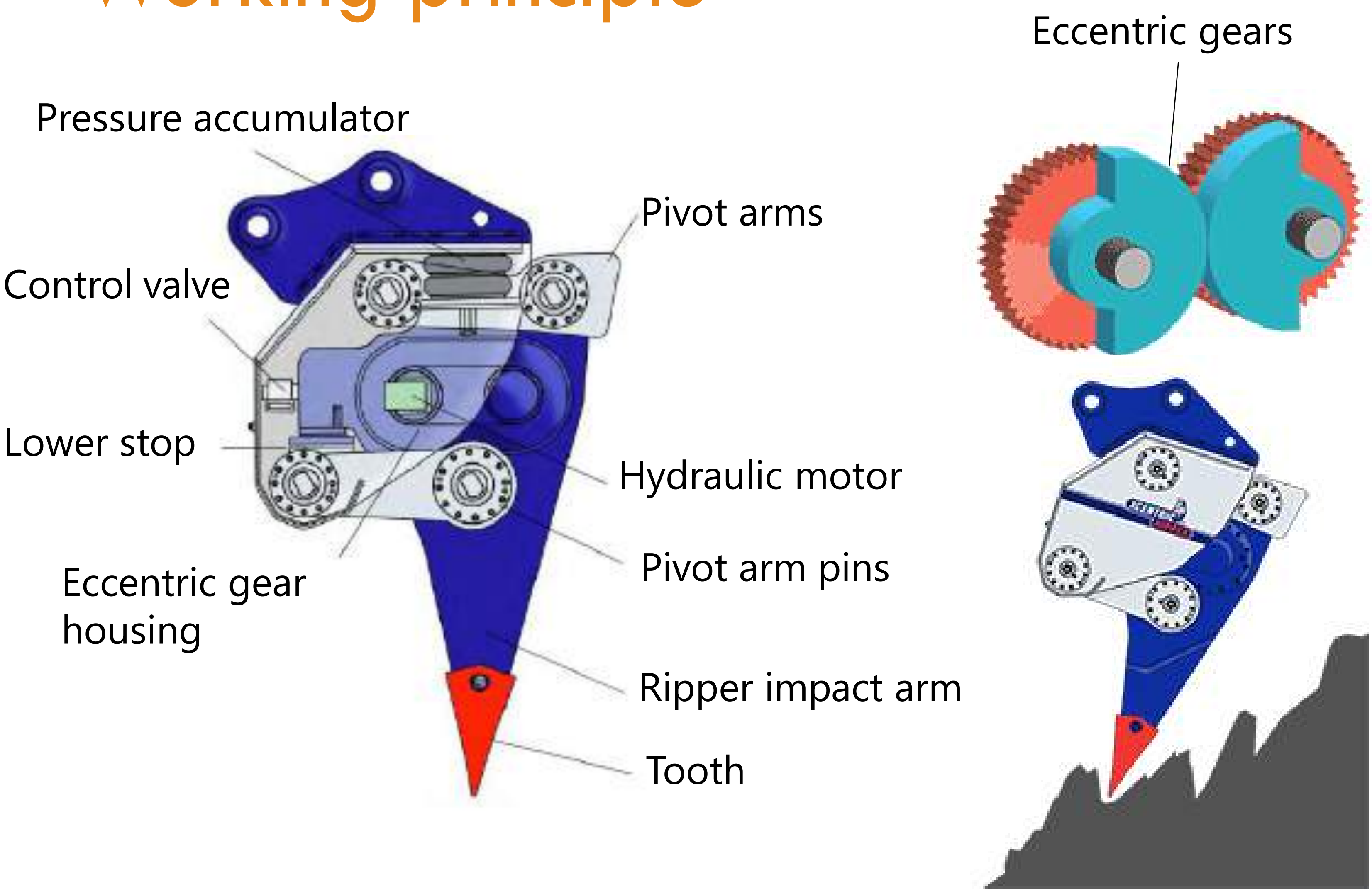
What is an Xcentric Ripper?

- A new type of excavator attachment for overburden removal mining
- An alternative to costly and risky drilling & blasting
- Mounted on normal backhoe hydraulic excavators

STM Construction Equipment

XCENTRIC RIPPER

Working principle

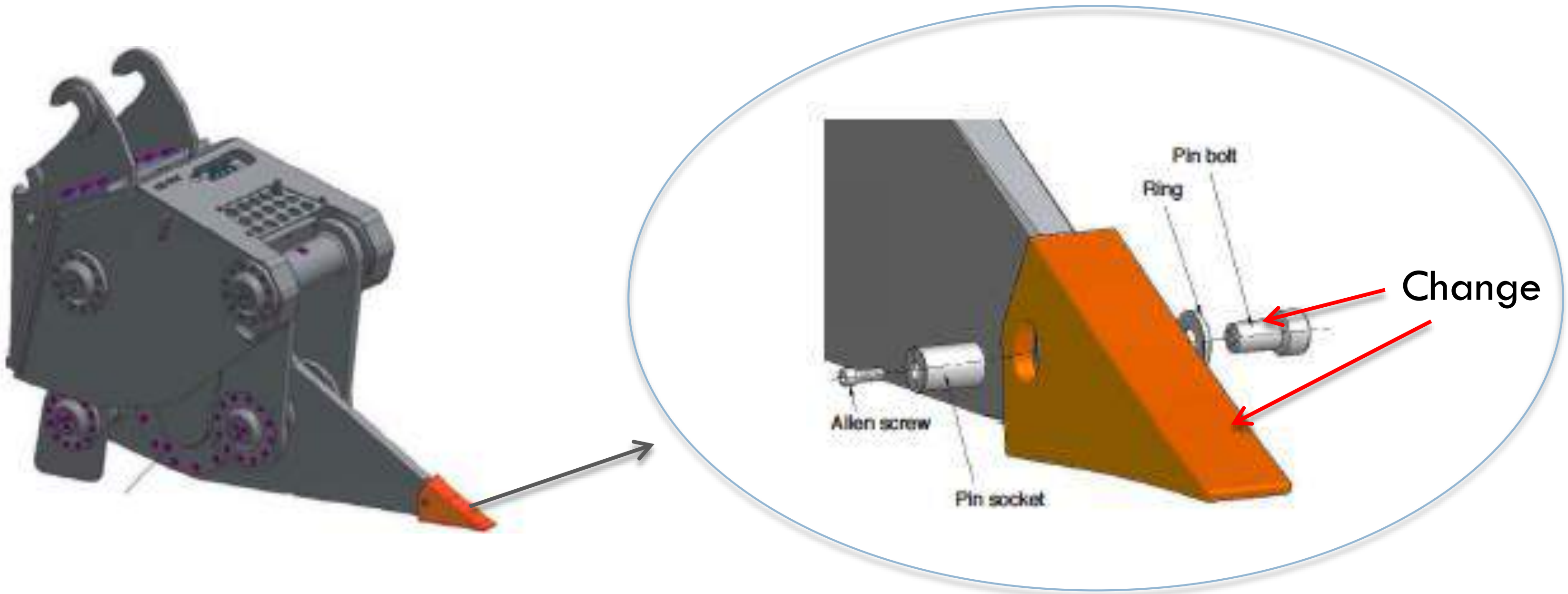


Xcentric Ripper product range

XR10 XR15 XR20 XR30 XR40 XR50 XR60 XR80 XR120

- 9 models in total – from 1 ton up to 13 ton
- Suitable for excavators from 7 ton up to 150 ton weight class
- Match the Xcentric Ripper model with base machine weight

Xcentric Ripper consumables



Only two consumables:

Tooth point: Change every 200 to 400 hours of operation

Tooth retaining pin : Change every 600 to 1000 hours

Xcentric Ripper maintenance

Daily inspection: check accumulator pressure, tooth, leaks, cracks or deformations

Every 250 hours: change hydraulic oil in eccentric gear housing

Every 250 hours: check grease level in pivot arm lubrication chambers

Advantages compared to Drill & Blast

Safety

- No risk of fly-rock or damage to nearby habitats
- Can work in fiery mines
- No risky secondary blasting required for boulders
- No environmental pollution

Versatility

- Can be uses for trench cutting, boulder breaking & dressing of wall
- Can remove areas of OB & Coal where drill machine and surface miner cannot access

Precision

- Can remove inter band between coal seam without degrading quality of coal

Low noise & vibrations

- No noise and no vibration effect on underground mining operations

STM Construction Equipment

XCENTRIC RIPPER

XR Productivity for some models

- XR120
  - **250-300 m^3 / hour**

OB: 1.5-2.0 million m^3/year
Coal: 4.5-6.0 million ton/year

- XR50
  - **150-200 m^3 / hour**

OB: 1.0-1.3 million m^3/year
Coal: 3.0-3.9 million ton/year

- XR40
  - **120-150 m^3 / hour**

OB: 0.8-1.0 million m^3/year
Coal: 2.4-3.0 million ton/year

Note: Production is calculated on 20 hours per day for 330 days in a year. Coal being softer, the productivity increases by more than double than OB

Cost comparison for OB removal - Xcentric Ripper vs. Drill & Blast

- CMPDI RI-2 made a cost analysis of Xcentric Ripper in Oct 2018 with the following results:
  - a) by Drill & Blast… Rs. 58/m^3
  - b) by Xcentric Ripper… Rs. 56/m^3 (includes cost of excavator)

- The cost analysis is based on a conservative productivity of 100 m^3 per hour with Xcentric Ripper, while actual productivity is 150 m^3 per hour, resulting in an actual cost of Rs. 38/m^3

- SECL has awarded a contract in Nov 2021 for removal of 23.641 million m^3 OB by Xcentric Ripper at Gevra project at Rs. 40.15/m^3

Conclusion: Xcentric Ripper provides a saving of **Rs.18/m3** compared to Drill & Blast

Current price for most common models

- XR40: INR 75 lakh
- XR50: INR 100 lakh
- XR120: INR 250 lakh

Note: Above pricing is excluding of GST (18%) and transportation from Navi Mumbai.

XR in Coal India- OB Removal

- Coal India's current OB removal is **1344 million m^3** per year
- Considering 1.5 million m^3 p.a. per XR in mixed sizes, Coal India would require **900 units of Xcentric Ripper**
- With a supply rate of 200 units per year, Drill & Blast can be completely phased out in **4-5 years**
- **Potential savings:** Based on Rs.18 in savings per m^3 in OB, the total annual savings may amount to over **Rs. 2,400 Crore p.a.** by switching from Drilling & Blasting to Xcentric Ripper in OB

Note: Similar savings can be achieved in open cast mining of **other minerals**

XR in Coal India – Coal Removal

- Coal production by Coal India is approx. **650 million ton p.a.**,
- Considering 4.5 million ton p.a. per XR in mixed sizes, Coal India would require **150 units of Xcentric Ripper** to phase out Drill & Blast completely

- **Potential savings:** Assuming similar savings as for OB (Rs.18 per m^3), the total annual savings may amount to over **Rs. 700 Crore p.a.** by switching from Drilling & Blasting to Xcentric Ripper in coal.

Thank You!

XR50 at Gevra project in SECL

Hearty Welcome

To The Workshop on
Technology Roadmap in Coal Sector

Introduction of Highwall Mining System
and Its prospect in India

HIGHWALL MINER GHWM300M

"MADE IN INDIA"

GAINWELL

AGENDA

- **Highwall Mining Definition, Machine Features & Manufacturing**
  - Highwall Mining Definition & Benefits
  - Highwall Mining Machine Construction, Variant & Team
  - Highwall Mining Digitization Features
  - Highwall Mining Internet Based Asset Monitoring

- **Highwall Mining Operation**
  - Highwall Mining Technique
  - What is needed for Highwall Mining
  - What can Highwall Miner do
  - Evaluation & Potential for HWM Sites
- **Value Added Services**
  - Turnkey Projects
  - HWM Training, Mine Survey & Asset Mapping

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Milestones

1944
Tractors India incorporated. Representative for Caterpillar, USA, in Eastern India

1955
Tractors India goes public

1974-78
Distributorship for Caterpillar extends to Nepal, Sikkim, Bhutan and Myanmar

1985
The name of the Company changes from Tractors India Ltd to TIL Limited

1994
50th year of TIL's corporate journey

2003
Initiates first Maintenance and Repair Contract (MARC)in India with Tata Steel (South Eastern Block)

2009
Inaugurates a state-of-the-art component rebuild centre in Asansol, West Bengal

2013
Acquisition of Bucyrus Business from Caterpillar

2016
Transition of TIPL to New Management

2017
TIPL Signed IP Licensing Agreement with Caterpillar for Manufacture, Sale & Service Highwall Miner for select Market

2018
Amalgamation of TIPL to GAINWELL COMMOSALES PRIVATE LIMITED

2019
GAINWELL set up state of the art manufacturing facility at Asansol, India

2021
GAINWELL Signed IP Licensing Agreement with Caterpillar for Manufacture, Sale & Service of select Room & Pillar products and Highwall Miner for world market

GAINWELL

HIGHWALL MINING

DEFINITION & BENEFITS

WHAT IS HIGHWALL MINING

Whether you're operating a trench, open cast or contour mine, the Gainwell highwall mining system can extract coal affordably and safely.

- **Open cast:** Highwall mining is used to mine coal from underneath the final highwall, when the strip limit is reached due to economic reasons or surface conditions.
- **Contour mining:** In a mountainous area, the Gainwell highwall mining system can follow a coal seam along the side of the hill
- **Trench mining:** The unit mines coal from both sides of a purpose-prepared trench; this mining method is used when an open pit is not an option.

GAINWELL

BENEFITS OF HIGHWALL MINING

BENEFITS OF HWM

- NO PERSONNEL GOING UNDERGROUND.
- AUTO FIRE DETECTION & SUPPRESSION (AFDSS)
- CCTV SYSTEM
- METHANE MONITORING

PRECISION MINING BY FULLY AUTOMATIC OPERATION WITH GUIDANCE CONTROL

PRESERVATION OF SOIL LAND, FORESTS ON TOP

HIGH OUTPUT PER MAN SHIFT (OMS)

- HWM OPERATOR – 1 no
- PUSHBEAM LOADER OPERATOR – 1 no
- COAL LOADER OPERATOR – 1 no
- GROUNDSMAN – 1 no.

MINIMAL OR NO IMPACT ON PEOPLE & HABITAT RESIDING ON TOP

- MINIMAL STARTUP INFRASTRUCTURE
- BOOST IN INDIA's COAL PRODUCTION & MAKING INDIA SELF RELIANT
- LESS IMPORT, SAVINGS IN FOREX

EXPLORING TRAPPED COAL WHICH CANNOT BE EXTRACTED BY ANY OTHER MINING METHOD

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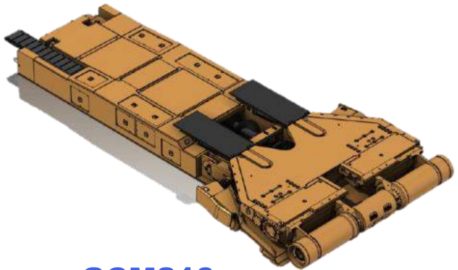
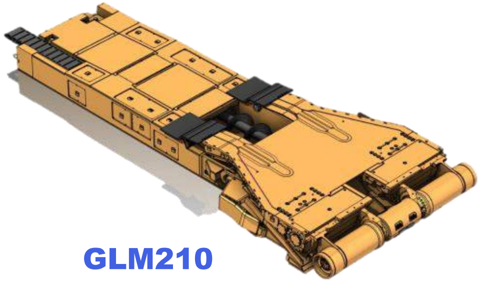
HIGHWALL MINING MACHINE

CONSTRUCTION, FUNCTION, VARIANTS & TEAM

CONSTRUCTION OF HIGHWALL MINING



GCM210
LOW SEAM CUTTER MODULE



GLM210
LOW-TO-MID SEAM CUTTER MODULE

BASE MINER

+

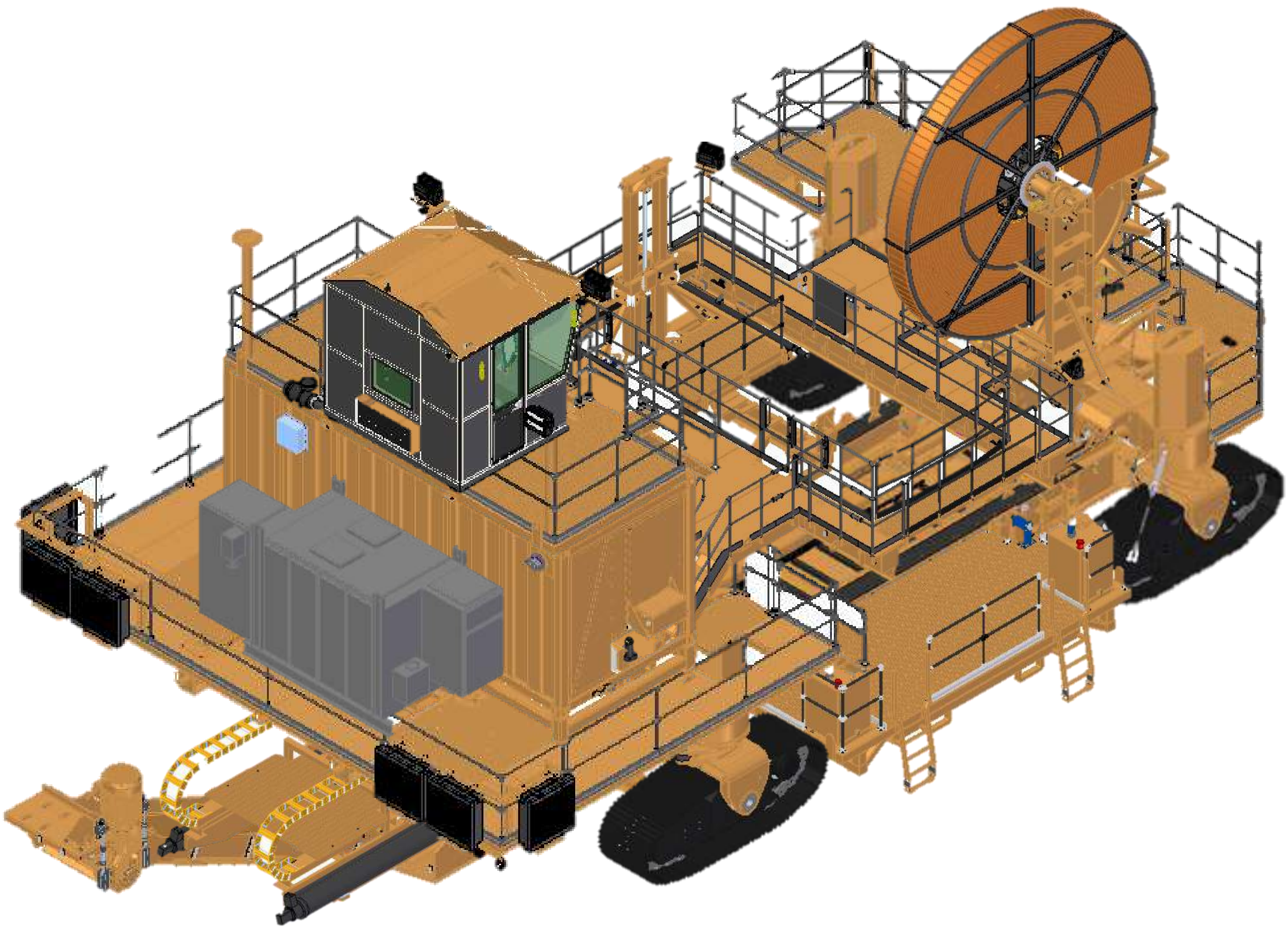
PUSHBEAMS

+

GHCM235
HIGH SEAM CUTTER MODULE

GAINWELL

BASE MINER – SUB ASSEMBLIES & FUNCTIONS



1.BASE FRAME
SUPPORTS WEIGHT OF THE MINER & CARRY COAL

2.REAR SUPER BEAM
SUPPORTS ECM BPM, SUBSTATION, OP CAB & CARRY TRACKS

3.FRONT SUPER BEAM
SUPPORTS HOSE REEL & CARRY TRACKS

4.STORAGE RACK
GREASE & OIL STORAGE

5.POWER HEAD
SUMPING & RETRACTION

6.STRAIGHT DISCHARGE
CONVEY COAL & DISCHARGE

7.BPM CATWALK
WALKWAY FOR ECM BPM & SS

8.PTM II
LOAD PUSHBEAMS INTO POWERHEAD DURING MINING & VICE VERSA

9.ECM BPM
SWITCHGEAR & HYDRAULIC POWER PACK ROOM

10.SUBSTATION
PRIMARY SWITCHGEAR & STEP DOWN TRANSFORMER

11.CAB CATWALK
WALKWAY AROUND OP CABIN

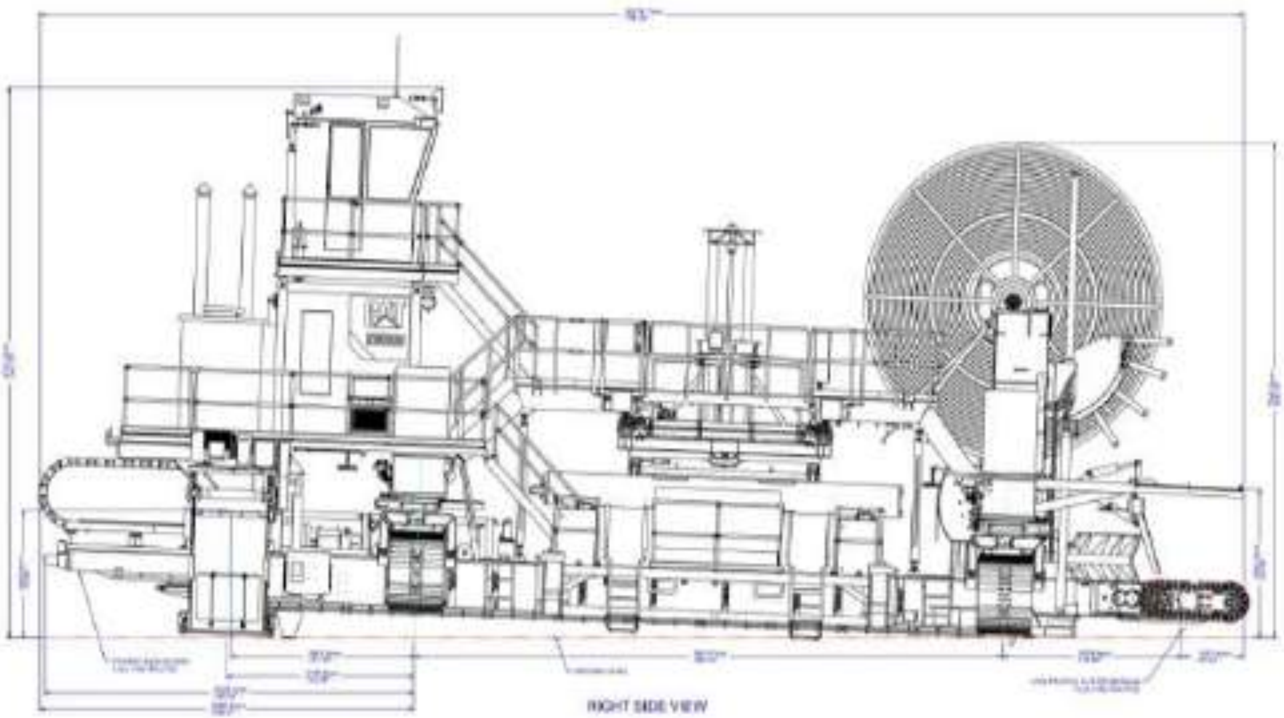
12.OPERATOR CABIN
MINER OPERATION CONTROL

13.FRONT CATWALK
WALKWAY AROUND HOSE REEL

14.HOSE REEL
WIND & UNWIND CABLES & HOSES RUNNING UPTO CUTER MODULE DURING RETRACTION & MINING

DIMENSION OF HIGHWALL MINER

- **Length (base)**
  - **55.3 ft.   (16.6 m)**
- **Width (base)**
  - **33.6 ft.   (10 m)**
- **Height**
  - **28.0 ft.   (8.4 m)**
- **System weight**
  - **496,040 lb. (225,000 kg)**



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PUSHBEAM

- Pushing/pulling cutter module
- Conveying coal
- Sturdy, simple, two moving parts only
- Enclosed, no external ash
- Low ground pressure
- Protect cables/hoses, coupled to a string
- Horizontally rigid — straight drives
- Vertically hinged — follow seam undulations
- Push beam length 20 ft. (6.1 m)
- Push beam weight 12,400 lb. (5,624 kg)
- 54 push beams per miner

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GAINWELL HIGHWALL MINER & CUTTER MODULE

- Four interchangeable cutter modules produces versatility
  - GCM210 Range- Height: 0.9–1.7m; Width: 3505mm
  - GLM210 Range- Height: 1.0– 3.1m; Width: 3505mm
  - GMCM235 Range- Height: 1.2–3.1m; Width: 3505mm
  - GHCM235 Range- Height: 2.4–4.5m; Width: 3505mm
- Max. Penetration 305m
- CM's equipped with Navigation and Steering – Maintain Heading
- Max. Conveyance Rate 1000 TPH
- Highly maneuverable Base Unit
- Machine Controlled through Touch Screen and PLC System
- Manufactured in India
- Engineering and Support Staff based in India
- HWM can be operated by mobile Generator Power (2000 kVA)

Photograph of Gainwell Manufactured Machine at Asansol Facility

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STRONG & EXPERIENCED TEAM

Head Highwall Project “made in India”

Paul Mulley is currently responsible for complete operations of Highwall mining business in terms of design manufacturing sales and aftersales internationally .Has extensive experience of over 40 years in mining equipment and Mining operations at the coal face. A Mechanical Engineer by Profession educated in the UK. A seasoned veteran of the Global Coal business and managed the entire Room and Pillar and Highwall Equipment Management inc. Sales, Design, Manufacturing and aftermarket customer care in Caterpillar

Head of Engineering & Technical Advisor Highwall Miner

Stewart L. Myers has a BS in Mechanical Engineering and has worked in the coal mining industry for over 38 years. 25 Years of his career has been devoted to the design, development, manufacture, maintenance sales and operation of Highwall mining systems globally.

Head of Design Highwall Miner

Robert E. Henry, Jr. is a Mechanical Engineer with over 38 years of experience in the design of coal mining and coal processing equipment. He has more than 14 years of experience working with the Highwall Mining System

Head of Technical Training & Maintenance Highwall Miner

David S Spooner. Has 30+ years in the maintenance field with experience in construction, military & Mining equipment. He has spent past 11 years in Mining industry working on Highwall mining system.

Head of Manufacturing Highwall Miner

Jayanta Bhattacharya.is currently leading the manufacturing operations of Highwall Miner. A Mechanical Engineer by profession who has got 24+ years of experience in Mining, Construction & Power Gen Industry. He worked both in Manufacturing & After market operations.

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HWM MANUFACTURED IN INDIA

- Sept 2017 Licensed from CAT to manufacture the Highwall product
- The Highwall team in CAT is now working for Gainwell India.
- Only dealer in the world to manufacture Highwall and allowed to sell anywhere in the world
- New dedicated facility built in Asansol for the Highwall manufacturing
- Supplier base to be moved to India *(as of today we are approx. 70% there)*
- **First machine** manufactured and delivered to **SECL-SARDA** Highwall Mining Project in **Jan 2019.**
- **2nd Machine** manufactured & supplied to **Tata Steel-West Bokaro** project in **Nov'20.**
- **3rd Machine** is ready at factory to be deployed to **ECL-Sripur Nimcha** Project in **March 2022.**

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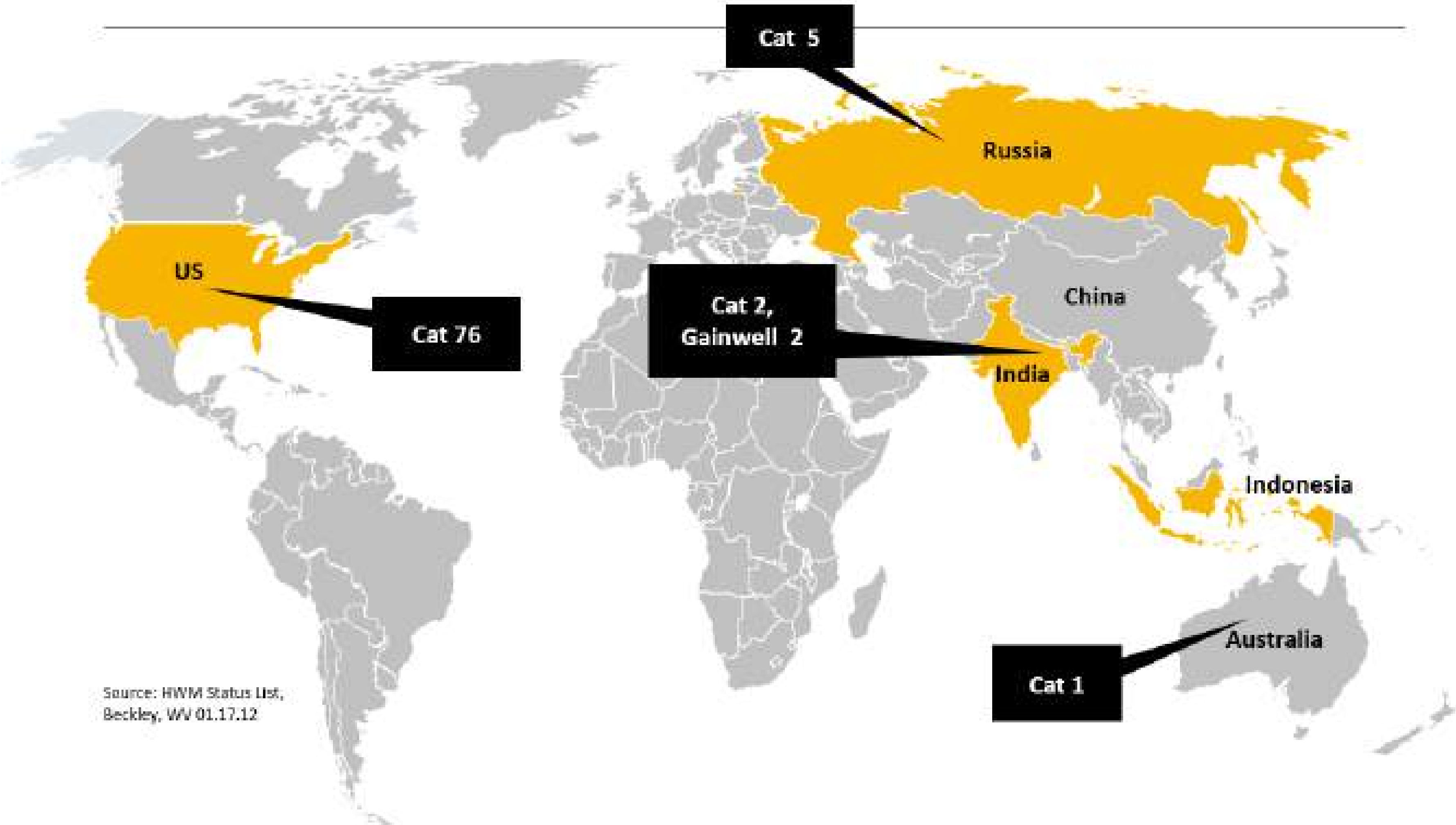
INSTALLED BASE



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HIGHWALL MINER

DIGITIZATION FEATURES

HIGHWALL MINER – SAFETY FEATURES

METHANE MONITORING

SAFETY FEATURES

- FAIL SAFE OPERATION
- CONTINUOUS CH4 MONITORING
- MINER OPERATIION STOPPED IN CASE OF COMMUNICATION LOSS
- CUTTER MODULE POWER SUPPLY WITHDRAWN IN CASE OF COMMUNICATION LOSS

WATER SPRAY INTERLOCK

SAFETY FEATURES

- PREVENTS CUTTER OPERATION WITHOUT WATER SPRAY
- ELIMIATES POSSIBILITY OF SPARKING FROM CUTTING FACE

HWM SAFETY INTERLOCKS

AFDSS

SAFETY FEATURES

- FAIL SAFE OPERATION
- ZONE-WISE MONITORING
- BOTH AUTOMATIC & MANUAL ACTUATION IN CASE OF FIRE
- MAIN POWER CUT OFF IN CASE FIRE DETECTED

ESTOP NETWORK

SAFETY FEATURES

- FAIL SAFE OPERATION
- DRIVE POWER SUPPLY CUT-OFF IN CASE OF ACTUATION
- OPERATOR ACKNOWLEDGEMENT MUST AFTER RESTORATION

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HIGHWALL MINER – DIGITIZATION FEATURES

ADVANTAGES
- SUPERVISION
- REAL TIME PROCESS DATA
- OPTIONAL BYPASS

INSTRUMENTATION HOOKUP

TOUCH SCREEN HMI

ADVANTAGES
- FULLY AUTOMATIC MINING

ASSET MONITORING

ADVANTAGES
- REAL TIME PROCESS DATA

ADVANTAGES
- LESS WEAR OF CHAIN
- LESS WEAR OF ASSOCIATED DRIVE PARTS
- COST SAVINGS
- HIGHER AVAILABILITY

BF CHAIN TENSION CONTROL (NEW ADDITION)

SOFTWARE & INTERLOCKS ARE DEVELOPED ON SIEMENS TIA PORTAL

- EASE DURING TRAMMING

MOBILE APP BASED CONTROL

- HIGHER AVAILABILITY

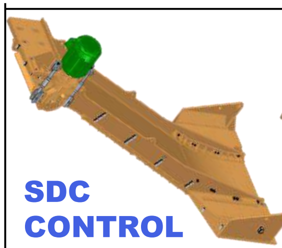
TENANCE

JMP &

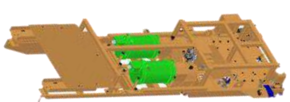
CYLINDERS
- COST SAVINGS

OIL HEALTH MONITORING (NEW ADDITION)

ADVANTAGES
- BETTER CONTROL
- LESS SHOCK, HIGHER LIFE
- SUPERVISION & PROTECTION



SDC CONTROL



AUGER DRIVES CONTROL

VFD

ADVANTAGES
- OPTIMUM TENSION
- LESS BRAKE WEAR
- HIGHER LIFE OF CABLE & HOSE

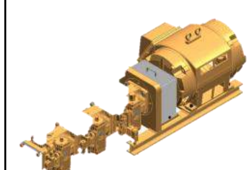
ADVANTAGES
- COURSE CORRECTION
- MAXIMUM COAL RECOVERY
- GEOLOGICAL STABILITY

SIEMENS S7-1500 ORIENTED DIGITIZATION

ADVANTAGES
- STATUS MONITORING
- SECONDARY LOGIC PREPARATION e.g. RUNHOUR

ADVANTAGES
- LESS SHOCK, HIGHER LIFE
- SUPERVISION & PROTECTION
- NO STARTUP HEATING, HIGHER LIFE
- 60Hz MOTOR with 50Hz SUPPLY

VFD



BPM PUMP CONTROL (NEW ADDITION)

ADVANTAGES
- INSTANT POWER WITHDRAWAL IN CASE OF FIRE
- SUPERVISION
- TEST & ISOLATION FEATURES
- FULLY AUTOMATIC

AFDSS INTERLOCK (BY GCPL)

ADVANTAGES
- REAL TIME MONITORING
- OPERATIONAL ERRORS CAPTURE

LIVE CCTV FEED (NEW ADDITION)

HOSE REEL TENSION CONTROL

NAVIGATION CONTROL

HV SWITCHGEAR HOOKUP

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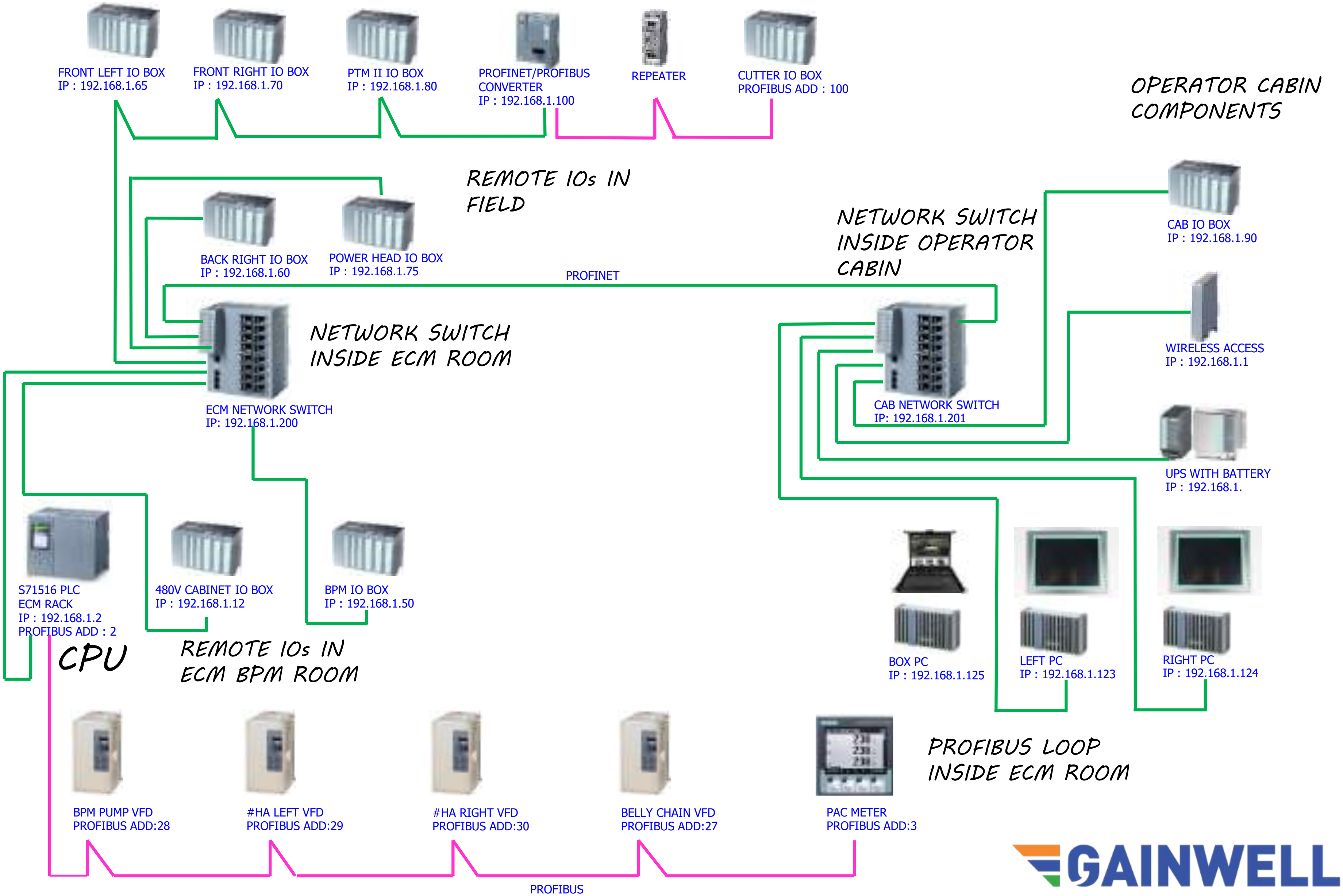
HIGHWALL MINER – AUTOMATION CONFIGURATION



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HIGHWALL MINER

INTERNET BASED ASSET MONITORING

ASSET MONITORING – WHY & HOW

FIELD EXPERIENCE & CHALLENGES FROM RUNNING FLEET TILL 2020

- WRONG OPERATION
- IMPROPER MAINTENANCE
- LACK OF DATABASE

SOLUTIONS INTRODUCED FROM DEC 2020

- REAL TIME PROCESS PARAMETER MONITORING
- ALARMs
- HISTORICAL DATA ANALYSIS
- LIVE VIDEO FEED

BENEFITS OF ASSET BMONITORING

- OP ASSISTANCE
- FAILURE ANALYSIS
- PREVENTIVE MAINTENANCE
- HEALTH MONITORING
- HIGHER AVAILABILITY

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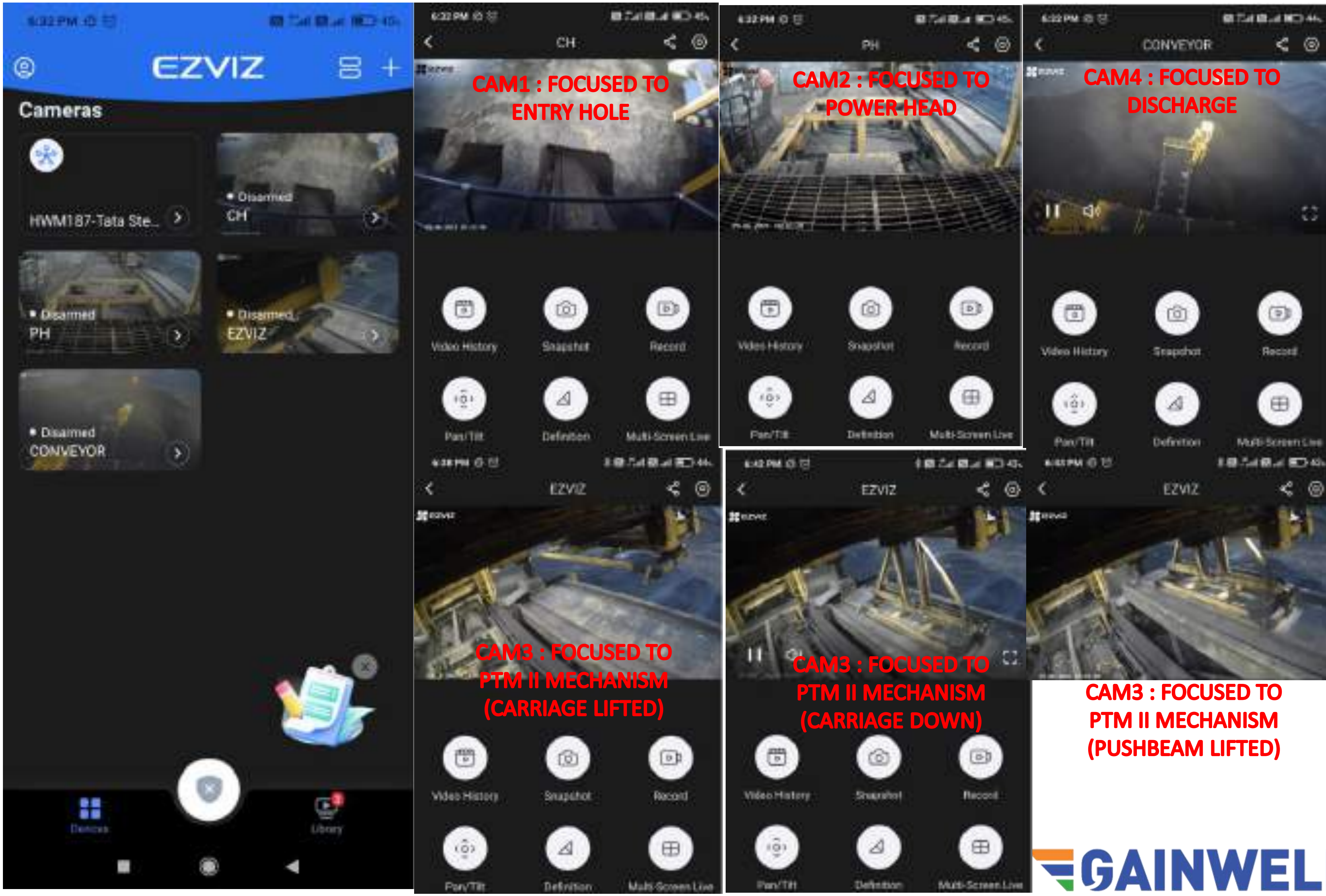
ASSET MONITORING – CCTV FEED



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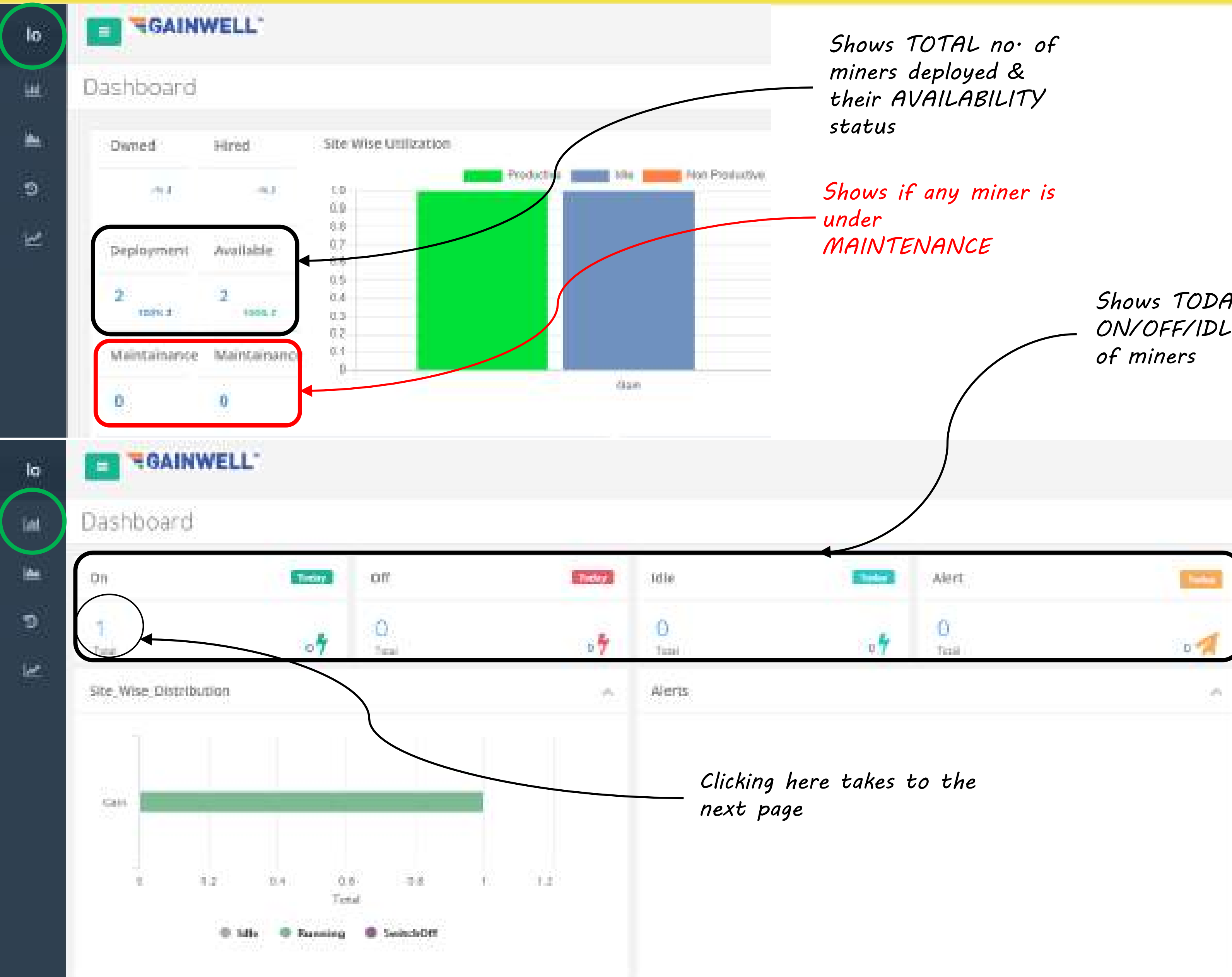
ASSET MONITORING – WEB BASED PORTAL



Shows TOTAL no. of miners deployed & their AVAILABILITY status

Shows if any miner is under MAINTENANCE

Shows TODAY's ON/OFF/IDLE/ALERT status of miners

Clicking here takes to the next page

HIGHWALL MINER

MINING & OPERATION

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HIGHWALL MINING TECHNIQUE

- Highwall Mining development started in the late 1970’s in the US.
- The purpose was to extract coal that could not be mined economically by Underground or Open Cast Mining.
- In Eastern US, HWM was used primarily with contour and mountaintop open cast mines.
- Production is dependent on many factors, seam height is the primary factor.
- Consistent Monthly Production ranges from 40K Tonnes in low seams to 100K Tonnes for High Seams.

WHAT IS NEEDED FOR HIGHWALL MINING

- Exposed coal seam
- Competent immediate overburden
- If overburden is not competent, coal may be left as roof
- Coal seams dipping from +5 to -12 degrees is ideal for Highwall Mining, however coal seams +8 to -20 degrees can also be mined with specialized technique
- Relative flat seams, no faults
- Minimum Coal Seam thickness 1m & above

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WHAT CAN HIGHWALL MINER DO

- Typical coal reserve recovery of 50 to 70% depending on geological conditions
- Mines coal from exposed coal seams when economical surface mining limits are reached
- Mines parallel entries to a depth of 1000 feet (300 m) without personnel working underground
- Flexible System – can mine multiple seam heights

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EVALUATION OF POTENTIAL HWM SITES

- **Greenfield Project:**
  - Maximum reserve has +/- 300m cut depth
  - Minimum Seam thickness 1m
  - Minimum extractable coal reserve 1.0 – 1.5 million
- **Existing Open Cast Mine:**
  - Minimum Highwall Miner Machine available 500m
  - Minimum Seam thickness 1m
  - Minimum extractable coal reserve 1.0 – 1.5 million

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VALUE ADDED SERVICES

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1ST TURNKEY PROJECT UNDERTAKE BY GAINWELL AT TATA STEEL-WEST BOKARO COLLIERY

- Project commenced in **Dec'2020**
- In first **APP** we have produced more than **6.0 Lakh Ton**
- Average Seam thickness we have operated there **1.0m to 1.5m with Low Seam Cutter Module and 3.5m to 4.5m with High Seam Cutter Module**
- Team Size - **32**
- Average Production Rate is **100T/hour with Low Seam Cutter Module and 225T/Hour with High Seam Cutter Module**
- Highest Production achieved **125T/hour in Low Seam Condition and 275T/Hour in High Seam condition**

- **We will commence our 2nd project at ECL- Narayankuri by Q3'2022.**

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Tata Steel - West Bokaro – Operational Highlights

- APP Target – 0.60 Million Tonne
- Production Achievement – 0.62 Million Tonne (expected)
- Highest Production in a Month – 77,027t
- Average Production/month – 40,000t (Low Seam) and 65,000t (High Seam)
- Highest Production in a Day – 5130t

- Highest seam cut by GHCM235 – 5.4m with DOP 286m

First Cut – 4.2m

Second cut – 1.2m

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HWM TRAINING, MINE SURVEY & ASSET MONITORING

- We have the literature and the people to train.
- We have access to experienced operators in the USA to assist in training new operators here in India.
- We have a new Training facility in Asansol to provide the quality computer based training
- Simulator for Highwall to be installed in Asansol
- We provide quality training for our internal employees as well as customers.
- We have subject matter expert for exploring our HWM Asset.
- We can extend Mine Survey Expertise to identify Highwall Mining Property for all customers.

We can provide end to end solutions from mine survey, asset finalization, machine manufacturing, machine maintenance & repair, machine operation and production contract.

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Comments and/or Questions

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Annexure- 7

"

The Largest Mechanized Underground Coal Producing Mine of India

A. K. Sharma

Area General Manager

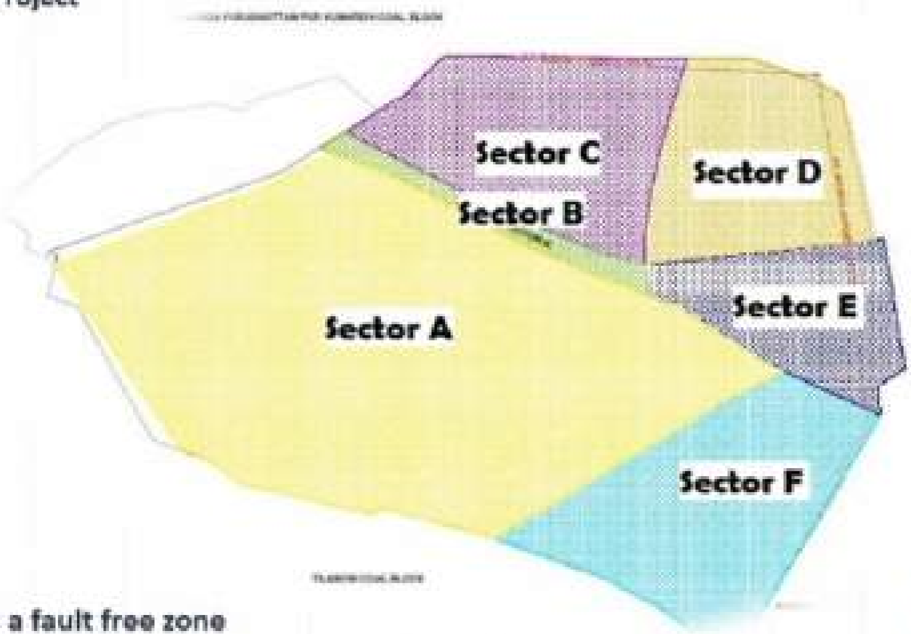
Jhanjra Area housing Jhanjra Project Colliery

Eastern Coalfields Ltd.

(A subsidiary of Coal India Ltd.)

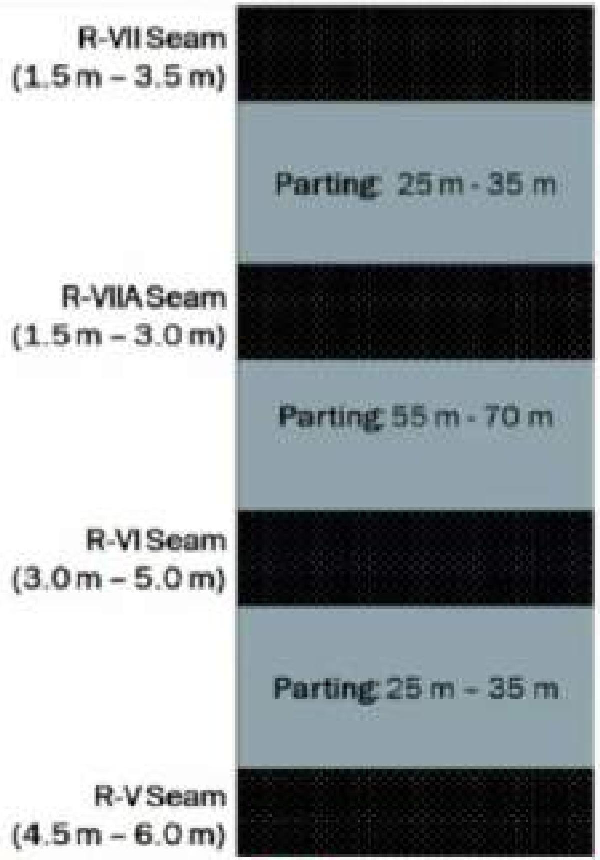
Mine Introduction

- Jhanjra Project Colliery is the largest Coal producing Underground Mine in India.
- Jhanjra Project Colliery is the highest Profit making Underground Coal Mine in India.
- Total 8 workable seams of different thickness are present at Jhanjra Project Colliery, out of which 4 seam are being extracted presently.
- The realized grade of R7, R7A, R6 and R-5 seam are G5 (Presently workable seams)
- Coal of this grade has high demand for power utilities and sectors other than power utilities.
- Jhanjra UG Mine is a Single Mine with two operating units namely Main Industrial Complex Unit and 3&4 Incline Unit
- The total block area of Jhanjra Project Colliery has been divided into 6 different sectors.
- The Longwall Package has been deployed at Sector A. This sector is a fault free zone and most suitable for Longwall Operation.
- Presently Average Daily production of the Mine is more than 10000 tonnes per day



Workable seams at Jhanjra Project Colliery, ECL

Current Workings



Brief History of Mechanization at Jhanjra

1982
approved a Feasibility report in collaboration with Soviet Experts in December 1982

1989
Two sets of powered support were procured from Ex USSR in 1989 along with Road Headers

1995-99
Two sets of Longwall namely Ex-Dhemomain and Ex-Churcha were transferred to Jhanjra Project to serve as 3rd and 4th set at the project.

2000
Ex Satgram set was also brought to Jhanjra as a replacement of one of the surveyed off Russian PSLW set

2007
First Standard Height Continuous Miner was introduced, Manufactured by Joy Mining Machinery

2014
Second Standard Height Continuous Miner was introduced, Manufactured by Caterpillar

2015
Longwall Package manufactured by CODCO(China Coal Oversees Development Co. Ltd) was procured and gate road development started

2016
Production from CODCO Longwall Package Started with higher support capacity

2018
2 nos. of India's First Low Height Continuous Miners Manufactured by Caterpillar deployed

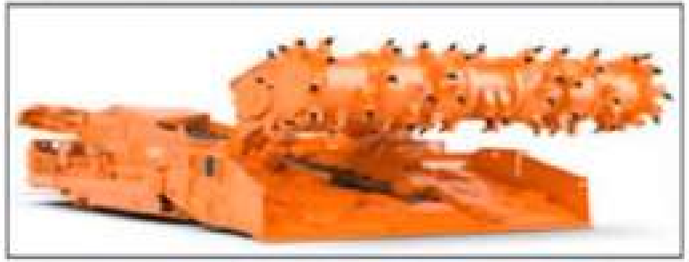
2020
Expansion project Report (EPR), 2019 of Jhanjra UG Mine was approved with an nominal capacity of 5.0 MT

2021
Record Productio since inception o mine : 3.565 MT the year 20-21.

Journey of Underground Mechanization in India

For mechanized mass production through UG, prevailing technologies adopted till now in Indian mines are:

- Powered Support Longwall Technology – 3 nos.
- Continuous Miner Technology (Board/Room & Pillar) – 25 nos. and few under commissioning
- Bolter Miner – 3 nos.



Introduction of First Longwall in India: 1978

ntroduction of First Continuous Miner in India: 2002

Technological Advancement is lacking behind for Longwall Technology in India though it was deployed 3 decades earlier than Continuous Min

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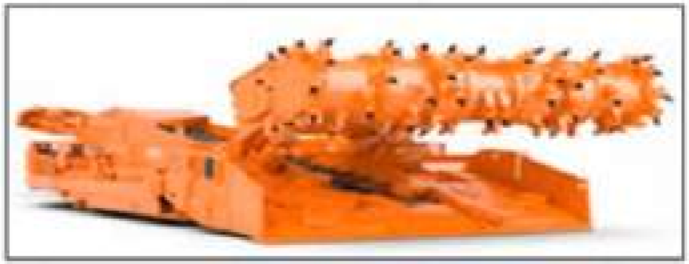

Introduction of First Longwall in India: 1978

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UG Mass Production Technologies

- Longwall Equipment
- Road Header Equipment for development of Longwall Gate Road ways
- Standard Height Continuous Miner with Bord and Pillar
- Low Height Continuous Miner with Bord and Pillar Technology for thin seams

OUT OF THESE MASS PRODUCTION TECHNOLOGIES, THE LONGWALL MINING HE SAFEST AND MOST ECONOMICAL TECHNOLOGY FOR COAL EXTRACTIO

MASS Production Technologies at Jhanjra Project Colliery,ECL

Longwall Package

Make: CODCO

Capacity of Power Supports: 1100 tonnes

Shearer dia:2.8m

Web Depth: 0.8m

Max. Cutting Height: 5.5m

Standard Height Continuous Miner-1

Make: Joy Mining Machinery

Cutting Height:2.16m-4.6m

Cutting Width: 3.3m

Cutting Drum Dia: 1.12m

Standard Height Continuous Miner-2

Make: Caterpillar

Cutting Height:2.16m-4.62m

Cutting Width: 3.5m

Cutting Drum Dia: 1.16m

Two Nos of Low Height Continuous Miner-2

Make: Caterpillar

Cutting Height: 1.27m-2.54m

Cutting Width: 3.5m

Cutting Drum Dia: 1.11m

Equipments for Man and Material Transport

Trailer for Carrying LW Power Support SH-150D

Operational Video: Longwall

Prerequisites for Deployment of Longwall

- The Coal Property should be fault free and free of Stone or shale bands and length of Panels shall be at least 1-2 km long for maximizing the Productivity.
- Minor Geological disturbances can also be tackled
- Relatively flat lying seam.
- The hardness of Coal is desirable between 15Mpa-22Mpa for efficient Cutting.
- Cavable roof: Roof is desirable to be moderate to difficult cavable (Cavability Index: 4000-6000)
- Efficient and Scientifically designed equipment to be deployed.

Prerequisites for Deployment of Continuous Miner

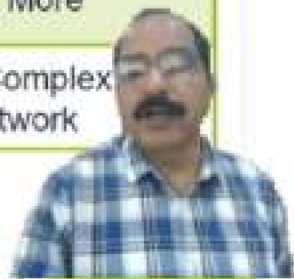
- Sufficient Coal Reserves
- Varying Seam Inclination
- The hardness of Coal should be between 15Mpa-22Mpa for efficient Cutting.
- Cavable roof: Roof must be moderate to difficult to cave
- Uniform Thickness of the coal seam
- Efficient and Scientifically designed equipment to be deployed.

Advantages of Deployment of Longwall & CM

- High Recovery of coal
- Lower Operating cost per tonne
- Also applicable under weak roof conditions
- Minimal Manual Handling
- Simplified Ventilation Network
- Maximize safety of Machine and Manpower
- Also Suitable for higher seam thickness
- Higher and Faster Return on Investment

Comparisons Between Longwall and Continuous Miner

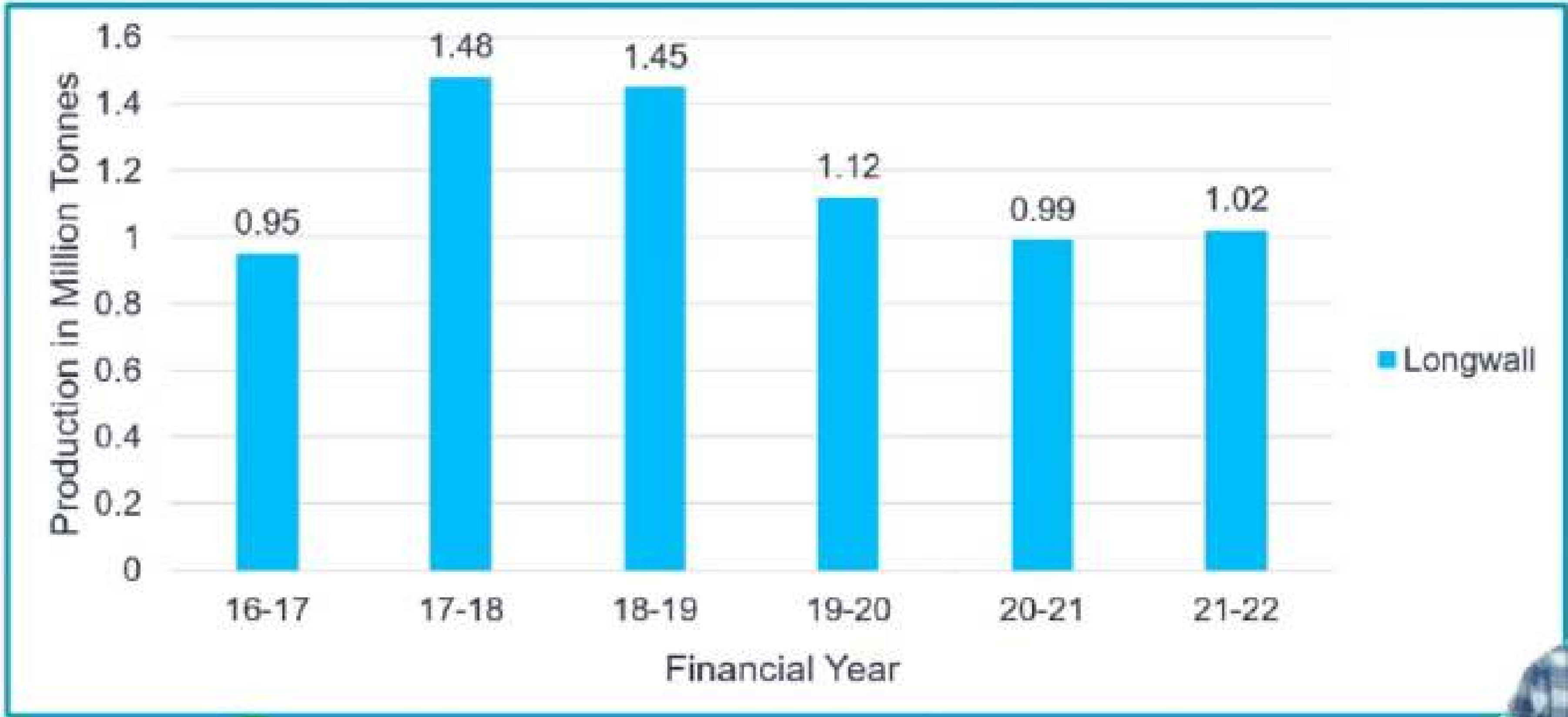
Sr. No	Parameter	Longwall	Continuous Miner
1.	Percentage Extraction of Coal	More than 95%	Around 80%
2.	Capital Investment	Relatively Higher	Relatively Lower
3.	Geology	Completely Fault free and Geological Disturbance free area required	Some geological Disturbances may be tackled
4.	Coal Production	9000-10000 Tonnes per day	2000-3000 Tonnes per day
5.	Production Cost Per tonne	Comparatively Less	Comparatively More
6.	Ventilation	Simple Ventilation Network	Comparatively Complex Ventilation Network



Success story of Longwall at Jhanjra

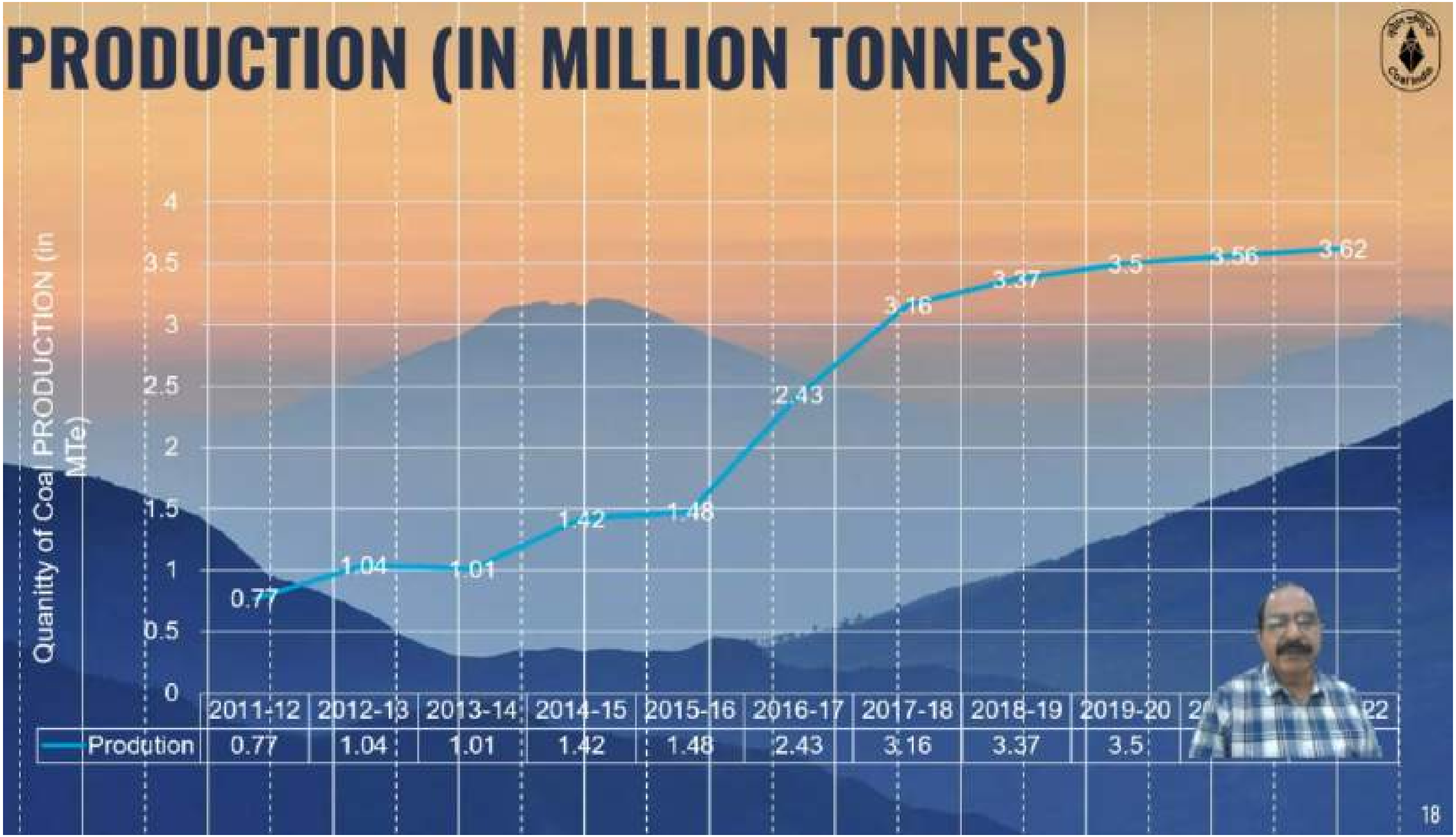
- The coal property at Jhanjra in Sector-A is most suitable for longwall operation and is free from any geological disturbances.
- Hardness of Coal is around 15 Mpa due to which efficient cutting is possible
- Even though different packages which failed at different mines were deployed at Jhanjra (Dhemomain, Churcha and Satgram) these packages proved successful at Jhanjra. 23 longwall panels were successfully extracted with the help of these packages.
- Thickness of the coal seam is up to 5.5m which results in more coal production per cycle.
- Coal seam with a gradient of 1 in 16 which is very much suitable for Longwall Mining.
- Easily cavable and moderately cavable roof characteristics hence no cavability issues while excavation.

Production figures of Longwall

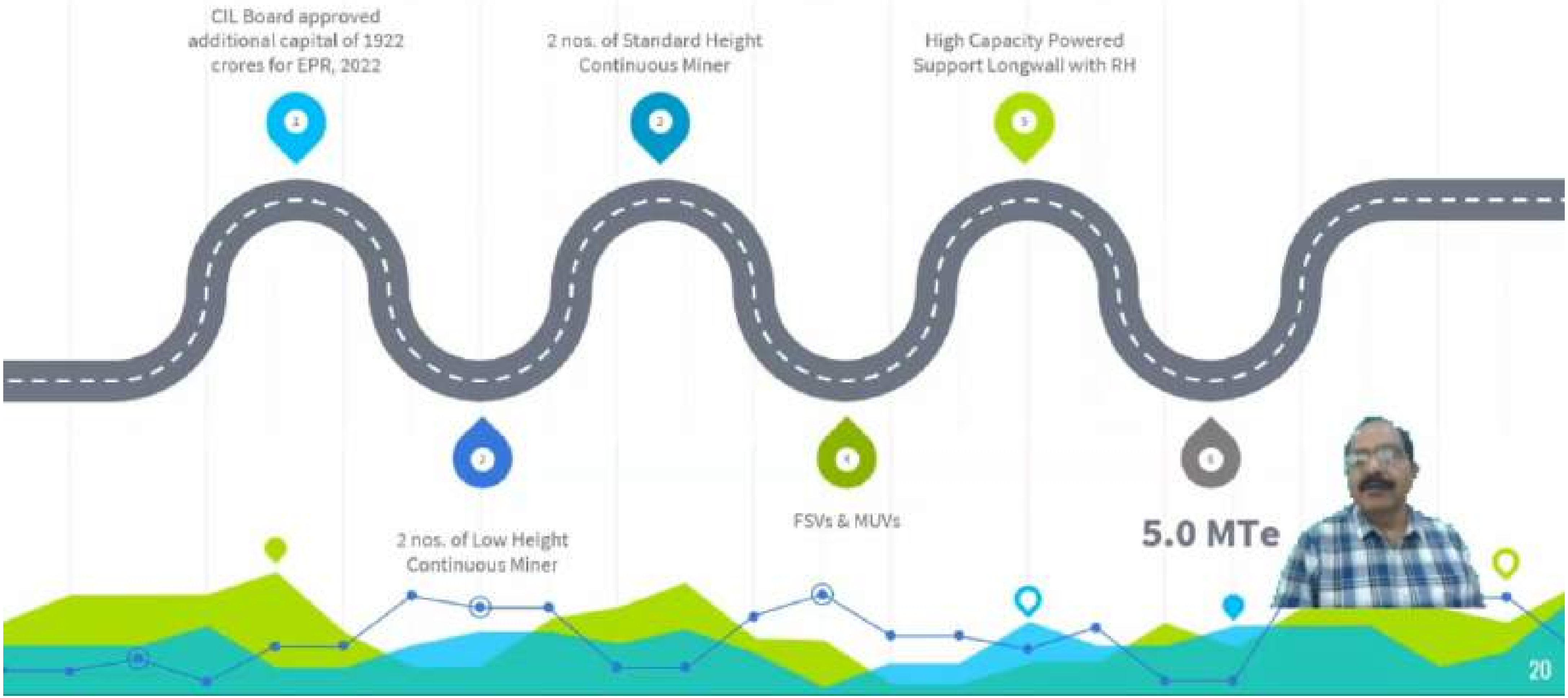


Production figures of Jhanjra Standard Height Continuous Miners

Major Overhauling:
CM-1: April'19-May'19
CM-2: May'18-Aug'18


PRODUCTION (IN MILLION TONNES)
Quanity of Coal PRODUCTION (In MTe)
4
3.5
3
2.5
2
1.5
1
0.5
0
0.77
1.04
1.01
1.42
1.48
2.43
3.16
3.37
3.5
3.56
3.62
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
Prodution
0.77
1.04
1.01
1.42
1.48
2.43
3.16
3.37
3.5
18

A Brief of Expansion Project Report, 2019



Conclusion

- Underground Mining contributes only 5-6% of the total production but it has to be augmented to sustain in the near future.
- Similar UG Mega Mechanized Projects , like Jhanjra being the most successful mega UG Project, may be planned for future sustainable growth in line with international standards .
- Presently there are only 3 sets of Longwall operating in India but the number of Longwall packages operational has to be increased after proper geotechnical investigation and feasibility. Longwall gives the highest IRR amongst all mining technologies with highest OMS in UG Mining.
- Longwall & CM Packages may be deployed at all coal properties which are Free from Geological disturbances, Adequate Hardness of Coal, Easy to difficult cavable roof and Sufficient geological reserve to augment production from UG.
- Adding to planning of Mega UG mines, indigenous manufacturing of Mass Producing Equipment's in India may also be sought after.
- It is a step to achieve our dream of producing 5.0 MT of coal per annum from Jhanjra, a step towards achieving the vision of Coal India Limited of producing 1 billion tons of coal

Annexure 8

CONSTRUCTION AND OPERATION OF

HIGH CAPACITY LONGWALL PROJECT AT ADRIYALA

EXPERIENCE’s

THE SINGARENI COLLIERIES COMPANY LIMITED

(A Government Company)

Lessons from earlier LW's in SCCL

- In adequate Exploration data – mostly concentrated on coal seams and immediate roof and floor (as that would be enough for manual mining & OC mines)
- No detailed information on interburden strata (up to 100 - 200m above) and limited understanding of its role on longwall supports/ caving
- Traditional roof supporting practices – cement capsules, girders, ..etc
- Extensive issues with outbye systems and logistics
- Inadequate ventilation
- Very low roadway development rates
- Flawed equipment selection with inadequate rating of supports, shearer and coal clearance systems.

To Finalize Mine Design by eliminating earlier problems, SCCL appointed Technical Consultants:

1. M/s **CSIRO**, Australia entered in to Collaborative research agreement with SCCL - for detailed geo-tech studies, Support capacity estimation and finalisation of tech.specification for modern high capacity LW s in SCCL.

2. Mr. **Andy Rutherford**, Australia for formulating Specifications, testing, drawings and commissioning of LW project.

3. Mr. **Russell Firth**, Australia, as a Geo-Technical Studies.

4. Additionally various Indian Institutes assisted in scientific studies and investigations.

5. A team of senior officers of Singareni visited Australia and inspected various high productive LW Mines and Mines with access/operation through Punch Entries in the highwall of Opencast Mines.

6. Subsequently, various internal meetings were conducted to deliberate:

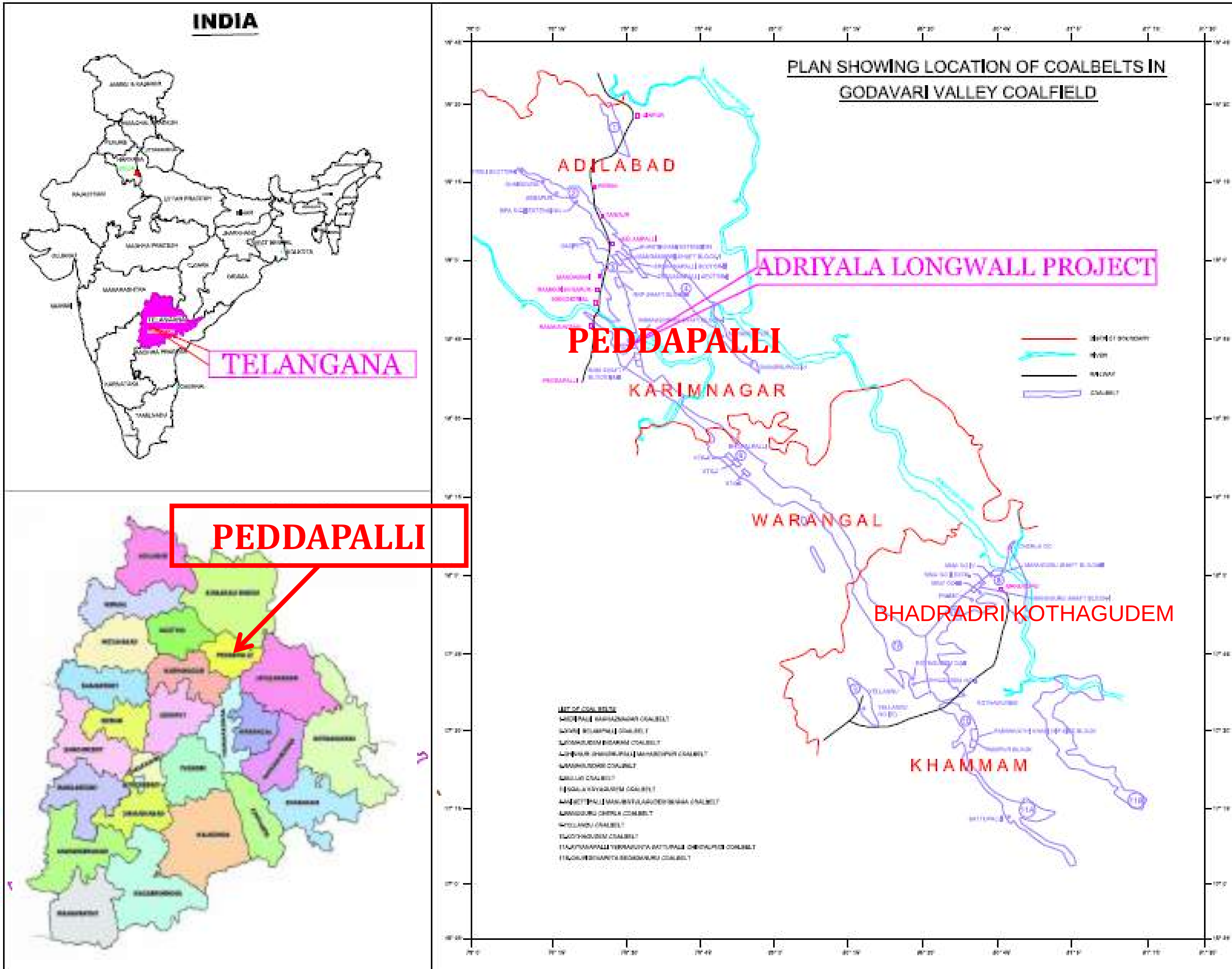
   The technological changes which had taken place around the world such as Length of LW face, Width of LW face, Modernization of Equipment, face automation as explained by Consultants

   The success level of 250m conventional LW faces etc.

Recommendations on Mine design

- **Equipment specifications**
  - 1 set of high-capacity Longwall equipment for thick seams viz. 1 seam, 3 seam, 4 seam of Adriyala
- **Entries**
  - **Punch entries** as mode of entry on southern side of the boundary to have Longer panels,
  - **Separate entries** to the Mine workings for coal evacuation
- **Panel lengths -** greater than **2 km**
- **Longwall Face -** **250m** instead of 150m.
- **Voltage -** Operating Voltage of 3.3 kV instead of 1.1 kV and Supply Voltage of 11 kV instead of 3.3 kV
- **Mode of transport -** Diesel vehicles for men and material transport
- Air chilling plant
- High capacity N2 plant for goaf inertization

LOCATION PLAN



Significance of Adriyala

- **The present operating Under Ground and Opencast mines are exploiting coal reserves up to 300m depth and will be depleted in next 10-15years.**
- **Future mining has to be done beyond 300m depth with Under Ground methods.**

Challenges in exploitation of deep deposits :

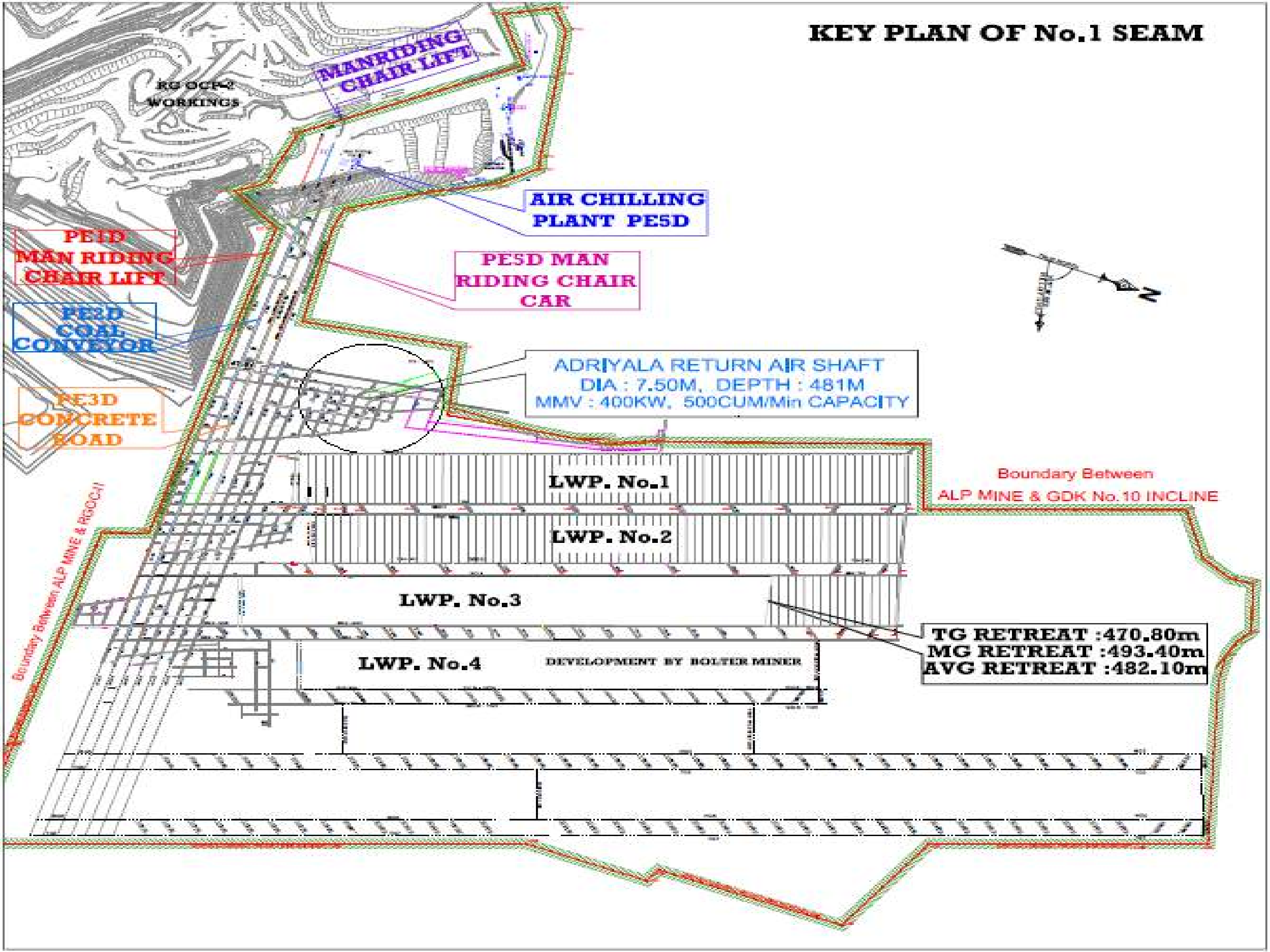
- **High strip ratio (OC Mines)**
- **Greater strata control problems**
- **High investments**
- **Ventilation problems**

Conventional Underground methods are not adoptable at greater depths –

Longwall technology is a proven UG mining method for deep seated deposits.

Hence sustainable Under ground coal mining is possible only by successful adoption of Longwall mining.

KEY PLAN OF No.1 SEAM



Salient features of Adriyala Longwall Project

- Total extractable Reserves : 78.597 MT
- Total Mine take area :4.845 Sq. Km.
- Seam gradient : 1 in 6 to 1 in 7.8
- Gassiness of the Mine : Degree-I
- Depth of working : 294.0m– 644.0m
- Targeted production : 2.817MTPA
- Life of the Mine : 35 years
- Productivity
- at Mine level (OMS) : 12.35 T/Man shift
- Breakeven
- production per annum : 1.451MT

Uniqueness of ALP

The following new technologies have been introduced for the first time in SCCL:

- Punch entry (Direct access to coal from Opencast highwall)
- 11 KV power transmission to UG (for less voltage drop)

- Pre tensioned Cable bolting (For effective roof support)
- 400 KW high capacity fan commissioned (To supply more air with high water gauge)

- Floor Concreting in underground (For Diesel vehicle movement with heavy equipment)
- Automation systems (For sequence control/less manual intervention)

Uniqueness of ALP

The following new technologies have been introduced for the first time in SCCL:

- Diesel transport vehicles (FBL)
  (For speedy & safe equipment transportation)
- VFD controlled un-manned Belt conveyor system
  (For soft start and power conservation)
- Mine cruiser(for faster transport of men)
- Surface air chilling
  (To create comfortable environment conditions)
- 1200 CFM Membrane type N2 plant
  (For goaf inertization)
- RO water for LW hydraulics
- Bolter Miner
  (For faster rate of development)
- Pan Line Bolter
  (for Cable Bolting and Steel Bolting during meshing operation of Longwall)

Specifications of Equipment

POWER ROOF SUPPORTS

- Support capacity : 1152 T (2 legged DTDA version)
- Operating Range : 2.8 to 3.6 m
- Support width : 1.75 m
- Operating Range : 2.8 to 3.6 m
- Closed & open height : 2.4 to 3.9 m
- Length : 6.5m to 7.5m

SHEARER

- Type / Model : EL 3000
- Operating voltage : 3.3 KV
- Web depth : 0.85 m
- Drum diameter : 2.3 m
- Rated capacity : 2245 KW

AFC

- Capacity : 3X855 KW, 3.3 KV, 3-Phase, 50 Cycles
- Width : 1142 mm
- Capacity : 3100 TPH

BSL

- Capacity : 400KW, 3.3 KV, 3-Phase, 50Cycles/ sec.
- Width : 1342mm wide,
- Speed : 2.06 m/sec
- Capacity : 3200 TPH.

Electricals

- 2 X 4.5MVA transwitches

Diesel Vehicles

- **Underground transport and installation:**
  - Total equipment transportation and installation was done by diesel vehicles from surface to Longwall face.
- **Men Transport:**
  - Miner cruiser of M/s BEML (In collaboration with M/s Bird, South Africa) was deployed for men transportation in underground.

Sl.No	Description	FBL-10/ CL-210	FBL-15/ CL-215	FBL-55/ SH-660	Mine Cruiser
1	Equipment	F-1 & F-2	F-3 & F-5	F-6 & F-7	BMC-01
2	Capacity	10T	15T	55T	16 persons
3	Licencer/ Manufacturer	M/s. GMMCO / Caterpillar			BEML/ Bird Machines
4	Fuel Consumption	Diesel			Diesel
5	HP @rpm	230 HP @2200 rpm			84 HP @2300 rpm
6	Torque @rpm	720 Nm @1400 rpm			360 Nm @1450 rpm
7	Cooling	Liquid Cooled			Liquid Cooled
8	Aspiration	Turbo Charged			Turbo Charged
9	Cylinder Liners	Wet			Wet

Installation of Longwall equipment using Diesel vehicles

Transport of shield with SH150 Shield trailer

Transport of pump unit with CLT210

Transport of MG Drive and Shearer with SH660

Outbye conveyor system - CODCO

- Total number of Gear heads : 12 nos
- Capacities varying from : 4 X 315KW to 4 X 500KW
- Speed : 4 m / sec

- Type of Drive : VFD
- Belt capacity : 3500 TPH
- Belt Type : Steel cord (ST 800 to ST2500), PVC Type 15
- Total Length : Surface - 6436m
  Underground - 2976m
- Total installed power : 14849 KW

Development Equipment – 12ED30Bolter Miner

Roadway dimensions W x H : 5.50m x 3.60m

Main Dimensions

- Total length 13.10 m
- Total width for transport, approx. 4.60 m
- Total height for transport,

  with dust collector 2.75 m

  without dust collector 2.50 m
- Total weight, approx. 123 tonnes
- Total width in operation 5.50m
- Width of the crawler track 2662 mm
- Ground clearance 281 mm

Details of Longwall Panels

S.No	Particulars	LWP-1	LWP-2	LWP-3
1	Face Length (m)	250	250	250
2	Panel Length (m)	2340	2232	2486
3	Avg. Depth			
	Maximum	455	506	557
	Minimum	356	409	444
4	Reserves in the panel	3.36 MT	3.30 MT	3.50MT
5	Date of commencement	05.11.2014	20.08.2017	21.07.2021
6	Total reserves extracted	3.36 MT	3.32 MT	0.70 MT (Under extraction)

Proactive Inertization

- Proactive inertization with **Nitrogen flushing (99.5% purity) in to the working goaf** with a capacity of **800cub.m/hr.**

Mine Environmental Monitoring

- **Tube Bundle System:**
  - To monitor the atmosphere at relevant locations underground.
  - One **analyzer room** is provided at surface, **tubes are be laid from analyzer room to underground monitoring locations**.
  - The data is **transmitted through OFC** from **analyzer room** to **control room** where, **continuous monitoring** of gases (**CO, CH_4, CO_2 & O_2**) is being done.

Challenges during construction stage

- **Drivage of gate roads**
  - **Initially there were some apprehensions on workability of Bolter Miner (BM) due to its steep gradient and stone cutting in the floor in the gate roadways.**
  - **Hence, Road Headers (RH) were introduced for drivage of roadways to avoid surprises with BM as RH technology is well established system for decades.**
  - **However, RH drivages are not meeting the project requirements due to their inherently low development rates, inability to provide a quality roadway conditions suitable for High capacity LW equipment and requirement of more man power.**
  - **Hence a decision was taken to introduce BM for drivage of roadways and order is placed for deployment of BM.**

Challenges during construction stage

- **Initially, the project operations were interrupted by opencast activities like blasting and movement of heavy machinery movement. Later, the OC workings progressed well away from Punch entries and there was no interference.**

Strata Control Management during development:

- **Gate roadways:**
  - **Initially roof disturbances were observed and on two occasions cavities occurred in gate road ways driven in bottom section taking middle clay in to working section.**
  - **Later geological mapping and litho logical study was done and working section has been changed by leaving middle clay in the overlying strata with 1m coal underneath it, which improved the stability of gate roadways.**

Challenges during construction stage

Strata Control Management during development:

- **Cut Throughs:**
  - **Initially cut throughs were driven across the major horizontal stress direction, in which severe strata control problems were encountered and cavities also taken place.**
  - **Later the direction of cut throughs has been changed and aligned with major horizontal stress direction which eliminated all strata problems.**
- **Initially gate roadways were supported with roof bolting with linked wire mesh in the roof.**
- **Later rigid wire mesh has been introduced in place of linked wire mesh to reduce supporting cycle time and to improve the supporting efficiency of the system. The roof conditions and drivage rates have been improved with introduction of rigid wire mesh.**

Challenges during construction stage

- **Face dip widening**:
  - **Strata problems were encountered while widening longwall installation face with 8m width.**
  - **As per the recommendation of Geotech consultant, Pre- tensioned cable bolting (6.1m) was introduced for the first time for better strata control and to eliminate vertical support in face dip to facilitate the movement of Diesel Vehicles.**
- **Laying of civil foundations on loose overburden for Conveyor belts**
  - **Existing loose overburden soil was dug out and replaced with soil recommended by experts. The soil was compacted layer by layer for a recommended length and depth during filling to obtain the required soil strength around the foundation. Thereafter concrete foundations were made by excavating the above compacted soil for the required foundation dimensions.**

1st Longwall panel - Challenges

- **Ventilation:**
  - An outsourced air chilling plant of 1400TR was installed at mouth of Punch Entry-5 (PE-5).
  - About 3500Cu.m/min of chilled air was supplied at 11 to 13 0C at the entry of PE-5.
  - Cooled air is ventilated to LW face through a separate air way via PE-5 and MainGate-1.
  - The temperature has been brought down by 3 to 4 0C. Efficiency and effectiveness of men and machinery increased considerably.

- **Failure of Electrical systems (Load centers and gate belt VSDs) and**
- **Numerous reports on Shearer**
  - Equipment issues were resolved under the guidance of CAT expats.

2nd Longwall Panel - Experiences

- **Problems in hydraulics**
  - **All the hoses & Parts are replaced .**
  - **Roof Support Flushing as per OEM procedure.**
  - **Emulsion percentage not less than 2.5% (Synthetic oil preferred choice).**
- **Cavity over more than half of the face length**
  - **Cavity filling with Rocksil and PUR products.**
- **Spontaneous heating**
  - **Control measures taken by drilling of boreholes from surface, flushing of inert gases (LN2 & CO2) from surface and underground. Heating controlled**

Way Forward

- Development of gate roadways at faster rate with Bolter Miner.
- Using complete automation for face operations.
- Extensive training for Longwall team.
- Increasing main fan capacity from 250m3/sec-500m3/sec.
- Chilled air supply to entire mine.
- Mine Environment monitoring with tube bundle system.
- Men and material transport with diesel vehicles.
- Increasing pumping capacity to 5000gpm.

Thank You…

__Annexure -9__

TATA STEEL
#WeAlsoMakeTomorrow

TATA

Technological Intervention at Tata Steel, West Bokaro Division

Manish Mishra
General Manager, West Bokaro Division

15th March,2022
Workshop on Technology Roadmap, CIL Kolkata

AGENDA

- *Location Map*
- *Washed Coking coal YoY basis.*
- *Material Flow West Bokaro Division*
- *Coal Beneficiation- Extracting best out of available resource*
- *Quality Control*
- *Customer based approach*

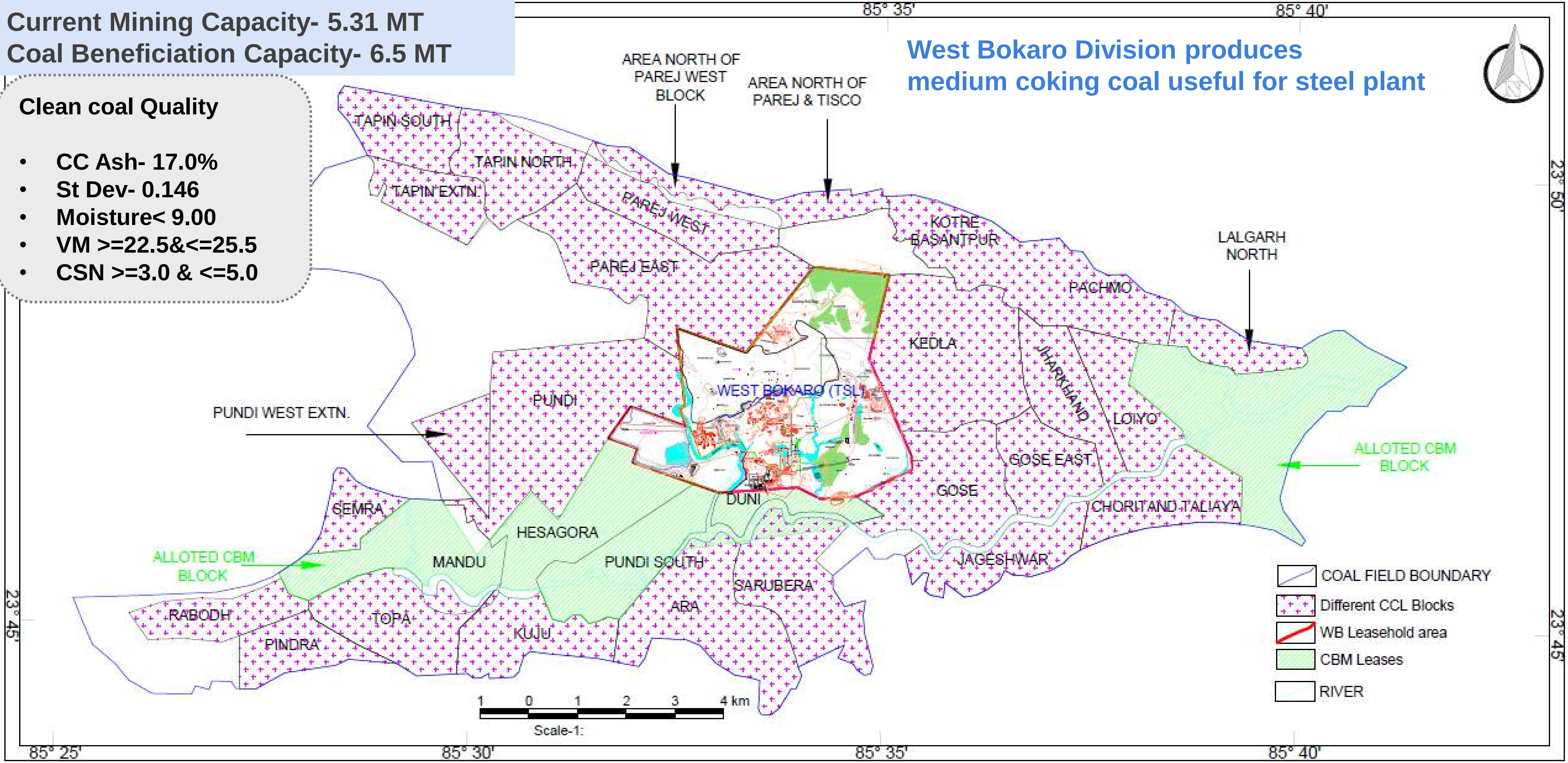
West Bokaro Division – Location Map

Current Mining Capacity- 5.31 MT
Coal Beneficiation Capacity- 6.5 MT

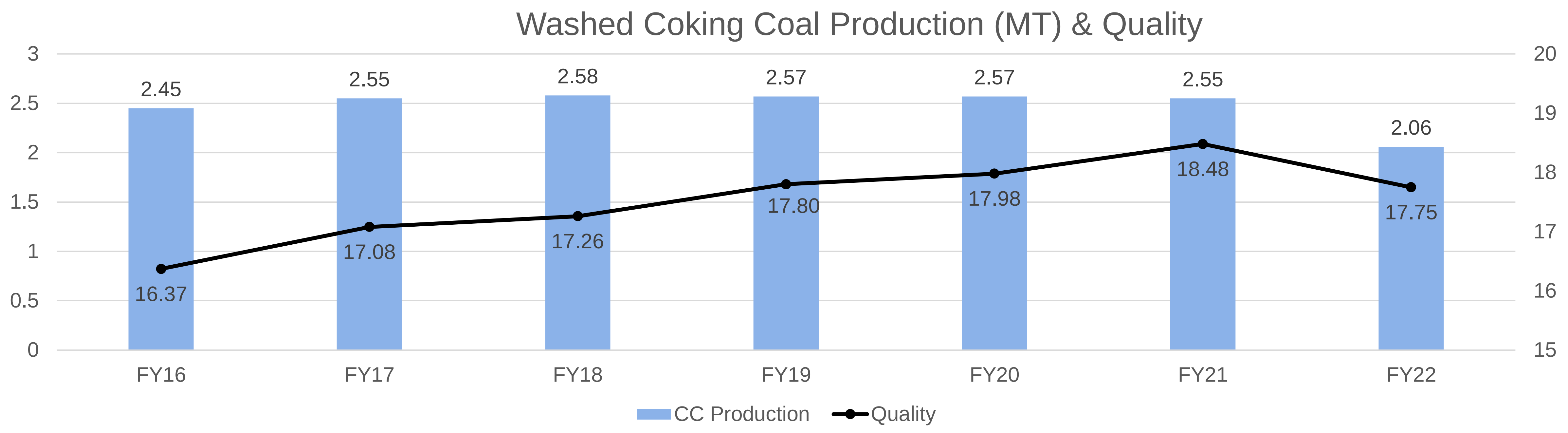
Clean coal Quality

- **CC Ash- 17.0%**
- **St Dev- 0.146**
- **Moisture< 9.00**
- **VM >=22.5&<=25.5**
- **CSN >=3.0 & <=5.0**

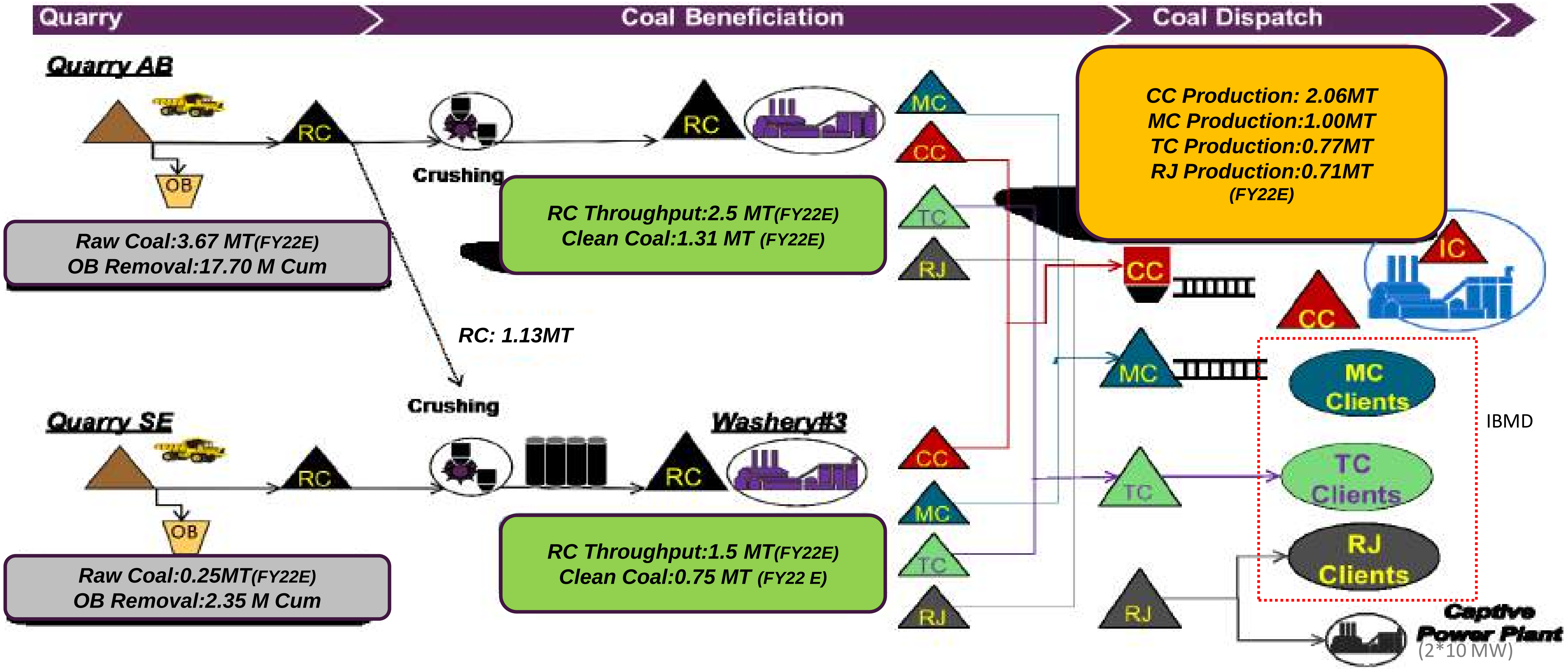
West Bokaro Division produces medium coking coal useful for steel plant



Washed Coking Coal Production & Quality from West Bokaro



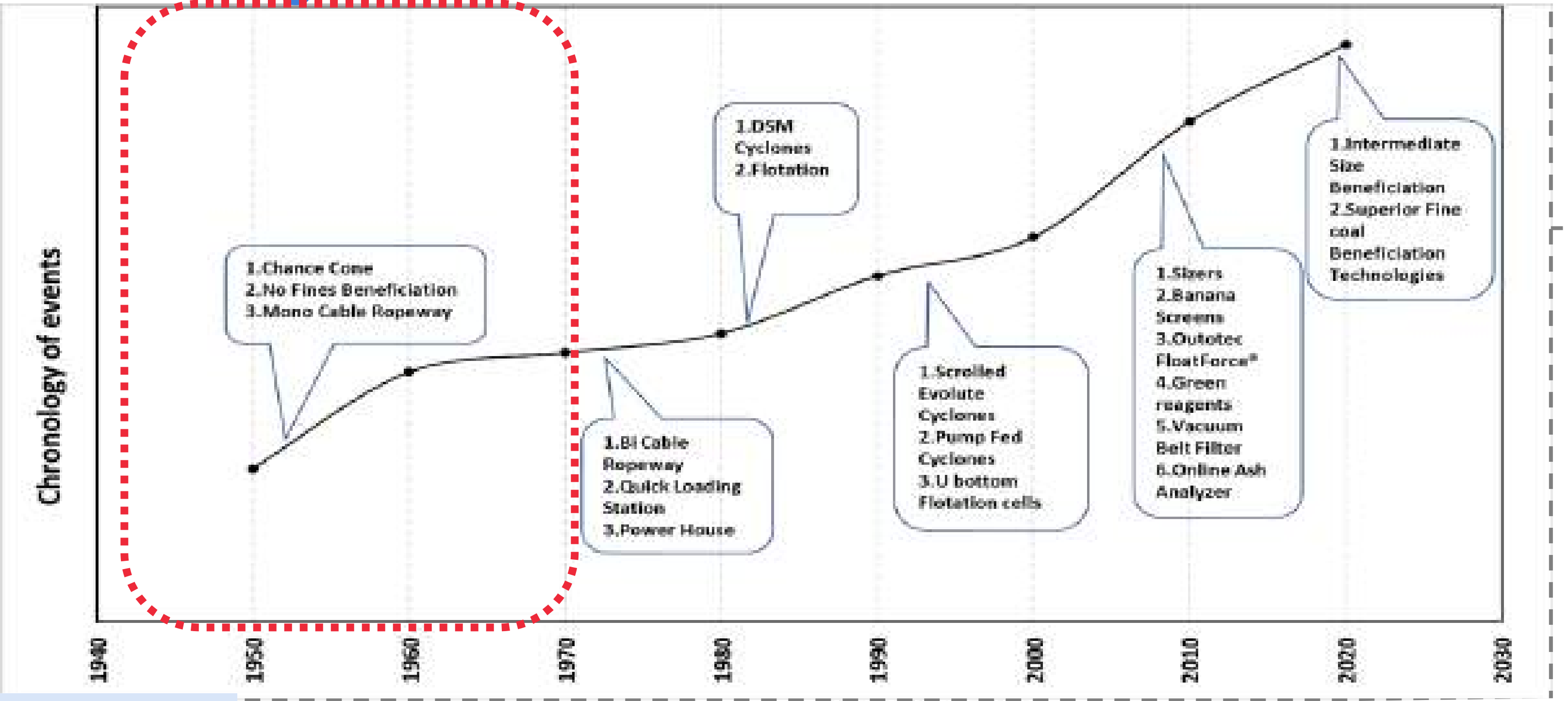
Material Flow: West Bokaro Division



100% consumption of all the products generated in the process

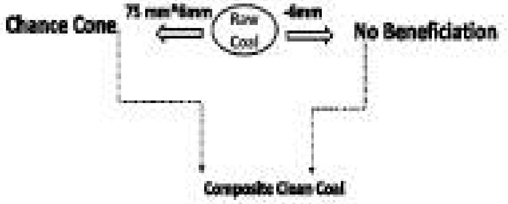
RC – Raw Coal, CC – Clean Coal, MC – Middling Coal, TC – Tailing Coal, RJ – Reject Coal, IC – Internal Customer (TSJ,TSK), OB – Over Burden, IBMD – Industrial Byproduct Management department

Coal Beneficiation- (1/2)
Extracting best out of available resource



1940-1970s

- Raw coal was crushed and reduced to -75 mm size followed by screening at 6mm
- **75*6mm** size fraction of coal was beneficiated in **Chance Cone** process (a dense media separator utilizing sand as media) whereas the finer fraction (-6 mm) was directly added without beneficiation to the washed coal
- Only **top seams** (good quality & high yielding) were mined
- The composite clean coal was transported to the railway siding via. a **mono-cable ropeway**



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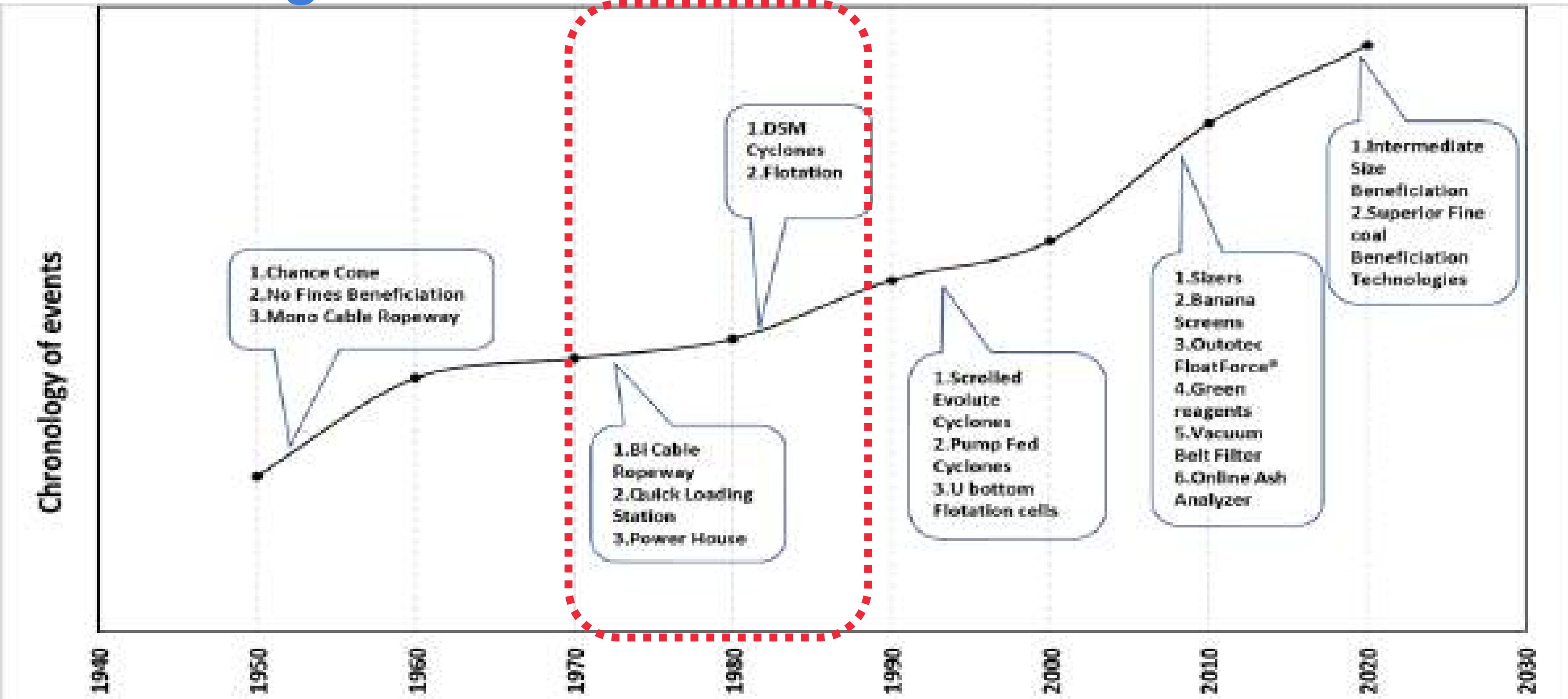
Extracting best out of available resource



1980s

- Detailed studies were carried out to arrive at the correct **feed top size (13mm)** the washery to optimize the clean coal yield at a desired ash
- In 1984 , Chance Cone process was replaced with **gravity fed Dense Media Cyclones** (DSM Cyclones) for processing coarser raw coal fraction:13 to 0.5mm and **flat bottom mechanical flotation** cells for processing finer raw coal fraction: -0.5mm

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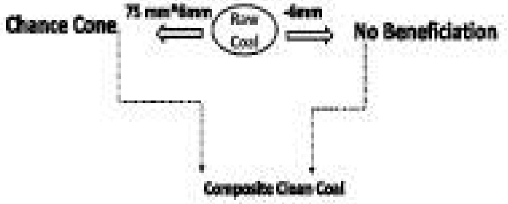
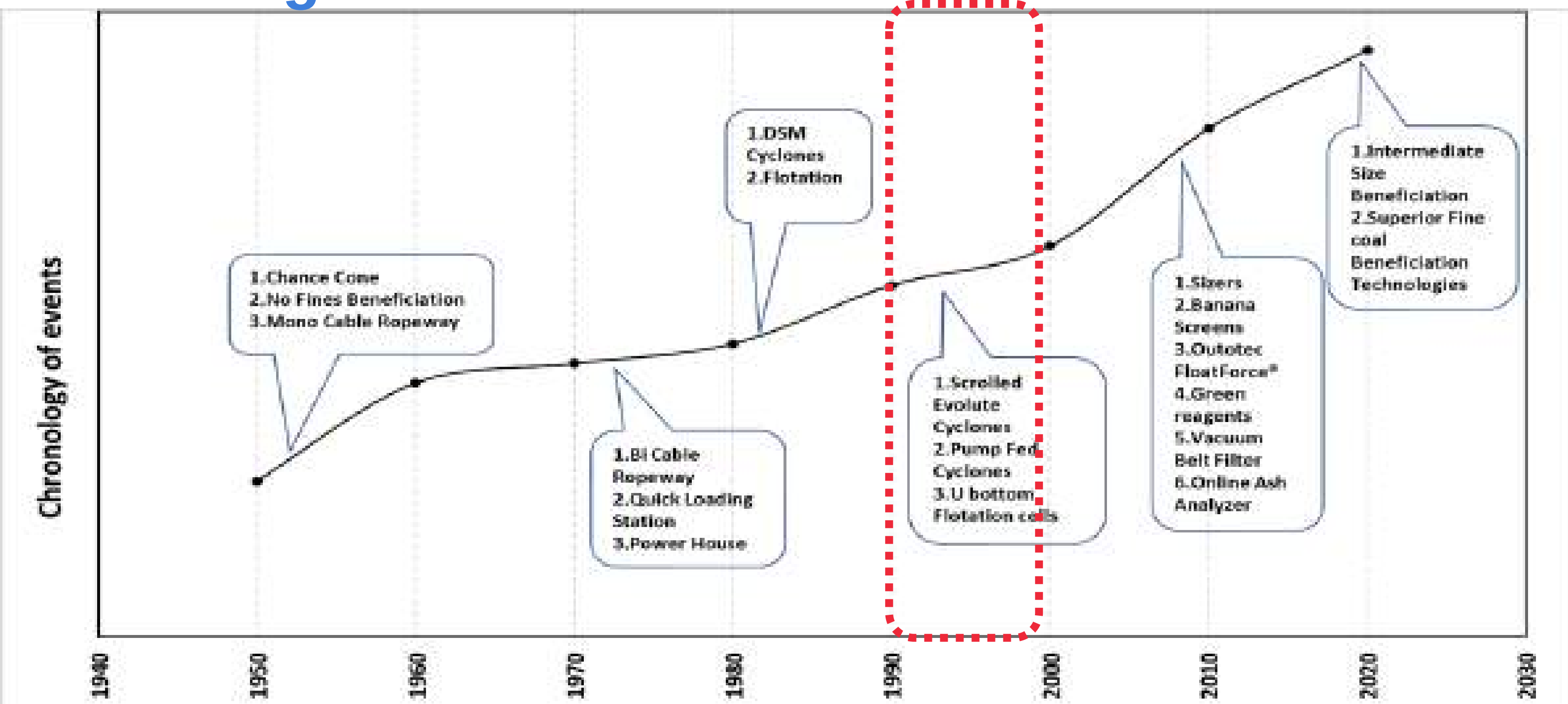


Coal Beneficiation- (1/2)
Extracting best out of available resource



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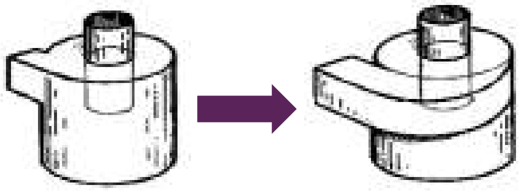
1990s

Low Ep Scrolled Evolute Cyclones: Washeries switched over from **tangential inlet design** in the Dutch State Mines (DSM) cyclones to **scrolled evolute design cyclones**

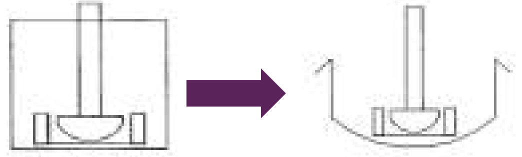
Capacity as well as process performance improved as the Ep obtained was 0.02-0.025 as against 0.035-0.040 in the DSM cyclones

Introduction of Pump Fed Cyclones : Gravity feeding requires higher footprint but achieves a more consistent flow, less pump wear and feed degradation.



Pump fed cyclones have V/f converters for maintaining the required inlet pressure thereby reducing the capital costs

Replacement of flat-bottom flotation cells with U-bottom ones: U-bottom cells minimize the sanding/silting phenomenon. Sanding is high in flat-bottom cells due to lack of velocity in the un-agitated zones thereby allowing the larger particles to settle down



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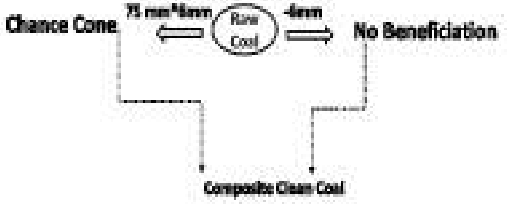
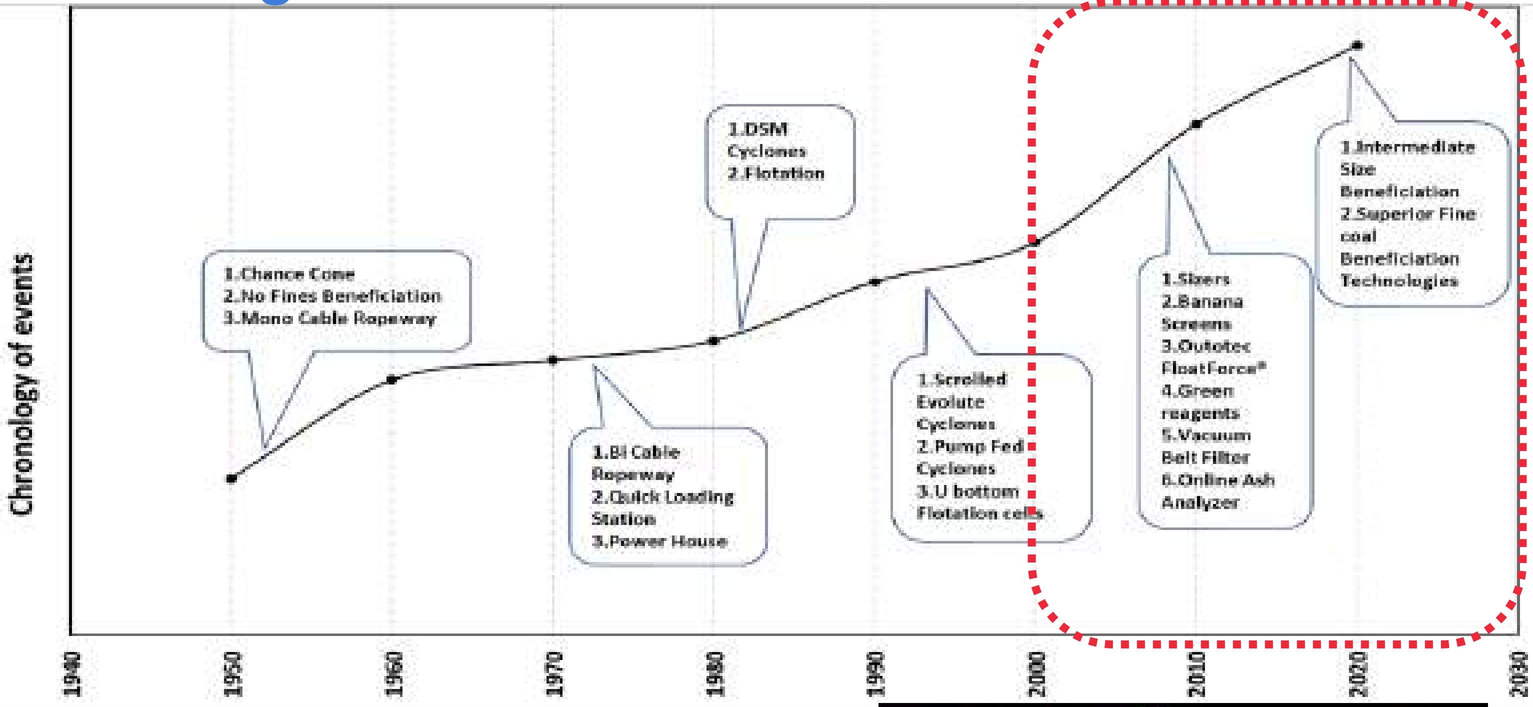
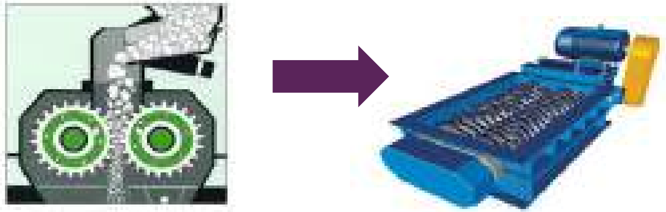


Coal Beneficiation- (2/2)
Extracting best out of available resource

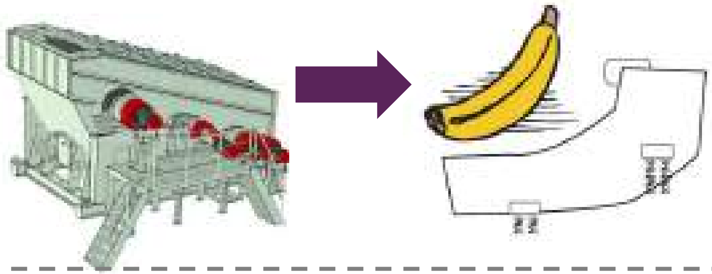


2000 to presents

Introduction of Sizers to improve liberation: Sizers were introduced in place of roll crushers to get optimum liberation at reduced noise and dust.



Replacement of Elliptical screens with Banana screens to improve the desliming efficiency: It was observed that a substantial quantity of undersize i.e. (-) 0.5mm reported to the screen oversize. These finer coal particles create difficulties in maintaining the cut density inside the cyclone thereby impacting the efficiency.

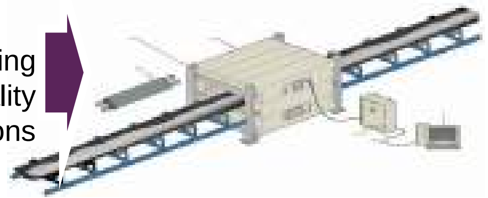


'Advanced new-generation mixing mechanism 'in Flotation cells: This mechanism creates more turbulent energy and generates finer bubbles as it has separate chambers for air and slurry in the rotor assembly of the flotation cell

Introduction of Vacuum Belt Filter for dewatering fine clean coal: Initially, Screen Bowl Centrifuges were used for dewatering fine clean coal: <0.5mm.However, it was observed that ultra-fine coal particles were getting lost with the centrifuge effluents. The belt filter installed at West Bokaro washery#3 is also the world's largest HVBF with an effective filtration area of 145 m² for coal slurry.

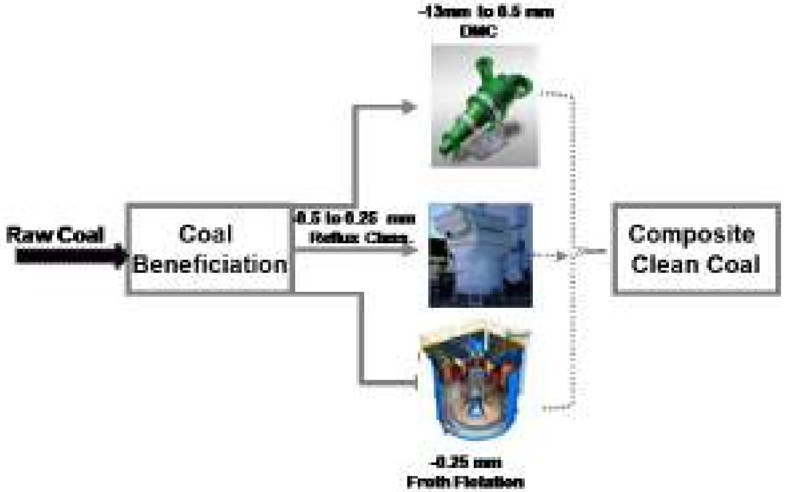
Substitution of Diesel with green reagents in Flotation With the stringent environmental regulations and policies, replacement of diesel with a reagent that is environment friendly as well as technically & economically competent became inevitable. Diesel is also highly inflammable and prone to pilferage and hence, poses safety as well as environmental hazards.

On Line Ash Analyzers for consistency in product quality: Taking representative samples from conveyor belt and analyses for effective quality monitoring & control was time consuming. As a result, corrective actions could not be taken timely resulting in in variations in the clean coal ash.

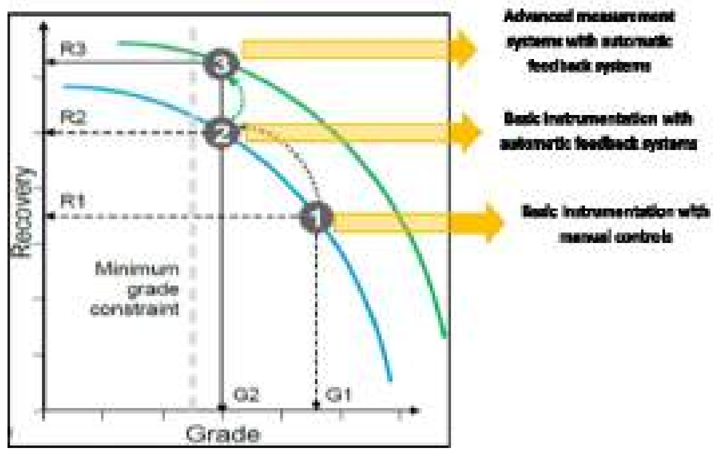


Other Digital & Technological Upgradation

Intermediate size beneficiation(In progress)



Fully automated plant (In Progress)

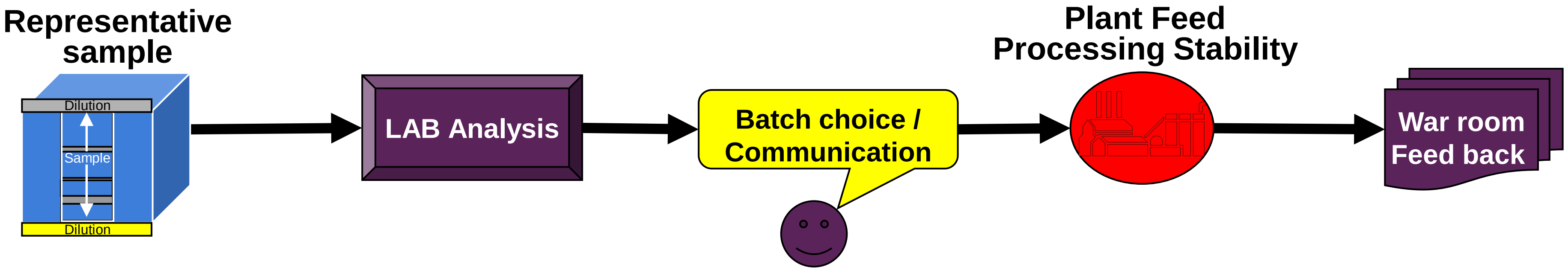


Centralized Control Room

Installation of Long pipe Conveyor for cleaner Dispatch

Quality Assurance

-To provide a stable and predictable feed to the constraint
-To protect Washery against variability



9SE/922 +SHALE +8SE/823

FROM	TO	THICKNESS	CORE SAVED	CR	LITHOLOGY	
0.00	0.98	0.98	0.93		MAINLY BRIGHT COAL (BROKEN CORE)	IX SEAM
0.98	1.00	0.02	0.02	0.95	CARB SHALE	
1.00	1.19	0.19	0.18		DULL & BRIGHT COAL (BROKEN CORE)	
1.19	1.52	0.33	0.31		MAINLY BRIGHT COAL (BROKEN CORE)	
1.52	1.81	0.29	0.28		DULL & BRIGHT COAL (BROKEN CORE)	
1.81	1.97	0.16	0.16		MAINLY BRIGHT COAL (BROKEN CORE)	
1.97	3.00	1.03	1.00	1.93	CARB SHALE (BROKEN TOWARDS TOP)	
3.00	3.15	0.15	0.14		CARB SHALE (BROKEN CORE)	
3.15	3.24	0.09	0.09		DULL & BRIGHT COAL (BROKEN CORE)	
3.24	5.37	2.13	2.04		CARB SHALE (BROKEN CORE)	
5.37	5.73	0.36	0.35		MAINLY DULL COAL (BROKEN CORE)	VIIISEAM
5.73	6.00	0.27	0.26	2.88	DULL & BRIGHT COAL (BROKEN CORE)	
6.00	6.16	0.16	0.15		DULL & BRIGHT COAL (BROKEN CORE)	
6.16	6.36	0.20	0.19		DULL COAL (BROKEN CORE)	
6.36	6.59	0.23	0.22		DULL & BRIGHT COAL (BROKEN CORE)	
6.59	6.71	0.12	0.11		MAINLY BRIGHT COAL (BROKEN CORE)	
6.71	7.16	0.45	0.43		DULL & BRIGHT COAL (BROKEN CORE)	
7.16	7.26	0.10	0.09		BRIGHT COAL (BROKEN CORE)	
7.26	7.35	0.09	0.09		DULL COAL	
7.35	7.84	0.49	0.46		MAINLY BRIGHT COAL (BROKEN CORE)	
7.84	8.23	0.39	0.37		DULL & BRIGHT COAL (BROKEN CORE)	
8.23	8.30	0.07	0.06		BRIGHT COAL (BROKEN CORE)	
8.30	8.58	0.28	0.27		DULL & BRIGHT COAL (BROKEN CORE)	
8.58	8.66	0.08	0.08		DULL COAL	
8.66	9.00	0.34	0.32	2.84	DULL & BRIGHT COAL (BROKEN CORE)	
9.00	9.21	0.21	0.19		DULL & BRIGHT COAL (BROKEN CORE)	
9.21	9.45	0.24	0.22		MAINLY BRIGHT COAL (BROKEN CORE)	
9.45	9.74	0.29	0.26		DULL & BRIGHT COAL (BROKEN CORE)	
9.74	9.92	0.18	0.16		DUL COAL WITH BRIGHT STRINGES	
9.92	10.00	0.08	0.08	0.91	SANDY SHALE	
		10.00	9.51	9.51		
CORE RECOVERY %				95.10		

Batch- 99	Yield from Pulp Partition Model (Primary cut point at 1.8)									
	Cl.coal	77.92	15.00	Recovery (-0.5mm)		Recovery (+0.5mm)		Composite data		
	Middlings	0.00	0.00	Yield (%)	Ash%	Yield (%)	Ash%	Yield (%)	Ash%	
	Tailings	14.44	25.84	65.07	7.40	83.37	16.63	78.79	15.00	
	Rejects	11.64	65.48	SEC CUT POINT		1.4694	YIELD% (COARSE)		62.52	
		104.00		PRI. CUT POINT		1.8000	YIELD% (FINES)		16.27	

IXSE CORE SAMPLE		CORE RECEIVED ON - 03.09.2011			
DATE OF ANALYSIS -04.09.2011				BATCH NO - 105	
SAMPLE NO: 9SE/922/11				F. FLOTATION TEST	
SIZE(mm)	WT(Kg)	WT%	ASH%	WT%	ASH%
+0.5mm	3.279	82.26	24.76	65.07	7.40
-0.5mm	0.707	17.74	13.84	34.93	25.84
TOTAL	3.986	100.00	22.83	100.00	13.84
Raw coal 'direct ash% = 22.60			Raw coal '-0.5mm ash% = 13.93		
SG	WT	WT%	ASH%	CUM.WT%	CUM ASH%
1.30	0.389	11.86	3.39	11.86	3.39
1.35	0.621	18.94	7.97	30.80	6.21
1.40	0.537	16.38	12.18	47.18	8.28
1.43	0.252	7.69	15.91	54.86	9.35
1.45	0.151	4.61	18.38	59.47	10.05
1.48	0.270	8.23	21.19	67.70	11.40
1.50	0.123	3.75	24.26	71.45	12.08
1.55	0.108	3.29	27.05	74.75	12.74
1.60	0.076	2.32	32.29	77.07	13.33
1.70	0.045	1.37	39.67	78.44	13.79
1.80	0.071	2.17	46.18	80.60	14.66
>1.80	0.636	19.40	66.76	100.00	24.76
TOTAL	3.279	100	24.76		

Customer Based Approach

Memorandum of Understanding (MoU)

MEMORANDUM OF UNDERSTANDING (MoU) WITH WORKS & HMCL
(FY '19)

Internal Customer :- Coke Plants of TSJ Works & HMCL | Supplying Partner : West Bokaro

Sl. No	MOU Parameter		Unit of Measurement	Base Level	Target Level	Responsibility	Review Frequency
1.1	Clean coal despatch to TSJ Works & HMCL (Own)		Lakh Tons	19.19	19.87	Chief (CB)	Quarterly
1.2	Clean coal despatch to TSJ Works & HMCL (OCL)		Lakh Tons	1.71	2.00		
1	Total Clean coal despatch to TSJ Works & HMCL		Lakh Tons	18.89	21.47		
2	SD of clean coal despatch		%	0.216	0.308	Chief (CB)	Monthly
3	Clean coal avg despatch ash		%	17.37	18.00	Chief (CB)	Monthly
4	Clean coal Ash range < 18.2 % ash		%	80.03	80.00	Chief (CB)	Monthly
5	Clean coal avg despatch Moisture	During monsoon (July - Oct)	%	10.50	10.00	Chief (CB)	Monthly
		FY (rest month)	%	10.20	10.30	Chief (CB)	Monthly
6	Clean coal VM >22.0 & < 26.0		%	91.80	91.00	Chief (CB)	Monthly
7	Clean coal CSN >=3.5 & <=5.5		%	97.75	96.00	Chief (CB)	Monthly
8	Clean coal Fluidity range 1600 - 5000 ddpm		%	96.58	97.00	Chief (CB)	Monthly

Sl. No	MOU Parameter	Unit of Measurement	Base Level	Target Level	Responsibility	Review Frequency
4	Customer Visit	Nos.	2	3	Head (Logistics)	Half yearly
2	Information of ash and other quality details before rake arrival at customer end	%	100	100	Principal Geologist (NPD)	Monthly

Name: Mr. [illegible] Designation: Chief, Operations, WB Signature

Name: Sanjay Singh Designation: General Manager (Coal) Signature

Name: Mr. Prashar Mishra Designation: Chief, Coke Plants, TSJ Signature

MoU Compliance Monitoring

SUMMARY							
DATE	DESPATCHED ON DATE (Qty)	CUM.ASH%	CUM.MOIST%	CUM.VM%	CUM.CSN	MAXDDPM	DESPATCHED TILL DATE (Qty)
31-May	7941.62	15.05	10.09	25.26	4.91	3598.88	151063.83

Sample

RAKE NO	DESPATCHED ON	DESPATCH TIME	QUANTITY (MT)	ASH% CLEAN COAL	MOIST%	VM%	Reported	LOT 1	LOT 2	LOT 3	LOT 4	LOT 5	LOT 6	Fluidity test results: Softening Tep(T)	Max.Fluid DDPM	Max.Fluid Temp	Plastic range	Solidification Temp
85	24-May	15:45	3912.30	14.94	10.00	25.46	5.0	5.0	4.5	5.0	5.0	4.5	5.5	403.8	3528	451.3	85.1	488.9
92	26-May	08:00	2621.40	15.09	10.12	25.13	5.0	5.0	4.5	5.0	5.0	4.5		405.5	5246	449.3	86.8	490.1
94	27-May	02:00	3953.30	15.03	10.07	25.22	4.5	4.0	4.5	5.0	5.0	4.5	4.5	404.9	2938	445.3	84.6	489.5
95	27-May	18:30	3988.50	14.68	10.03	25.13	4.5	4.5	5.0	4.0	4.5	4.5	4.5	401.8	2832	450.3	88.4	490.2
96	27-May	22:15	4025.00	14.85	10.14	25.87	5.0	5.0	4.5	5.0	5.0	4.5	5.0	405.8	3425	442.8	83.5	489.1
100	29-May	05:50	3985.80	15.03	10.18	25.65	5.0	5.0	4.5	5.0	5.0	4.5	5.0	401.1	3400	450.1	87.8	488.9
102	29-May	18:45	3981.25	14.79	10.20	25.23	5.0	5.0	5.0	4.5	4.5	5.0	5.0	401.0	2455	447.3	86.2	487.2
103	30-May	04:45	2320.30	14.90	10.05	25.44	5.0	5.0	5.0	4.5	5.0			407.5	2524	454.5	85.4	492.9
104	30-May	09:15	4953.20	14.48	10.07	24.66	5.0	5.0	5.0	5.5	5.0	5.0	5.0	404.9	3130	451.7	85.1	490.0

within the document. You can also replace the information with new text or formatting.

- **Voice of customer** is properly captured through various forum.
- **NABL accredited lab-** for quality assurance.
- **Compliance Monitoring-** Compliance to customer requirements is continuously monitored.
- **Reporting System-** Rake wise report to the customer is communicated through IT based system. Deviation is additionally reported through mail and SMS and confirmation is taken.
- **Complaint Management System-** There is a dedicated IT based customer complaint handling system and resolution to the compliant has to be done within 48 Hours.

This compliance is monitored at top management level.

Thank You

Annexure - 10

Welcome to Eimco Elecon

EIMCO ELECON : AN OVERVIEW

- Our state of the art factory is located at Vallabh Vidyanagar, Anand, Gujarat. Established in 1974, we are now India's largest manufacturer and supplier of underground mining equipment having supplied over 6000 loaders and drills to our esteemed customers that include the subsidiaries of Coal India Limited, Singareni Collieries, UCIL, HZL, MOIL, Hindustan Copper Limited, Monnet Ispat, Hindalco etc.
- We were the first Indian manufacturer to introduce mechanical loaders for underground mining applications to substitute the arduous Manual Loading of the blasted material into tubs and conveyors.
- About two decades back, we were also the first Indian Manufacturer to introduce underground drilling machines for coal applications .

EIMCO ELECON

OUR PRODUCTS FOR UNDERGROUND COAL APPLICATIONS

DGMS APPROVED CRAWLER MOUNTED ELECTRIC SIDE DISCHARGE LOADERS - SDL	BUCKET CAPACITY : 0.75 TO 1.7 CU M MACHINE HEIGHT : 1.250 TO 2 M
DGMS APPROVED TYRE MOUNTED ELECTRIC LOAD HAUL DUMP – LHD DGMS APPROVED TRYE MOUNTED ELECTRIC COAL HAULER	BUCKET CAPACITY : 1.5 TO 3 CU M MACHINE HEIGHT : 1.50 T0 2.115 M HOPPER CAPACITY : 5 CU M MACHINE HEIGHT : 2.115 M
DGMS APPROVED CRAWLER MOUNTED ELECTRIC UNIVERSAL DRILL MACHINE – (UDM)	MACHINE HEIGHT : 1.5 TO 2 M

OUR POPULAR MODELS FOR UNDERGROUND COAL APPLICATION - LOADERS

MODEL	BUCKET CAPACITY Cu M	MACHINE HEIGHT – Approx.	MOTOR RATING
SDL 625 – STD HT	1.1	2 M	65 HP
SDL 611 EXTRA LOW HEIGHT	0.75	1.250 M	55 HP
SDL 611 LOW HEIGHT	1.1	1.5 M	65 HP
SDL 621 – LOW HT	1.6	1.5 M	75 HP
SDL 635 – STD HT	1.7	2 M	75 HP
LHD 811 – STD HT	1.5	2 M	50 HP
LHD 811 LOW HT	1.5	1.5 M	50 HP
LHD 912E	3	2.1 M	100 HP
COAL HAULER	5	2.1 M	100 HP

OUR POPULAR MODELS FOR UNDERGROUND COAL APPLICATION – UDM

MODEL	HOLE SIZE mm	MACHINE HEIGHT – Approx.	MOTOR RATING
CRAWLER MOUNTED UDM 611	25 to 64	2 M	65 HP
UDM 612	25 to 64	1.50 M	65 HP

Advantages of SDL models 635 and 621

- High tramming speed to reduce travelling time.
- Higher capacity cable reeling drum to cover larger distances.
- Increased productivity because of higher bucket capacity and higher tramming speed of the machine.
- Improved visibility for ease of maneuvering.
- More importantly they can work in the same gallery dimensions as the other models equipped with smaller buckets.
- Available option : Side tipping bucket of suitable capacity for rock applications too.

CONTINUOUS CUTTING TECHNOLOGY

- Intermediate technology has been the backbone of underground coal production for over three decades.
- Restrictions on the use of explosives in underground mines , both in terms of quantity per hole and their strength have limited the scope of producing more coal per blast resulting in poor utilization of the underground loaders namely the LHDs and the SDLs.
- This encouraged the Indian coal mining industry to introduce continuous cutting technology in various underground mines with good success.

CONTINUOUS CUTTING TECHNOLOGY

- Eimco Elecon is the first Indian company to conceptualize, design and manufacture Continuous Miner and its peripheral equipment , namely, Shuttle car and Twin Roof Bolter. The package is ready for immediate deployment in any suitable mine.
- The flameproof design of these machines are certified by the DGMS.
- All the components are sourced from Internationally acclaimed and proven manufacturers.

Continuous Miner CM 3000

EIMCO ELECON

Key Benefits

Chassis

- ✓ Constructed of high strength steel plates (HSS)
- ✓ Offering maximum rigidity and stability
- ✓ Manufactured in a single structure

Tram Drive

- ✓ Developed in a modular and compact construction format
- ✓ Designed for heavy duty
- ✓ Offers an enormous underground maintenance facility

Cutter Head

- ✓ Cutter head is made using two independent and similar gearboxes
- ✓ Torque and power transmission is extremely compact and robust
- ✓ Guaranteeing all transmission elements double support, enormously increasing the service life and reducing maintenance cost

Conveyor

- ✓ Material transport system consists of two sets that work independently
- ✓ The first set installed in gathering head that collects material slashed by cutter head and directs to a trailing chain
- ✓ The second set hauls the material by pulling, which is installed in the tail end of machine
- ✓ This tail is allowed to swivel 45 degrees in both sides and elevate for smooth unloading

EIMCO ELECON

Technical Specification

Operating Dimensions	
Height Range	1600 - 3010 mm
Minimum Height	1600 mm
Maximum Reach	3010 mm
Ground Clearance	230 mm

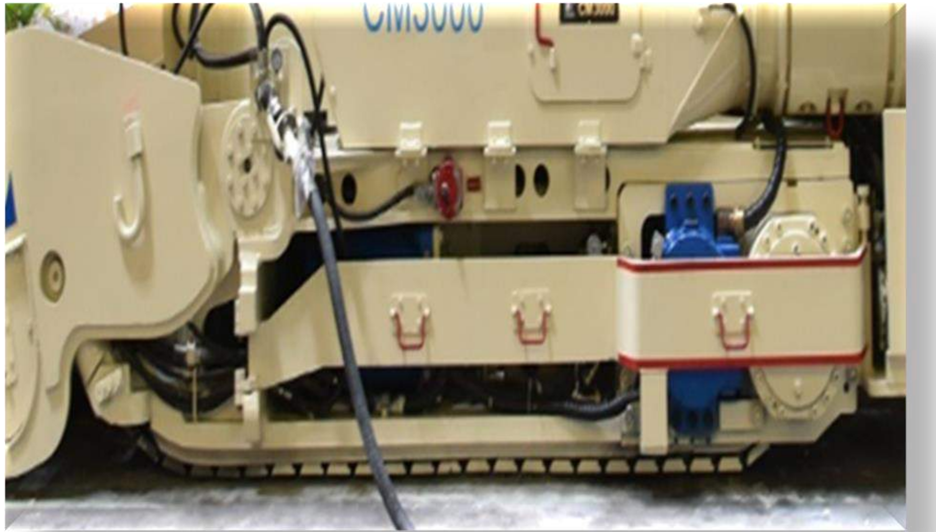
Transport Dimensions	
Chassis Frame Width	2900 mm
Overall Length	10800 mm
Height	1600 mm
Weight (Total)	60 tonnes (Approx.)

EIMCO ELECON

Technical Specification

Cutting Unit	
Cutting Drum Diameter	1045 mm (41")
Cutting Drum Width	3000-3200 mm
Cutting Drum Power	2 × 110 kW

Traction Unit	
Crawler Chain Width	505 mm (20")
Crawler Assembly Length	2700 mm
Ground Pressure	200 kPa
Crawler Speed	0 - 17 m/min
Traction Power	2 × 37.5 kW (DC 250V)



CM 3000 Continuous Miner Specifications

Operating Dimensions	
Mining Height Range	1600 - 3010 mm
Minimum Height	1600 mm
Maximum Reach	3010 mm
Ground Clearance	230 mm
Transport Dimensions	
Chassis Frame Width	2900 mm
Overall Length	10800 mm
Height	1600 mm
Weight (Total)	60 tonnes (Approx.)

Cutting Unit	
Cutting Drum Diameter	1045 mm (41")
Cutting Drum Width	3000-3200 mm
Cutting Drum Power	2 × 110 kW

Traction Unit	
Crawler Chain Width	505 mm (20")
Crawler Assembly Length	2700 mm
Ground Pressure	200 kPa
Crawler Speed	0 - 17 m/min
Traction Power	2 × 37.5 kW (DC 250V)

Pump Unit	
Pump Power	1 x 45 kW

Dust Suppression	
Scrubber Assembly	Side Mounted
Scrubber Type	Wet Bed
Scrubber Capacity	7 m³ /sec
Fan Power	20 kW

Electrical System	
Machine Voltage	1100 VAC 50 Hz
Control System	Radio Remote Control
Total Installed Power	485 kW
Loading Unit	
Loading Method	3 Finger CLA
CLA Power	2 × 40 kW
Conveyor Width	600 mm
Conveyor Depth	318 mm
Loading Capacity	8 - 10 tonnes/min
Conveyor Power	2 × 22.5 kW

Ease of Service

- We have provided centralized grease system.
- Ease of access to cutter head gear oil checks and replacement.
- We have designed cutter head assembly in such a way that the cutter head motor mounting location is easy to access for maintenance.
- Crawler shoes are fabricated from forged steel. They are high wear and corrosion resistance for longer life.
- The gear case has three independent oil compartments, allowing convenient viewing of oil levels through site gauges.

EIMCO ELECON

ROOF BOLTER RB2C WITH TRS

- Walk-thru Chassis reduces miner exposure to rib hazards.
- Operates in seam standard heights of 2meter.
- Dual heads install a full row of bolts from a single chassis position.
- Standard 90° mast tilt allows angle and rib drilling.

EIMCO ELECON

TRS (Temporary Roof Support)

- The Temporary Roof Support provides safety to the operator. It is constructed in a very Strong frame in “T” style and hydraulically operated through a 3 stages cylinder with a load control valve.

- Main characteristics:
  - Height reached – 4.5 m

EIMCO ELECON

RB2C Roof Bolter Specifications

Operating parameters	
Number of bolters	2 nos.
Operating mining height Min- Max, Std. Height	2.0 m - 4.5 m
Operating mining height Min- Max, Low Height	1.5 m - 3.5 m
Drilling length -Maximum	2.1 m
Drill hole size Min.-Max.	19 mm-29 mm
Tram speed	1.25 - 2.5 kmph
Weight	26000 Kgs
Ground Pressure	129 Kpa
Tire/ Track chain	Track Chain
Min. Platform elevation from ground	550 mm
Drilling nature (Dry/Wet)	Wet
Power	2x50 Hp
Operating voltage	525 Volts
Bolting rate	14-19 bolts/hr
Max. material hardness that can be drilled	50 Mpa

Dimensions	
Overall length, TRS Close position	8400 mm
Width	3100 mm
Height (chassis) from ground	1500 mm
Wheel base	2400 mm
Ground clearance	200 mm

Drilling System	
Torque	450 Nm
Rotation	0-700 rpm
Thrust	3000 Kpa
Feed length	700 mm-2000 mm
Feed rate	2 – 4 m/min
Mast height range	1250 mm-2500 mm
Mast tilt	90 Degree

EIMCO ELECON

SHUTTLE CAR SC10

EIMCO ELECON

SC10 Shuttle Car Specification

Parameters	
Track width	2772 mm
Wheel base	2775 mm
Steering angle	$\pm 22.5^{o}$, $\pm 17^{o}$
Rated Load Capacity	10 tonne
Machine Weight	22 tonne
Max. tramming speed	6 km/hr
Tyre	12x24-20 Ply
Overall Length	9160 mm
Overall Width	3620 mm
Maximum Height	1910 mm
Conveyor Width	1425 mm

Parameters	
Loading height	1230 mm
Minimum canopy height	1600 mm
Maximum canopy height	1910 mm
Inside turning radius	3000 mm
Outside turning radius	7500 mm
Cable reel capacity	175 m
Ground clearance	243 mm
Power Supply	550 V AC
Pump Power	1 x 18.5 kW
Conveyor Power	1 x 22 kW
DC Traction Power	2 x 28 kW

Conclusions:

Eimco Elecon is pioneer in the field of underground mine mechanization. We have a strong after sales team located at our branch offices closet to the customers, namely in Asansol, Dhanbad, Bilaspur, Nagpur, Ramagundam and also at various mine sites. Over the years we have successfully introduced several models of loaders and drills that benefited the Indian Mining Industry. We are sure that our newly introduced CM package shall meet the customer requirements and satisfaction.

For further clarifications on our products , please feel free to write to us on the following ID:

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Hitendra Shukla : 990 991 7833 (e mail: hbshukla@eimcoelecon.in)

THANK YOU.