LONGAWALL MINING METHOD

www.MINEPORTAL.in

Online Test Series for

DGMS COAL/METAL First/Second Class

GATE MINING

Management Trainee PSUs Exams

Call/Whatsapp- 8804777500

Basics of Longwall Mining

Presentation Profile

- Introduction
- Longwall Mining in India
- Longwall Method
- Longwall Equipment
- Longwall Strata Control
- Longwall Organisation
- Longwall Face Transfer
- Variants of Longwall – New concepts
- Longwall Performance in India

Coal Mining in India

- India is the 3rd largest producer of coal in the world.
- Coal India limited (CIL) and Singareni Collieries Company limited (SCCL) are two major public sector coal companies in India.
- Total coal production in India for the year 2009-10 is 531.67 MT.Total annual coal production from CIL for the year 2009-10 was 431.27 Mt and from SCCL, it was 50.422 Mt.
- CIL produces 81.12% of total Indian coal production and contribution of SCCL is 9.48%. Other public sectors and private sector contributes 8.97 %
- Around 89% of the out put from CIL comes from opencast mines. Where as in SCCL it was 73%.

Mining Methods..

- UNDER GROUND MINING
  - Bord & Pillar (conventional hand section)
  - Bord & Pillar (Semi-mechanized)
  - Blasting Gallery method for thick seams
  - Long wall Mining
  - Continuous Miner
- OPEN CAST MINING
  - Shovel and Dumper Combination
  - Draglines
  - In-pit Crusher-Conveyor systems
  - Surface Miner

Existing U/G Technologies

SDL mechanization	– where the gradient is 1 in 4 & flatter.
LHD mechanization	– where the gradient is 1 in 5 & flatter.
Longwall	– where the property is generally devoid of faults.
Blasting Gallery	– For thick seams and flatter than 1 in 5

Longwall in India

Longwall in India

- First mechanized powered support longwall caving face was introduced in August 1978 at Moonidih, CIL.
- First Longwall face introduced in GDK.7 Incline in September 1983 in SCCL.
- There is no much improvement taken place in India in respect of Longwall technology due to various reasons.

Longwall in India

Reasons for less concentration on Longwalls in India

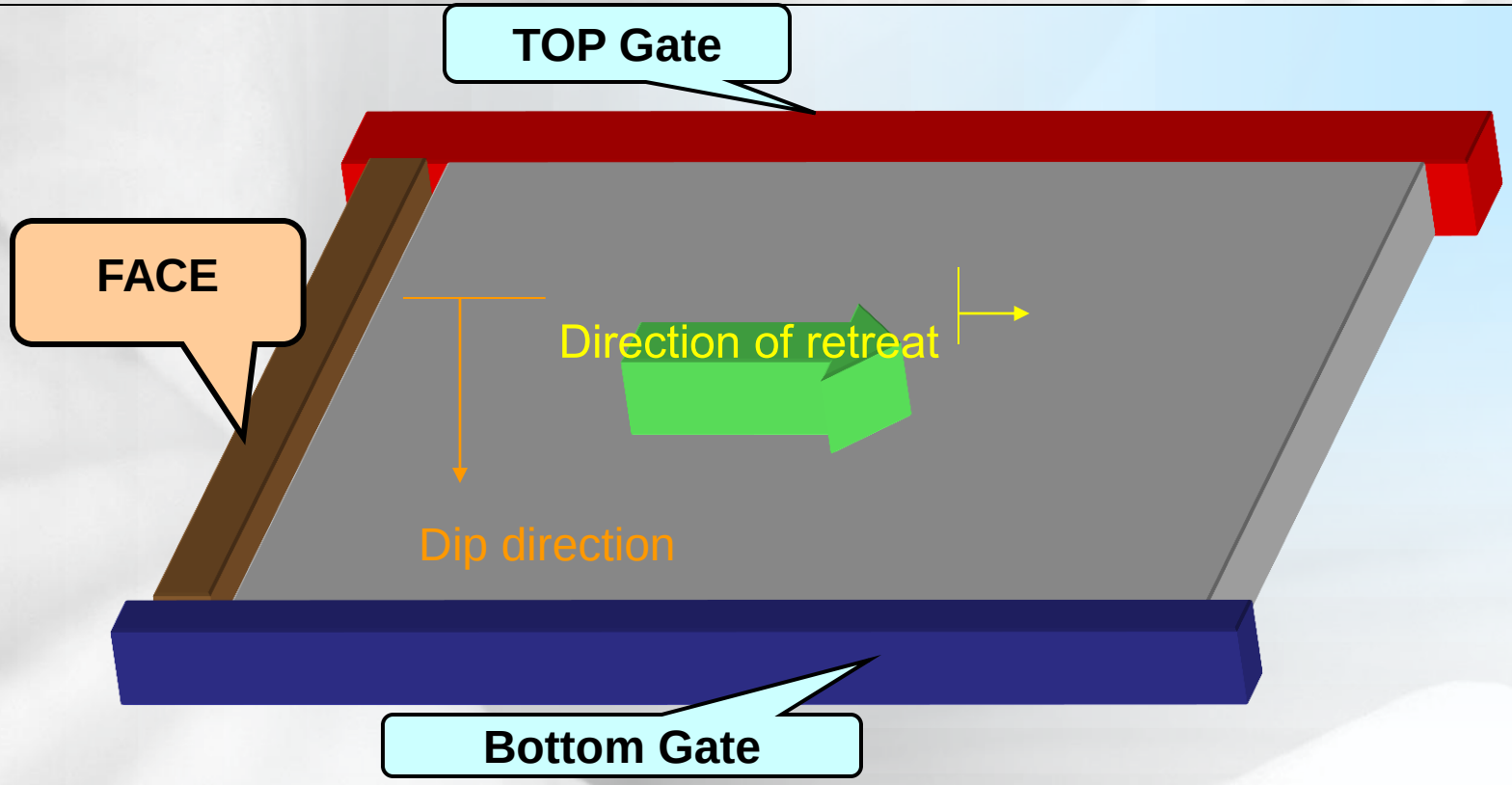
- Serious efforts not made perhaps due to availability of alternate technologies.
- Upgrading not made when most of the world improved in 90s.
- Spares management was poor.
- Coal India do not need due to opencast and flat gradients.
- Use of indigenous spares of low quality is increased, which deteriorated the condition of faces.

Longwall Geometry - World

Time	Width (m)	Length (m)
1970's	150	1200
1980's	225	1800
Today	330	3000

LONGWALL - METHOD

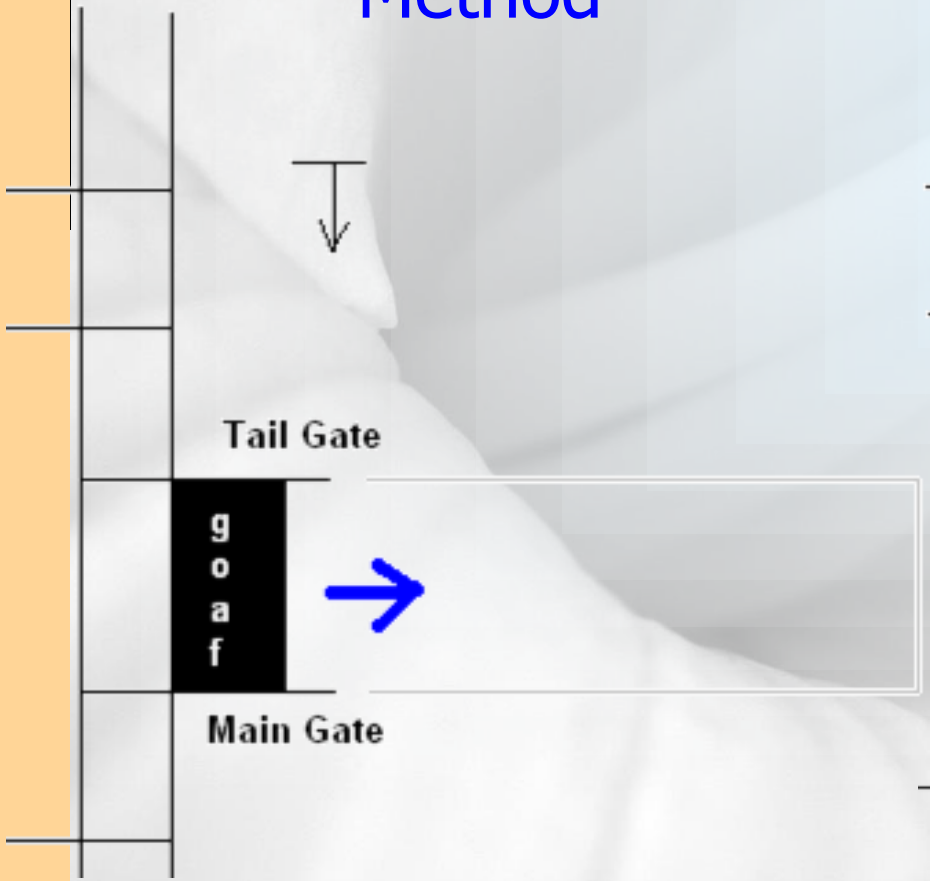
LONGWALL GENERAL LAYOUT



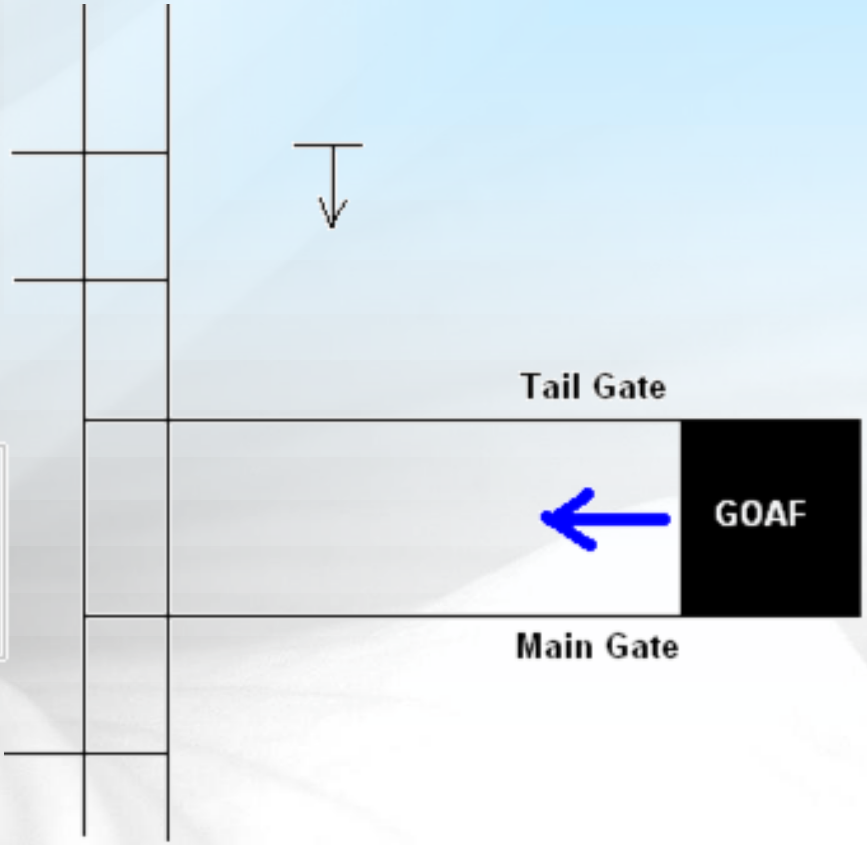
- Longwall mining method includes drivage of two long roadways in coal and joining them at the end by a perpendicular drivage forming a face.

Different Longwall Methods

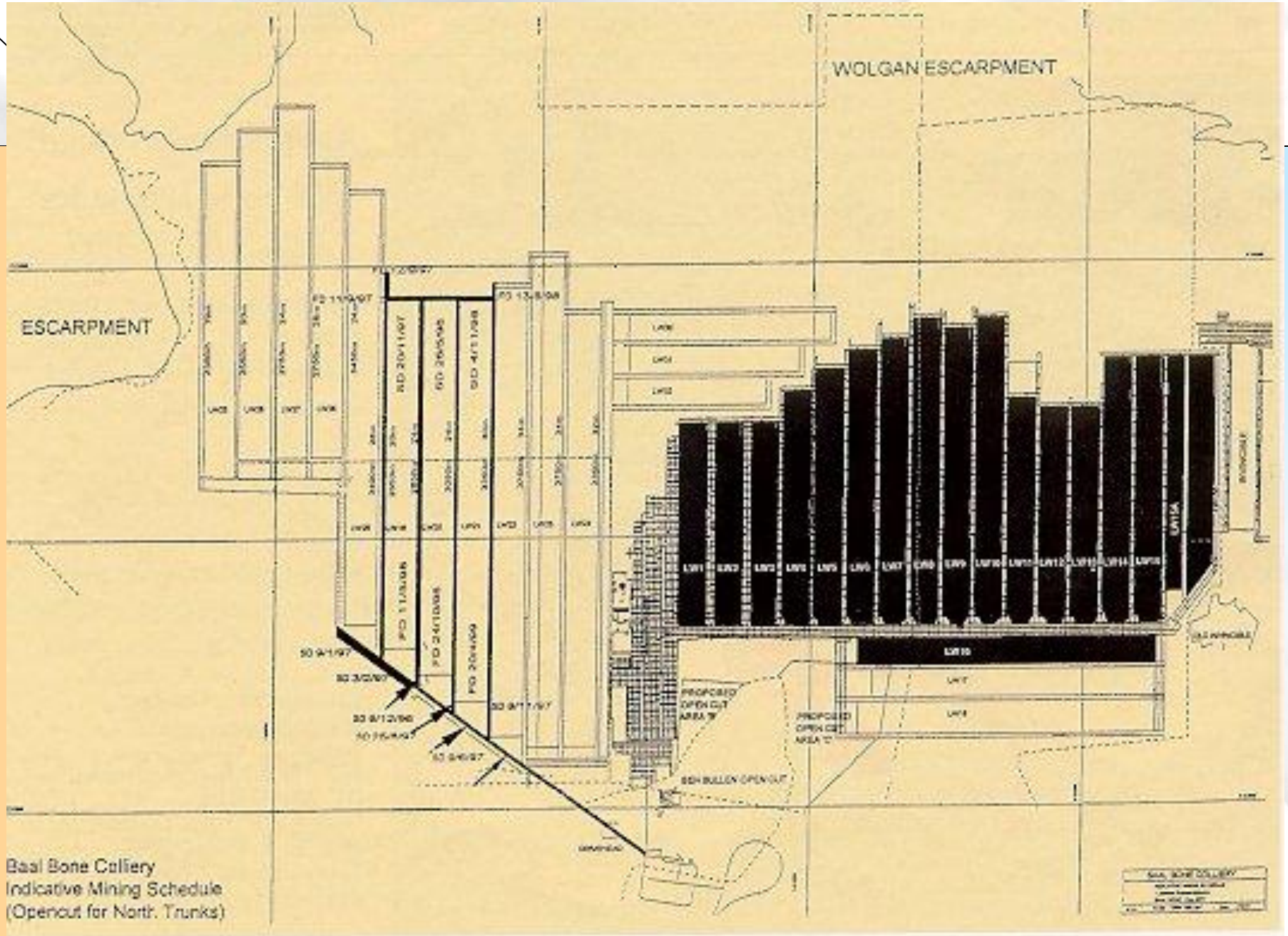
1. Longwall Advancing Method

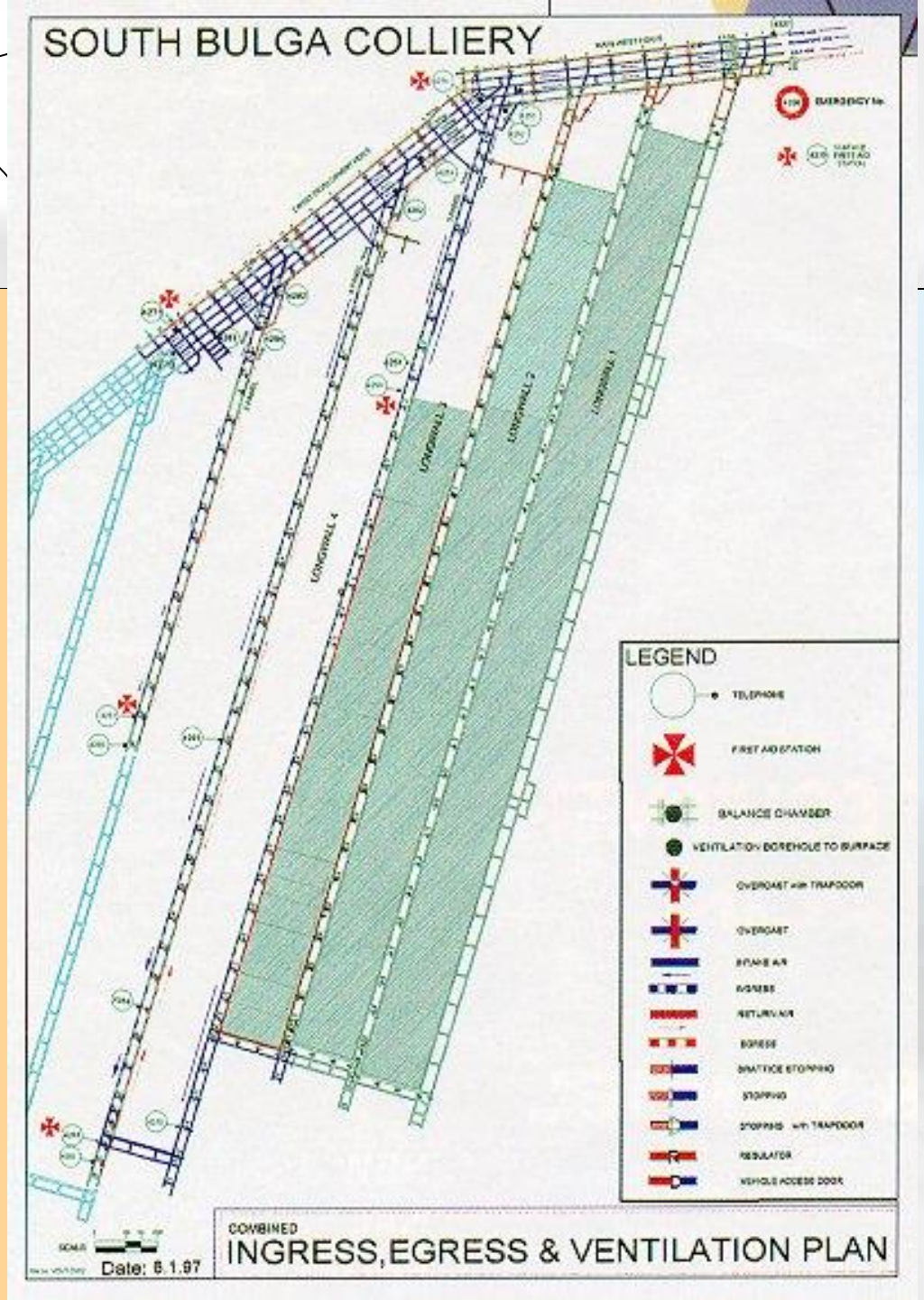


2. Longwall Retreating Method



Modern Longwall Plans in Australia





Modern Longwall Plans in Australia

Advantages of Longwall Method

- High Recovery.
- Lower Operating Costs.
- Easier to Supervise.
- Easier to Train Miners.
- Works Under Weak Roof.
- Clean Coarse Product.
- Simple Ventilation.

Disadvantages of Longwall Method

- Small Problems = Big Production Losses.
- Dust Control Difficult.
- Overloading Conveyor System.

Retreat Longwall Mining

Advantages Over Advance Longwall Mining

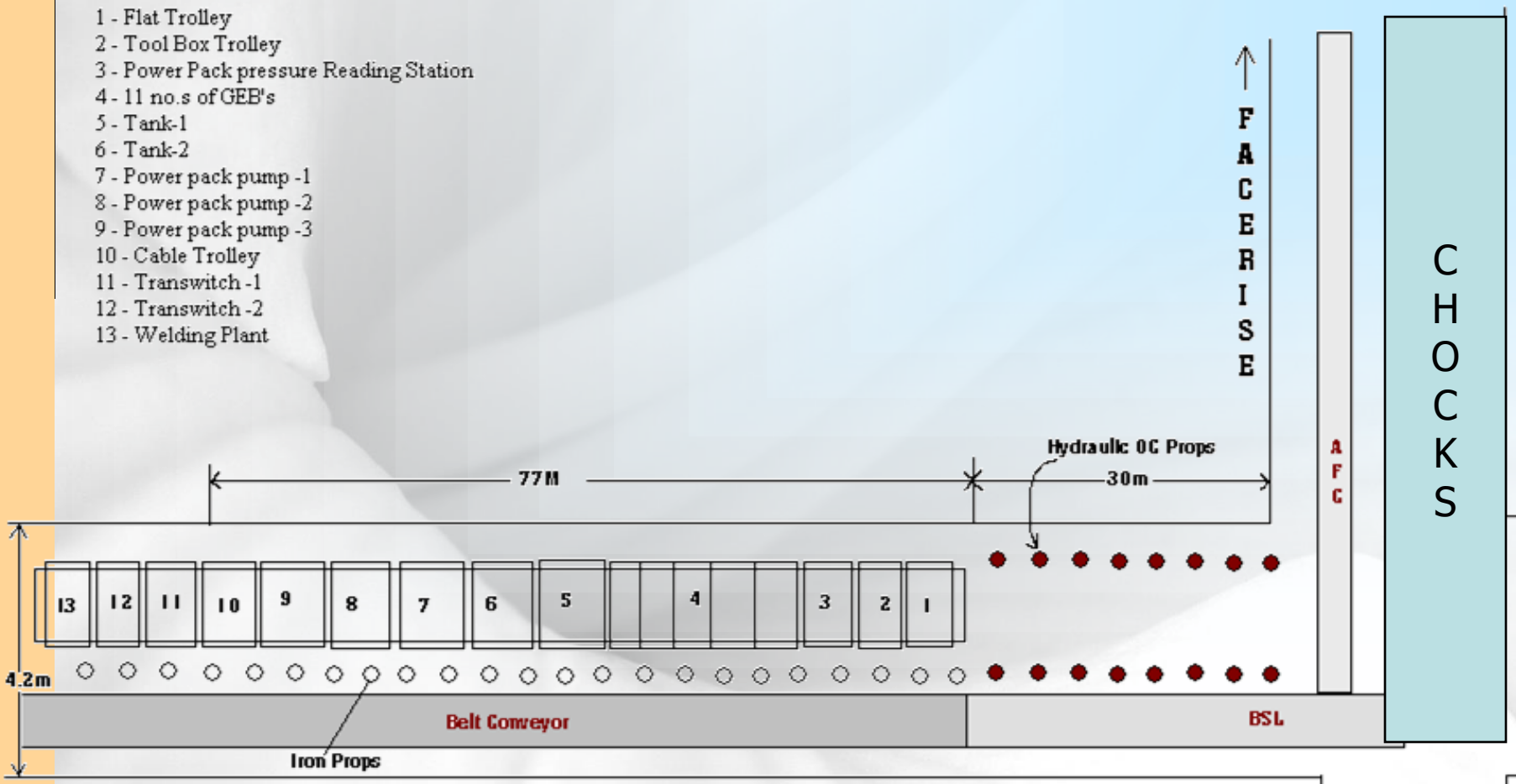
- Reserves are "Proven" on Development
- Gateroads in the "Solid"
- Gateroad Development is Separate
- Water Easier to Control
- Recovering Equipment Easier
- Easier Ventilation

Retreat Longwall Mining

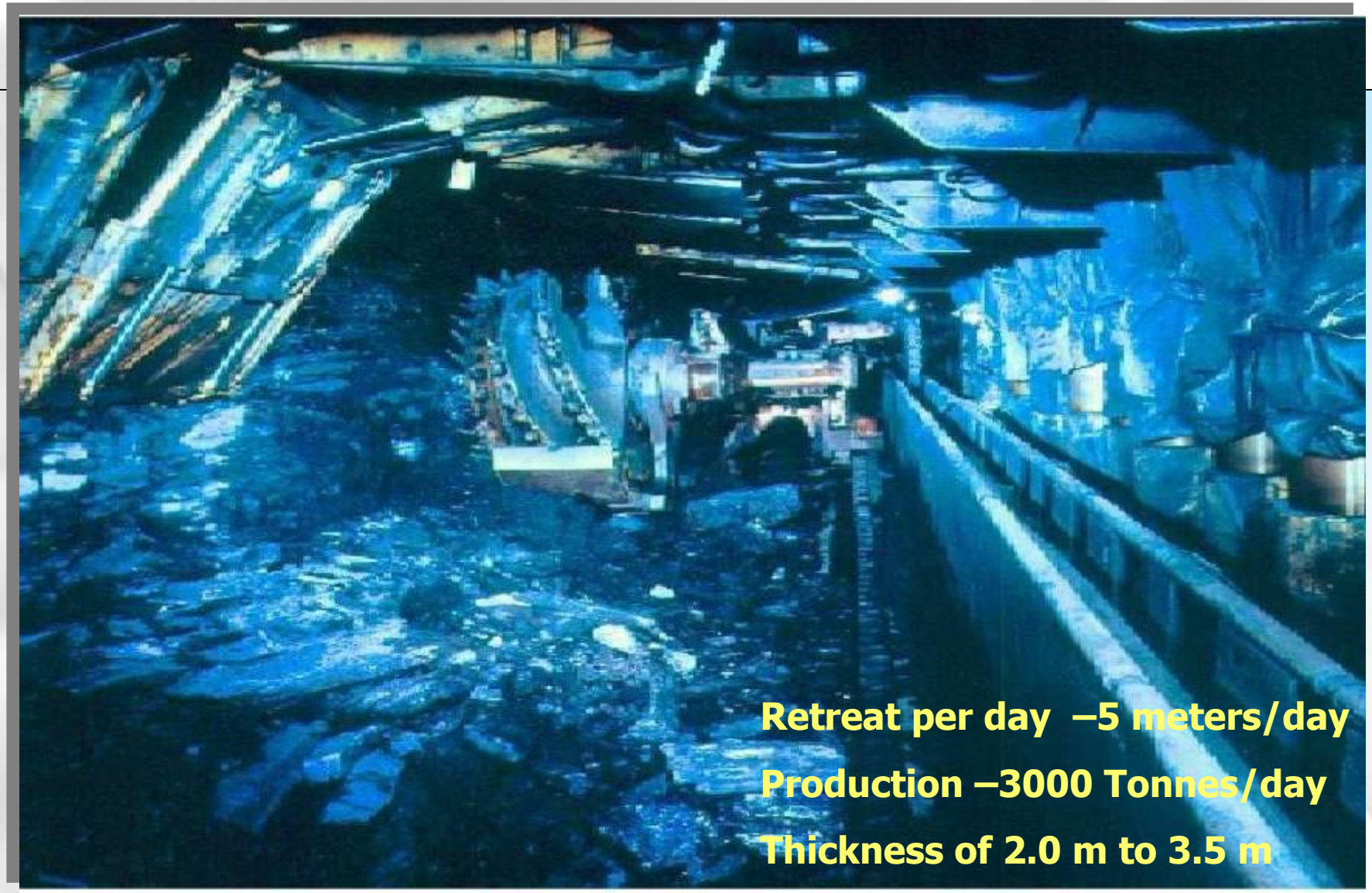
Disadvantages Over Advance Longwall Mining

- Delay in getting production for the preparation of first panel.

MAIN GATE WITH SWITCH TRAIN



LONGWALL METHOD



POWERED ROOF SUPPORT AT LONGWALL FACE

Cutting Sequences

- Uni-directional
  - The Shearer cuts the top section of the face traveling to the Main gate
  - The shield support is advanced behind the Shearer leading drum
  - The Shearer cuts the floor section of the face traveling to the Tailgate
  - The AFC is advanced behind the machine into the new track

Cutting Sequences

- Bi-directional
  - The Shearer cuts the full section of the face traveling in both directions
  - The shield support is advanced behind the Shearer leading drum
  - The AFC is advanced immediately behind the machine in both directions i.e. 10 pans behind the trailing drum

Cutting Sequences

Bi-directional

- TG to C 22, chocks & AFC both are advanced
- C-22 to MG only chocks are advanced when Shearer is moving to MG
- Shearer is brought back to C-22, one sump is made at MG
- AFC is advanced and straightened, second cut starts from MG to TG

PARAMETERS TO BE OBSERVED FOR SUCCESSFUL OPERATION OF LONGWALL FACE

- Horizon control
- Creep control
- Face alignment and Strata control
- Support maintenance

HORIZON CONTROL

- Horizon control is the maintenance of uniform surface at floor and roof on both planes while extracting the seam from a required section with the minimum contamination of coal from extraneous dirt

- Key features are of Horizon control are

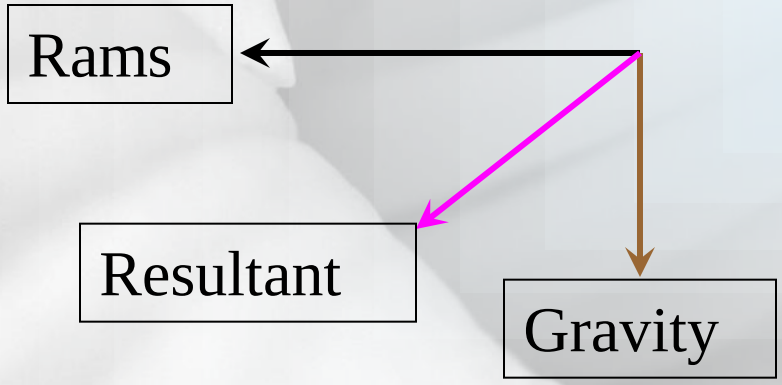
  - Maintenance of roof along the face line, line of advance, level, and uniform natural parting between seams
  - Symmetry at level and to be provided at floor
  - Steps in roof and floor is to be avoided.

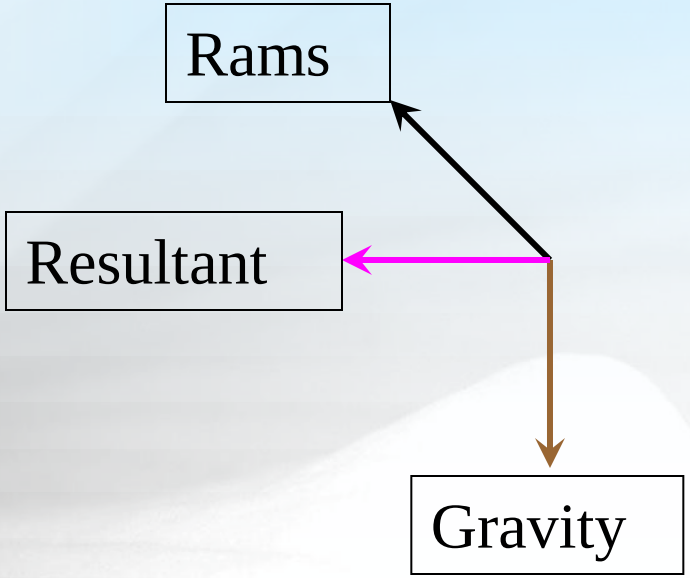
EFFECT OF HORIZON CONTROL ON PERFORMANCE OF FACE

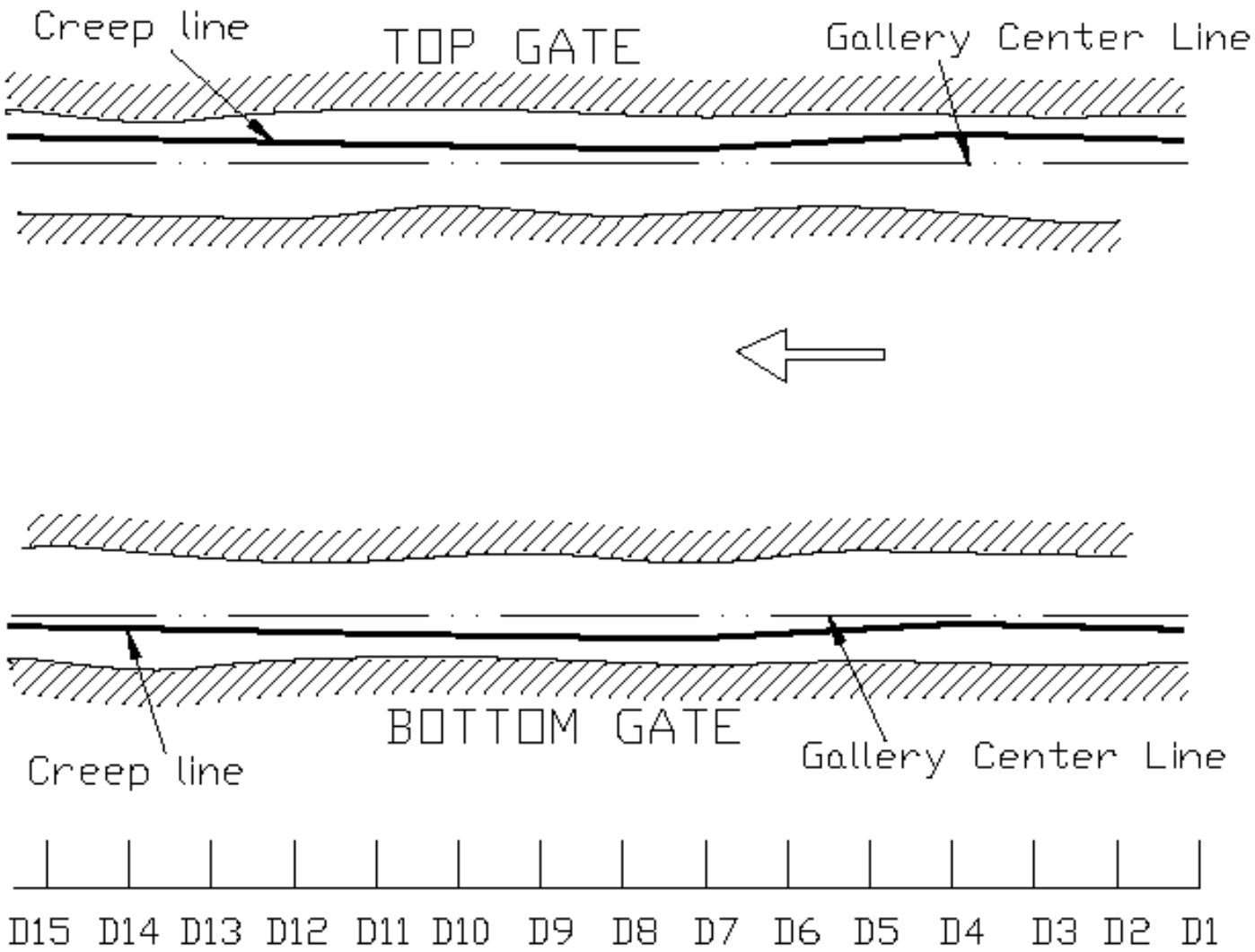
- If roof is weak the action of cutting will create rough surfaces and lead to spalling and displacement of immediate rock
- If roof is strong weak the action of cutting will rapidly worn and damage the cutting tools
- Effective roof control by the power roof supports will be reduced

Creep

- Relative movement of the face equipment (AFC,CHOCKS) with respect to the gate roads central lines is called CREEP







Graph showing the daily creep position and gap with barrier

FACTORS INFLUENCING CREEP

- GRADIENT
- ANGLE OF SUPPORT PUSHING AFC
- MOVEMENT OF SHEARER/ CUTTING SEQUENCE
- DIRECTION OF AFC ADVANCE

CREEP CONTROL MEASURES

- INCREASE / DECREASE STAGGERING
- PROPER AFC ADVANCE PATTERN
- PROPER SUPPORTS ADVANCE PATTERN
- USING SIDE SHIELDS
- CHANGING THE CUTTING SEQUENCE

EFFECTS OF CREEP

- AFC drive heads touching the barrier
- TG/MG junction bad roof
- Bottom cutting not up to face end
- BSL angle increases/ BSL discharge stool may derail

FACE ALIGNMENT

- AFC and power supports are to be kept straight as possible
- Snaking of AFC will lead to tension of Chain conveyors, damage the shearer guides and shoes.
- Bend face will lead to deterioration of roof control, poor working condition at face.

FACE ALIGNMENT

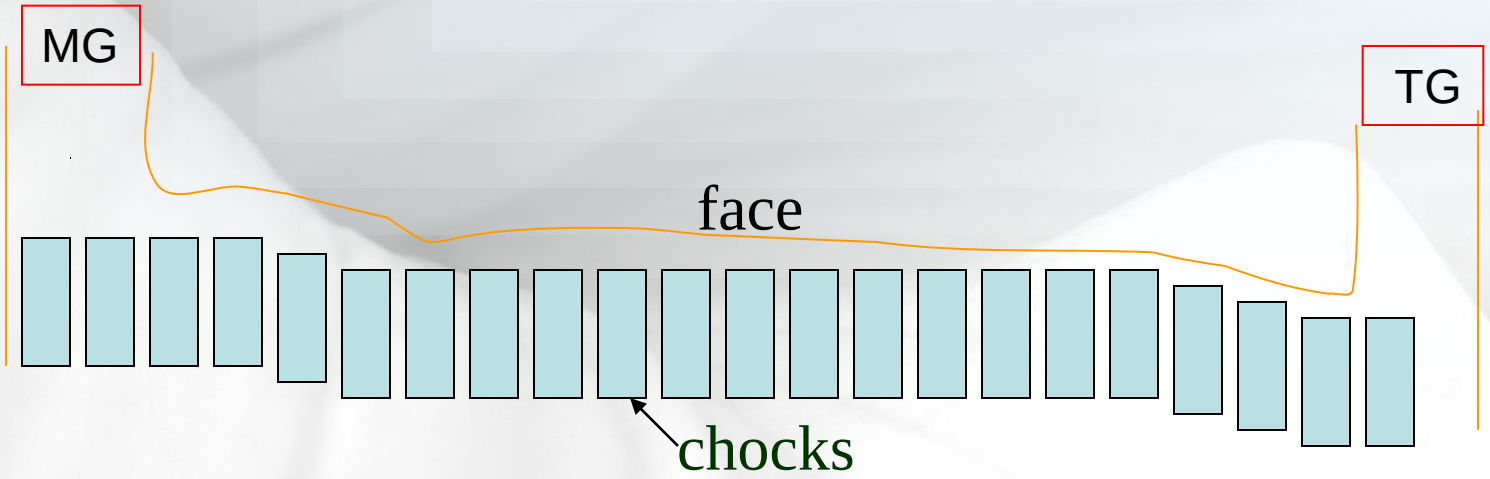
Causes of improper face alignment

- **AFC not advancing fully**
  - Due to conveyor advance ram/module by pass
  - Due to improper bottom cutting

- **Supports not advancing fully**
  - Due to conveyor advance ram/module by pass
  - Due to improper bottom cutting
  - Due to heavy malma/ materiel between AFC & supports

fuelling growth…

PLAN & SECTION OF LW FACE FOR KNOWING FACE STRAIGHTNESS



SUPPORT HEALTH MONITORING

Hydraulic support health monitoring is being done as per a plan which includes activities, and their periodicity.

- **The Activities included are:**
  - Static tests with pressure gauges to know the faulty Hydraulic circuits in the chocks.
  - Yield valve testing.
  - Chock in line filter checking
  - Control modules and valves inspection
  - Oil and water emulsion ratio monitoring
  - Rate of flow of fluid from power pack
  - Total pressure drop and flow drop from the gate road, having power pack to other gate road
  - Leakages in hydraulic system

LONGWALL - EQUIPMENT

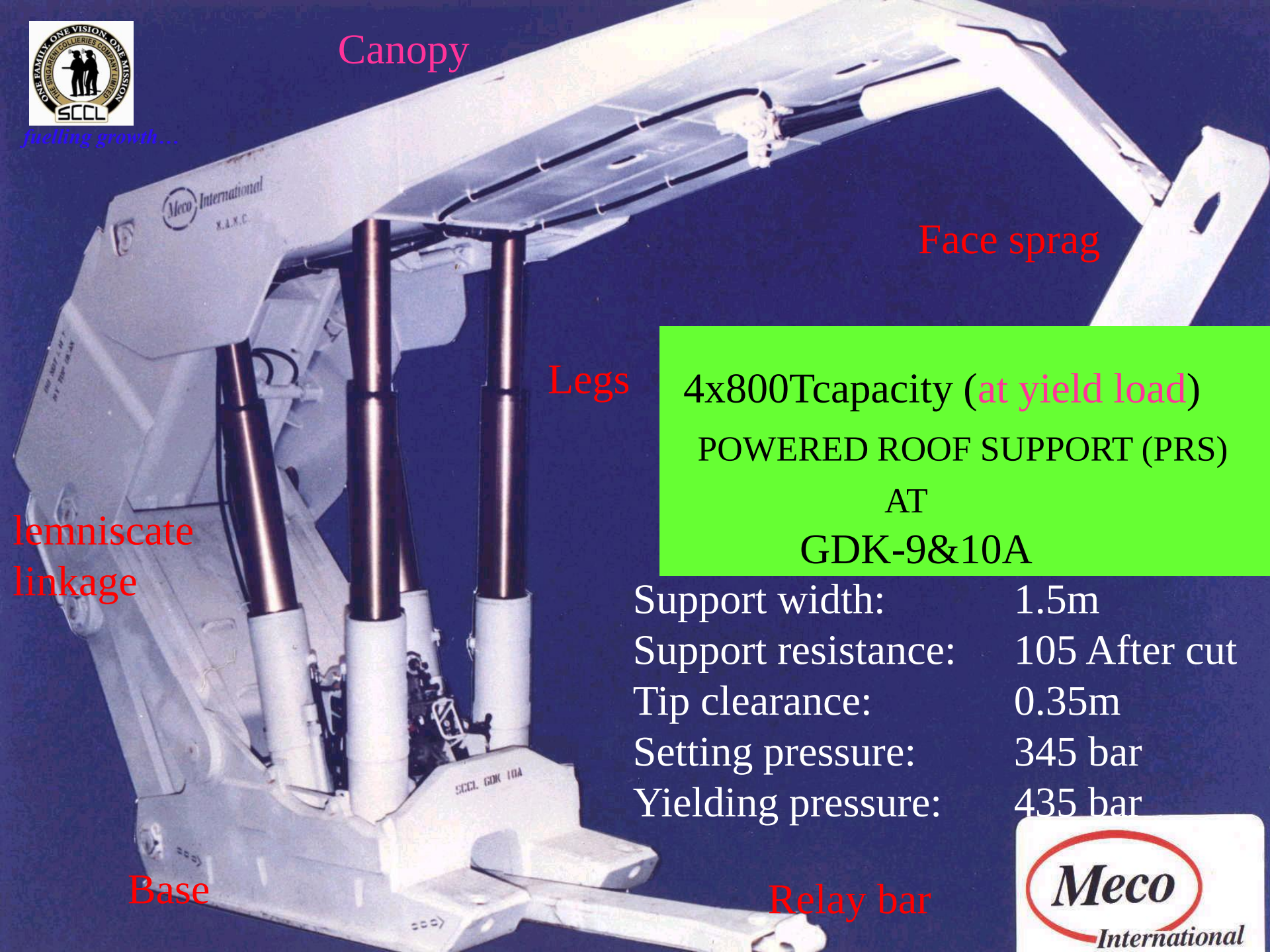
Equipment for Longwall Mining

- Powered Face Supports
- Shearer
- Armored Face Conveyor
- Conveyor System
- Electricals & Communication

PURPOSE OF POWERED SUPPORTS

- To resist vertical loading
- To resist lateral movement
- To provide protection from waste flushing
- To advance the AFC/snaking
- To be self advancing
- To provide a safe working are for the operations
- To provide a safe travelling path along the face line
- To provide for adequate ventilation through the face area

fuelling growth…



4x800Tcapacity (at yield load)

POWERED ROOF SUPPORT (PRS)

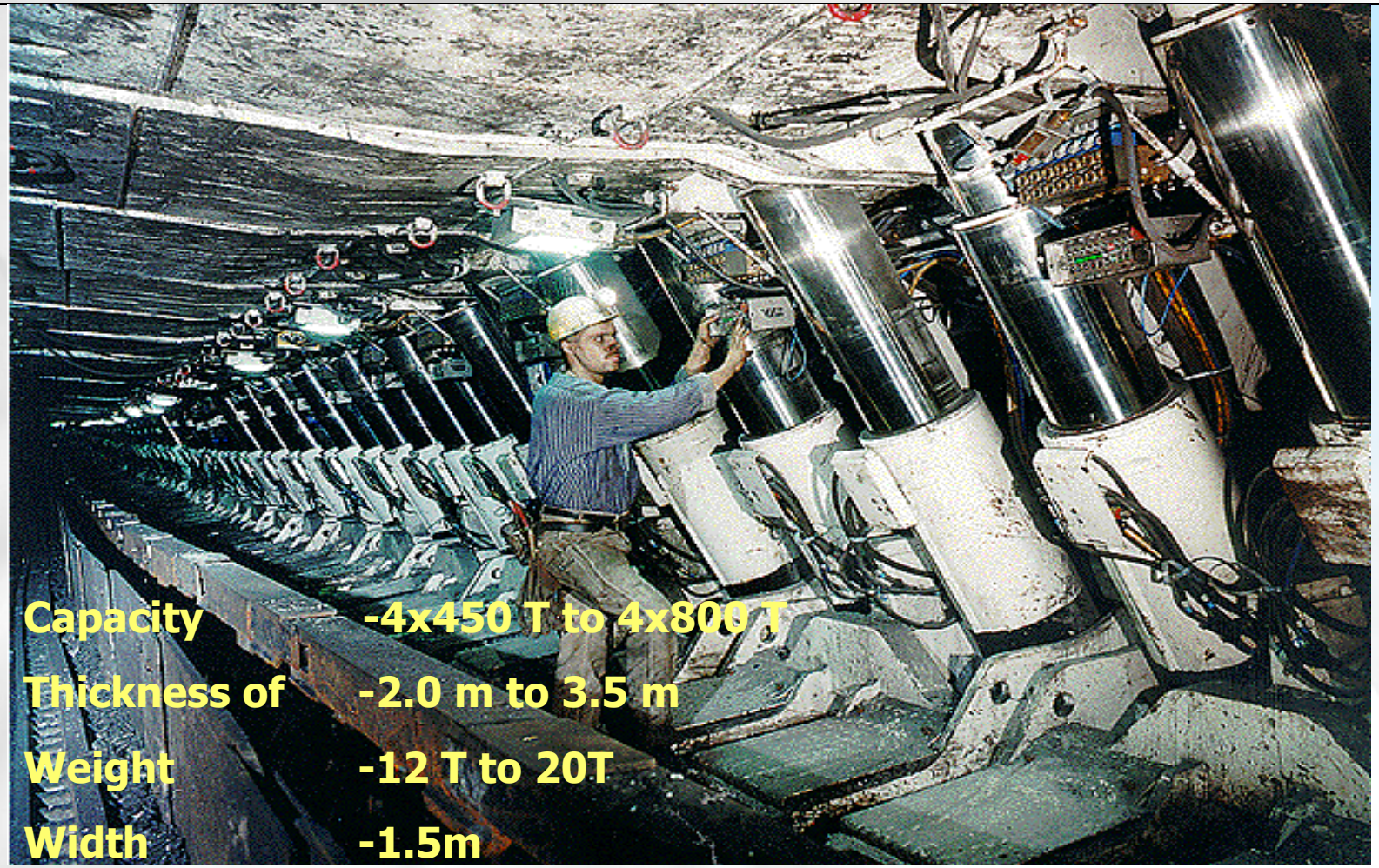
AT

GDK-9&10A

Support width:	1.5m
Support resistance:	105 After cut
Tip clearance:	0.35m
Setting pressure:	345 bar
Yielding pressure:	435 bar

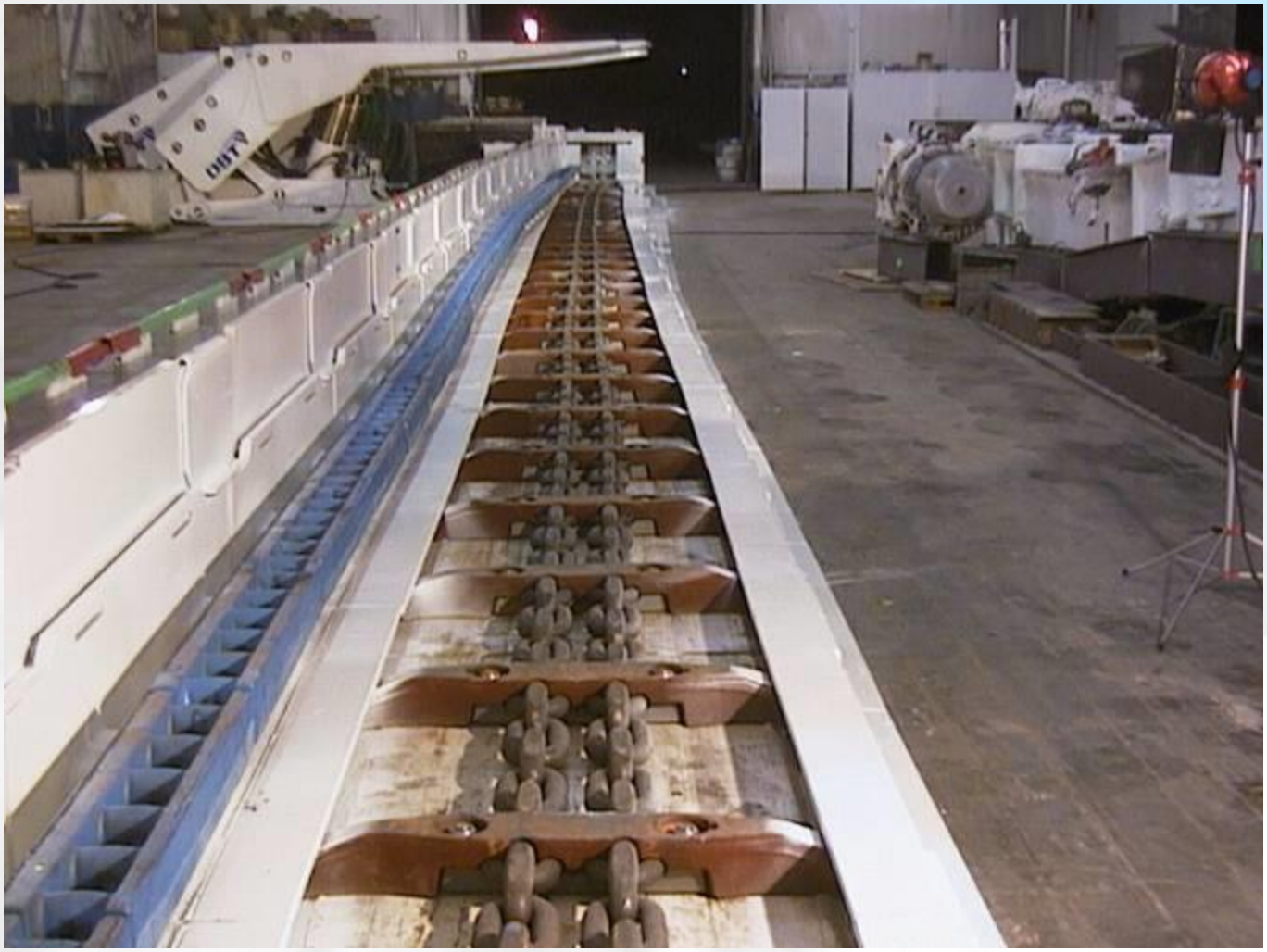
Powered Roof Supports (Two legged)

PRS AT LONGWALL FACE



Capacity	-4x450 T to 4x800 T
Thickness of	-2.0 m to 3.5 m
Weight	-12 T to 20T
Width	-1.5m

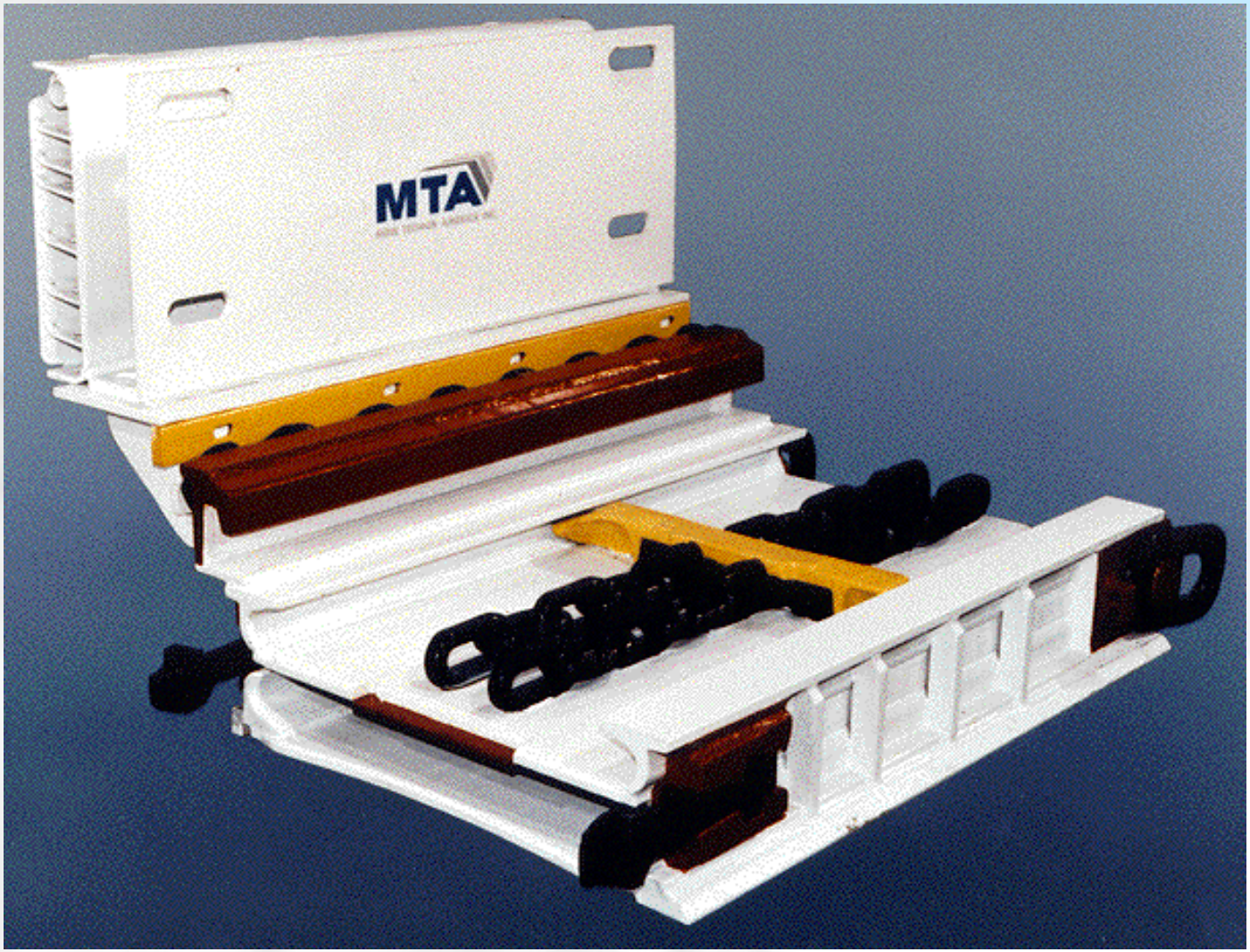
Armored Face Conveyor



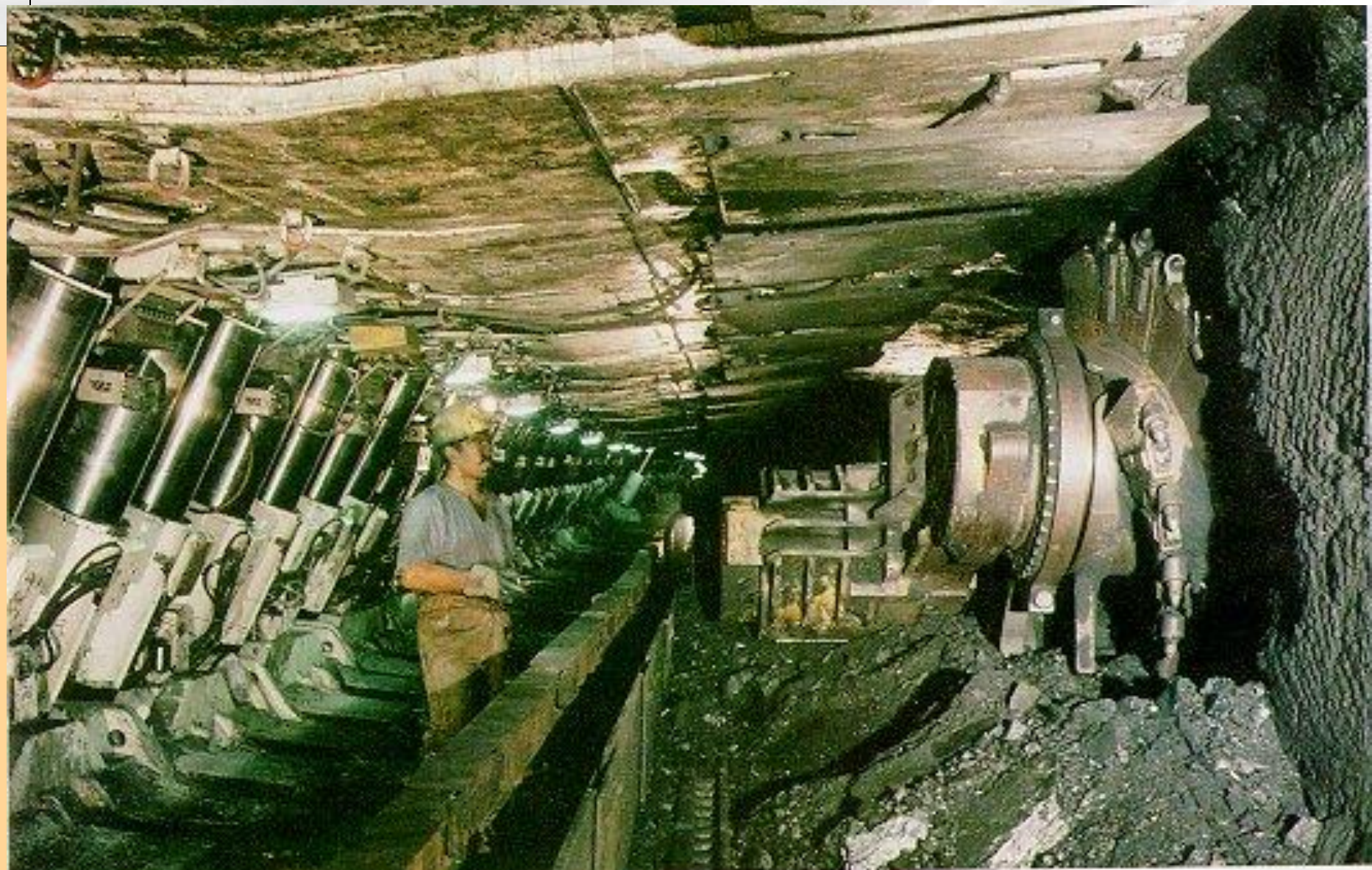
FUNCTIONS OF THE AFC

- To transport coal from face to outbye transport system
- To provide a track for mounting the Shearer
- Connection for attachment of the roof supports
- To provide easy advance of Power roof supports

Armoured Face Conveyor
(1 pan set)



Shearer working at Longwall Face



SHEARER WORKING AT LONGWALL FACE

fuelling growth…

SHEARER

- Shearer is preferred normally for seams more than 2.0m with single or double ranging arm.
- For cutting the coal and loading the coal onto the AFC

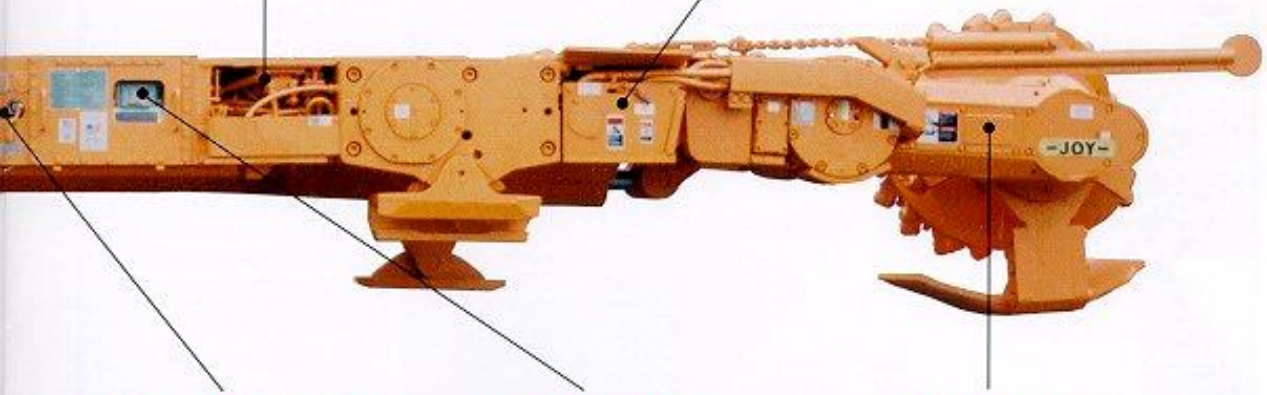
Shearer - Front Half

DUAL HAULAGE MOTORS

- State-of-the-art electronics furnish infinitely variable speeds for cutting and flitting that can increase the tons per shift
- Motor overloads are prevented by the use of torque-limiting electrical circuit protection

HYDRAULICS

- Hydraulic tank power fill system eliminates the need for a manual hand fill pump
- Various dust suppression systems are available as an option
- Available as an option, an automatic cowl oiler that flushes and lubricates the cowl bushing
- Two independent hydraulic systems control functions for each end of the machine



ELECTRICAL SYSTEM

- Microprocessor controlled haulage system
- Vacuum contactors on all AC motors enhances system life
- Single station radio remote allows one station to operate both ends of machine concurrently
- Machine parameters are easily adjusted to maximize performance
- Cutter motor feed back control feature allows for optimum cutting rate in any application

DIAGNOSTICS

- Machine diagnostics monitor haulage speed, motor temperature and motor currents
- Error messages are displayed for easy troubleshooting
- Data logging capabilities are a standard feature
- In-circuit fault indicator lights to assist in machine troubleshooting
- Headgate diagnostics are available as an optional feature

RANGING ARM

- Various cutter motor ratings are available to adapt to mining conditions
- Provisions for ventilated drums are available
- Increased drum mounting taper eases drum removal
- Square drum mountings
- Torque shaft protection is standard equipment
- Reliable enclosed cowl turning system
- Large diameter thick wall hydraulic cylinders maintain arm positions

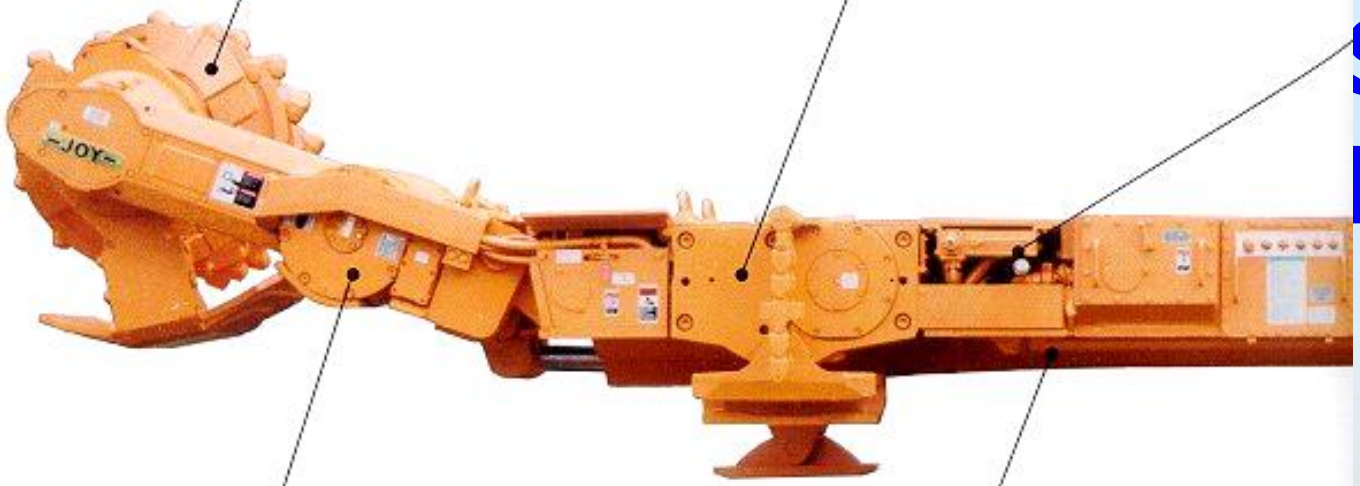
Shearer - Rear Half

CUTTING SYSTEM

- Ranging arms and cowls are designed to facilitate loading coal onto the conveyor
- Variety of cutter diameters and widths are offered for a wide range of seam heights
- Variety of heavy duty bit blocks are available to meet customer needs
- Various bit lacing patterns are available

FINAL HAULAGE DRIVE

- Final drives are designed to fit the modern face conveyor haulage systems
- Torque shaft protection is standard equipment
- Pin-on trapping shoes simplify replacement
- Numerous haulage sprocket assemblies provide for a wide range of machine heights



MULTI-MOTOR CONCEPT

- JOY multi-motor concept with outboard access to motors, gearcases, controllers and other major components is designed for simplicity and ease of accessibility
- Each major component is isolated for easier troubleshooting and maintenance

MAIN FRAME

- Three piece modular construction provides the ability to change machine design to accommodate different conveyor systems and particular mining conditions
- Choice of machine thickness provides a balance between tunnel clearance and the capacity for optional features in the pump and haulage compartments

Shearer Drum

Cutter Bits with Spray

Conveyor Belts

Floor mounted mine duty rigid structure

Catenary troughing idler

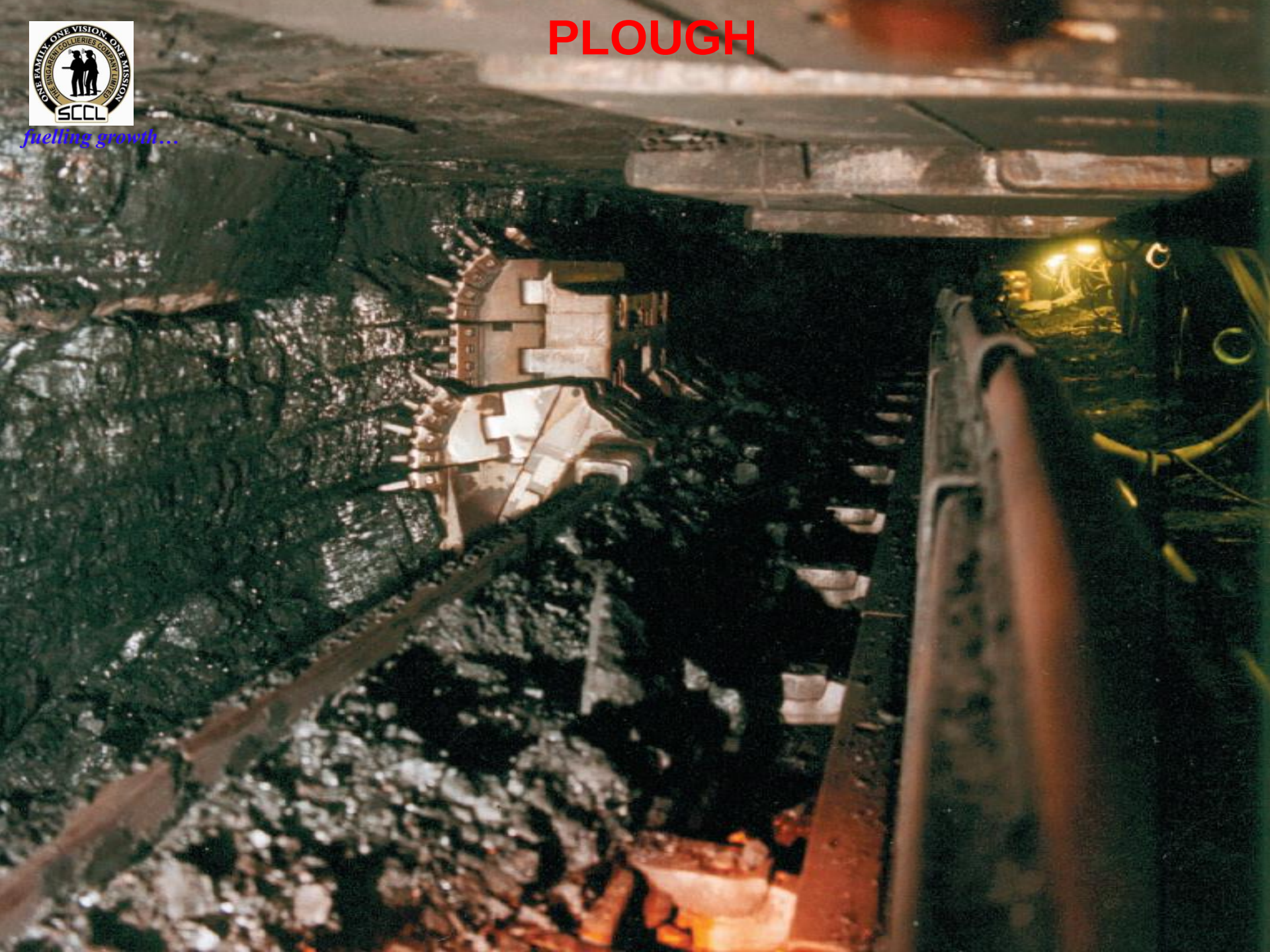
PLOUGH

- Plough is successful in working of thin seams up to 50cm in combination with self advanced power supports system under suitable conditions

- Soft coal ploughing is applied in seams up to 3.0m with great success

PLOUGH

fuelling growth…



Equipment Specifications – GDK10A Incline

BEAM STAGE LOADER (BSL)

Make - Anderson
Type - Chain 26 MM
Twin inboard
Power - 150 KW
Capacity - 1200TPH
Speed - 1.15 M/ Sec.

POWER PACK

Make - Hauhinco
Capacity - Pump supplying
150 LPM(33GPM)
at 300 bar
Tank capacity - 2x 2000 Ltrs.
Coupled together
Power - 125 KW.(94 HP)

GATE BELT

MAKE - Meco Huwood
Capacity - 1200TPH
Width - 1200MM
Power - 2 X 150 KW
Huwood Chieftan type

SHEARER

Make - Anderson, Type - AM–500 DERDS.
Chainless power track haulage with
twin traction drive.
Weight - 45T.
Length -15M.
Power - 2X375 KW (500HP).
Capacity - 800TPH@ 3M/Min &
1600 TPH @ 6M/Min.
Haulage speed - 0-9 M/Min.

ARMOURED FLEXIBLE CONVEYOR (AFC)

EQUIPMENT

Make - Anderson
Type - Chain 26 MM twin inboard
Power - 2 X 150 KW
Capacity - 1000TPH
Speed - 1.08 M/ Sec.

POWERED ROOF SUPPORTS

Make - Meco/LW International
Weight - 20. 5 T
Capacity - 4 Leg X 800T
Support height range - 2.2M-3.3M
Setting Pressure - 300bar
Yield Pressure - 400 bar

LONGWALL – STRATA CONTROL

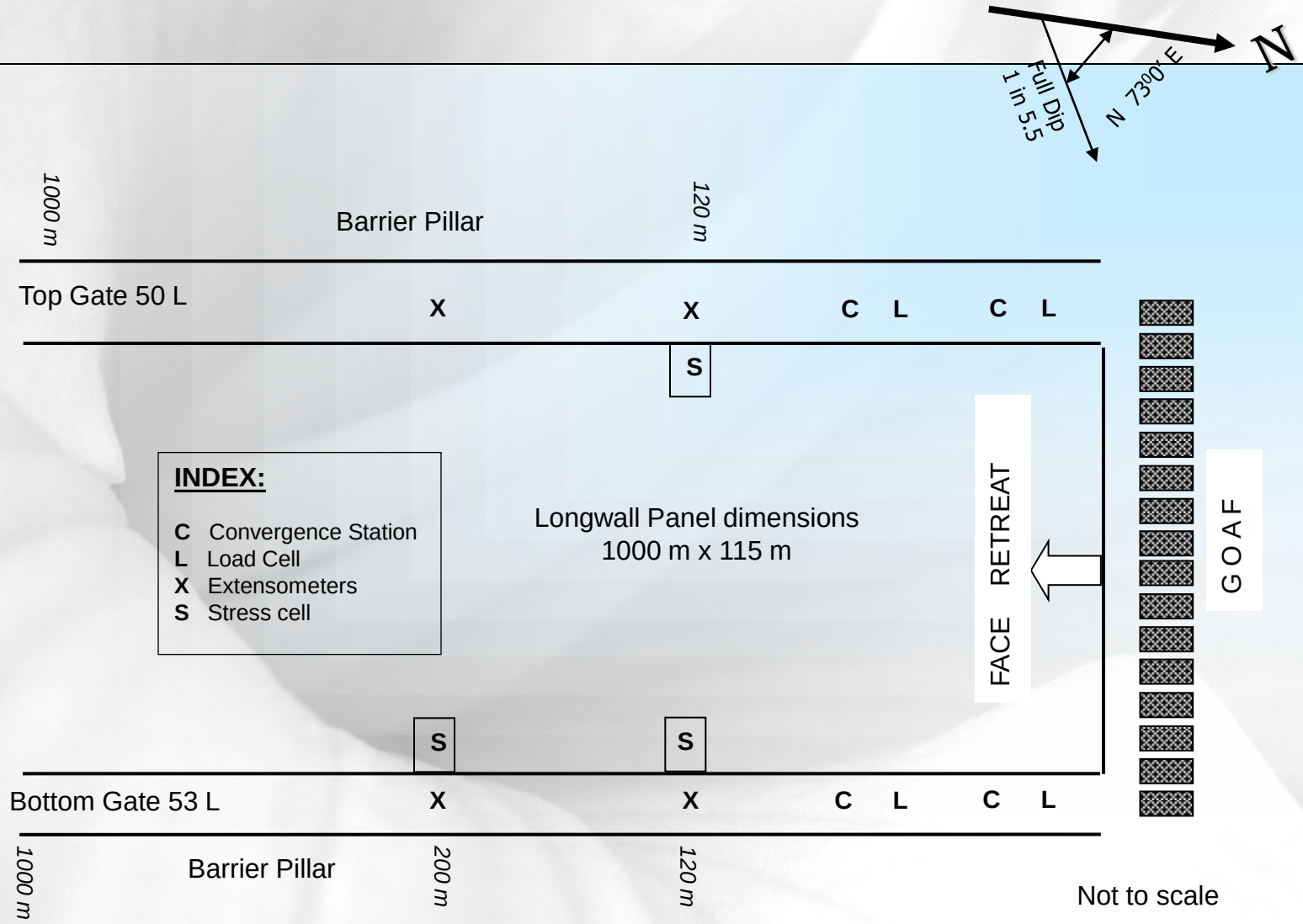
fuelling growth…

STRATA MONITORING

- **GATE ROADS**
  - Convergence at every 5 m interval.
  - Load on supports at every 10 m interval.
  - Bed separation
  - Pillar stress

- **FACE**
  - Face convergence.
  - Chock pressures of every chock.
  - Stress in font of the face.
- **Goaf Monitoring**

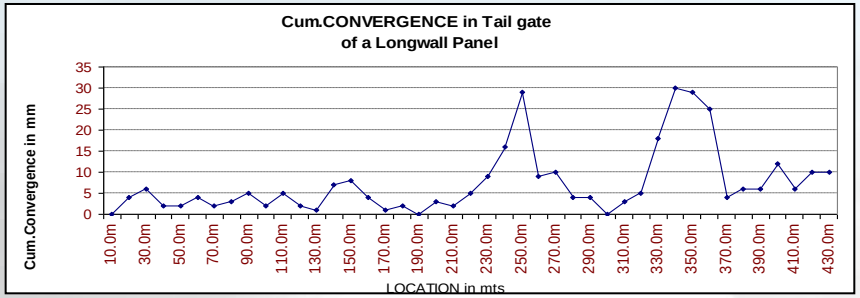
STRATA CONTROL PLAN OF A LONGWALL PANEL



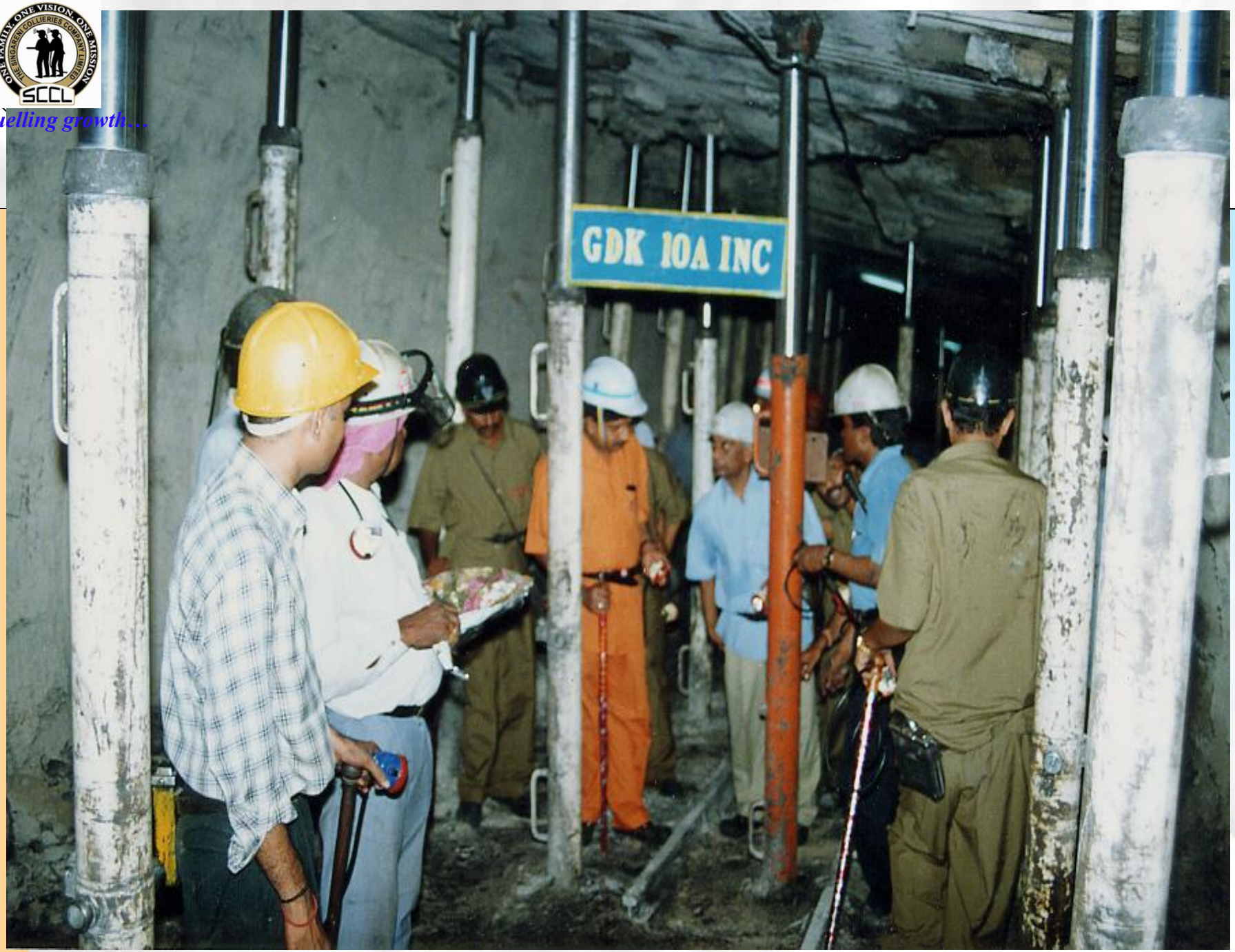
Gate Road ways studies –

Strata monitoring

- Convergence indicators
- Load cells
- Tell tales
- Stress capsules



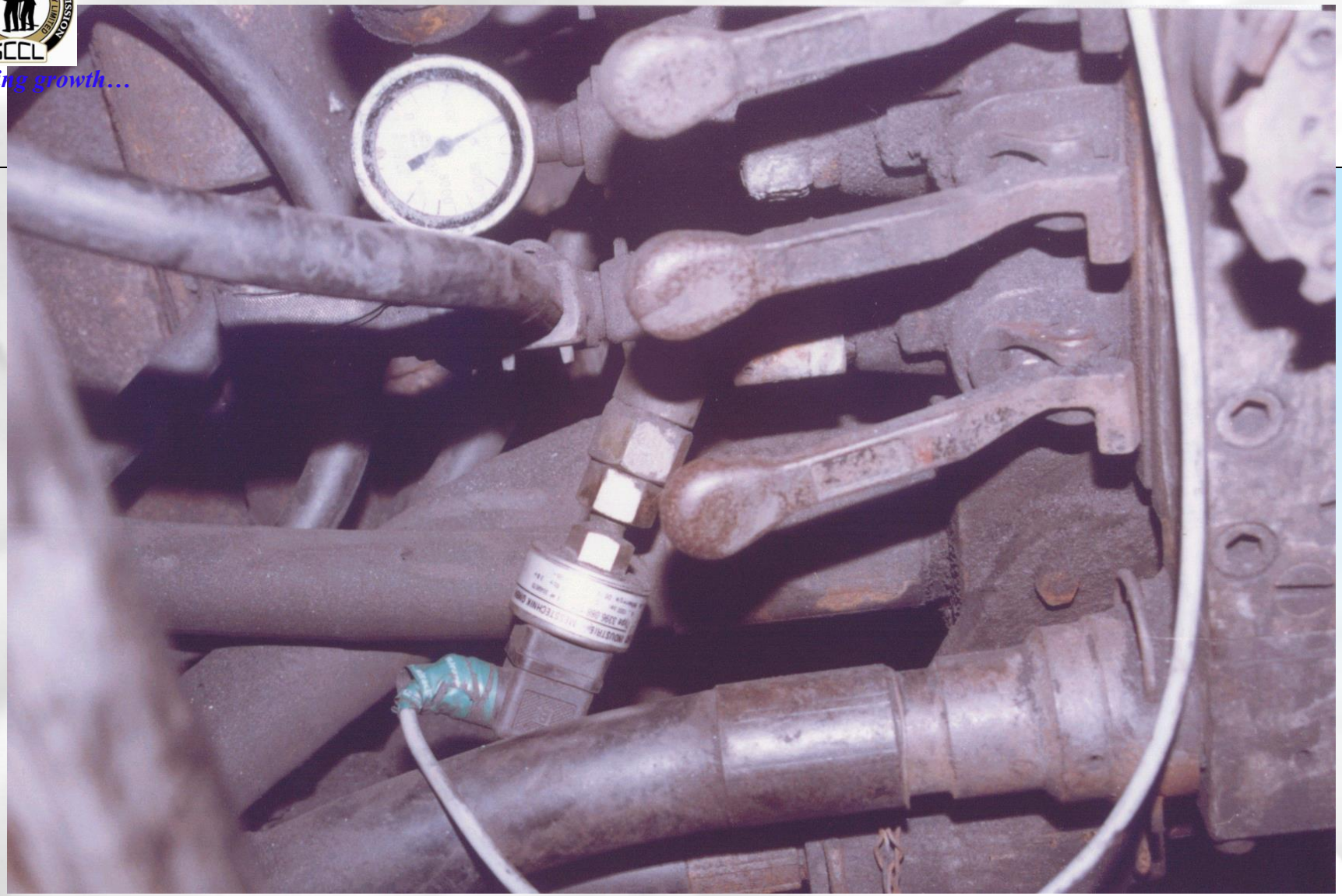
fuelling growth…



fuelling growth…

fuelling growth…

fuelling growth…



fuelling growth…

The maximum convergence depends on the following factors

- Caving properties of the strong bed causing weightings, indicated by the Caving Index Number 'I' of the strong bed.
- Thickness of cavable beds forming the immediate roof in between strong bed and the coal seam in terms of height of extraction.
- Resistance offered by the support system.

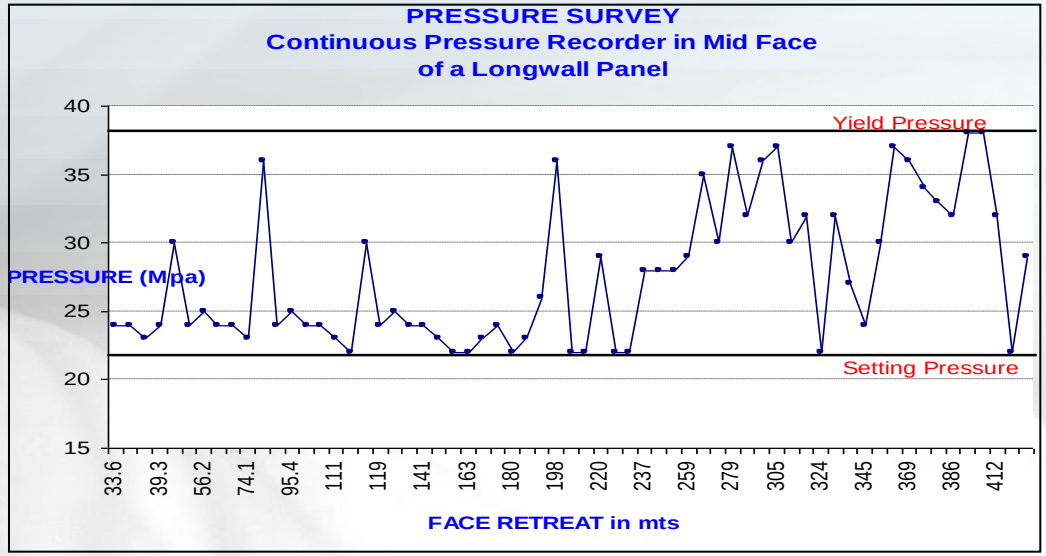
Convergence and Roof Degradation at Longwall Weightings(GDK.10A)

Maximum Convergence	Expected Roof Condition
Upto 60 mm/m	Convergence within permissible limit
Above 60 upto 100 mm/m	Minor roof fracturing increasing with the value of convergence
Above 100 upto 160 mm/m	Significant roof fracturing and roof degradation. Seriousness increasing with increase in convergence
Above 160 mm/m	Rock fall zone.

Face monitoring–

Strata monitoring

- Leg Pressures
- Leg Closures
- Face Convergence



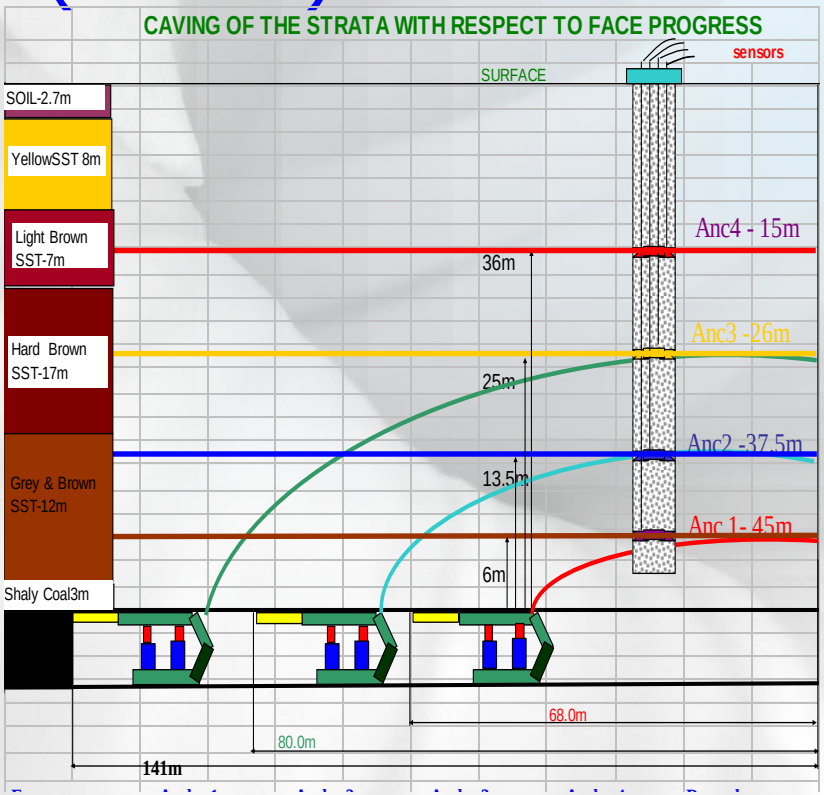
Rated Support Resistance

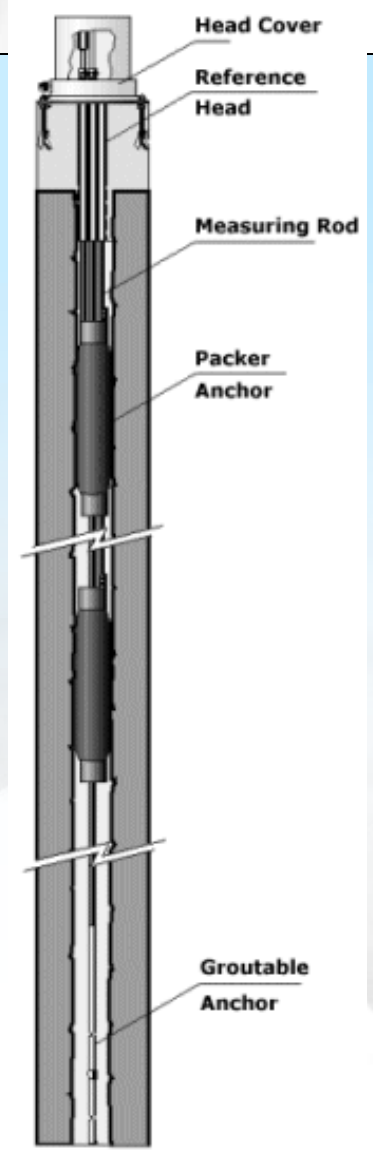
The Rated Support Resistance should take into account the following deficiencies during the actual operation.

1. Leakage in leg circuit
2. Setting load deficiencies
3. Miscellaneous (deviation from normal span, premature bleeding of leg circuits, etc.)

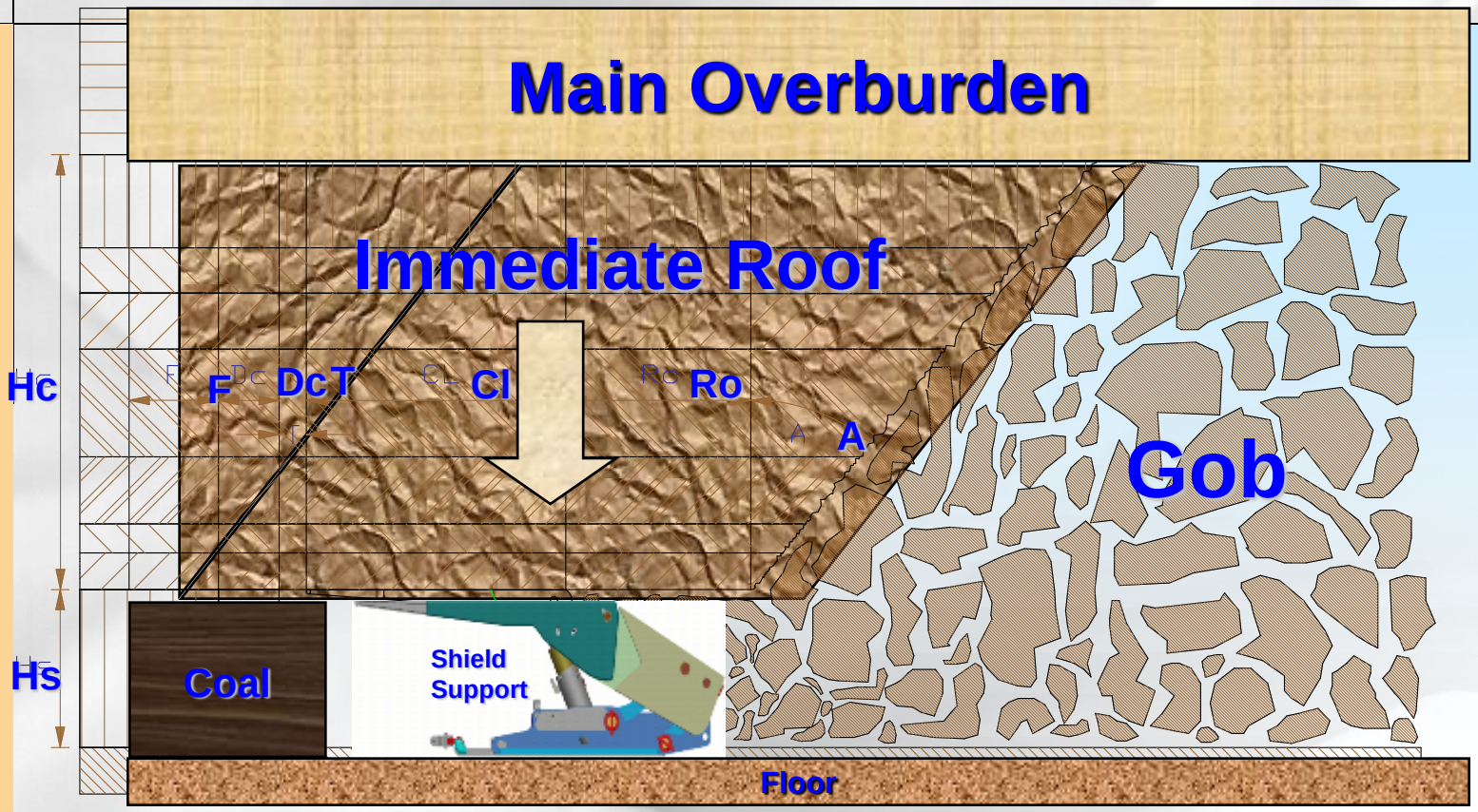
Goaf monitoring – Strata monitoring

- Remote convergence indicator
- Multi Point Borehole Extensometer (MPBEx)





Longwall Caving Diagram



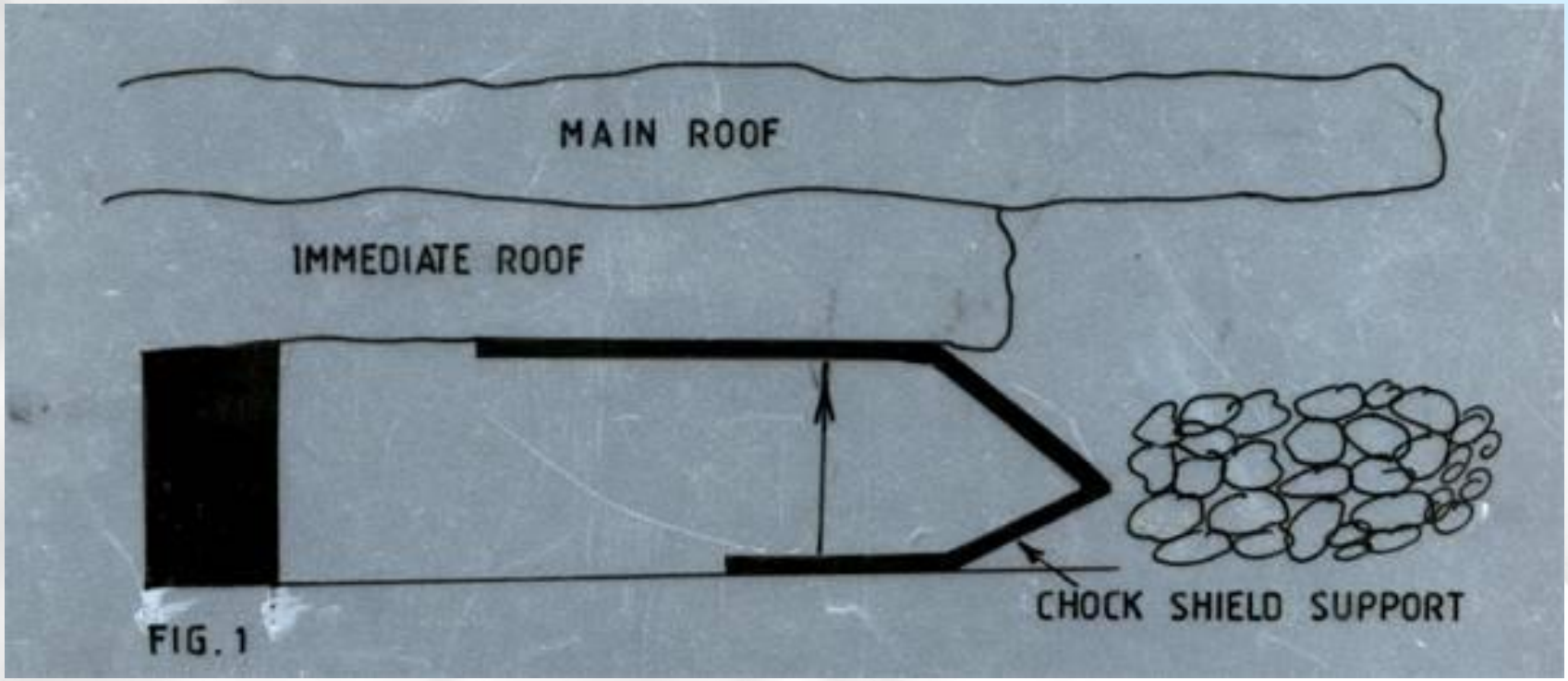
Hs = Seam Height
Hc = Caving Height
Cl = Canopy Length

Dc = Depth of Cut
A = Caving Angle
F = Forward Zone

Ro = Rear Overhang
T = Canopy Tip to Face
Sw = Shield Width (not shown)

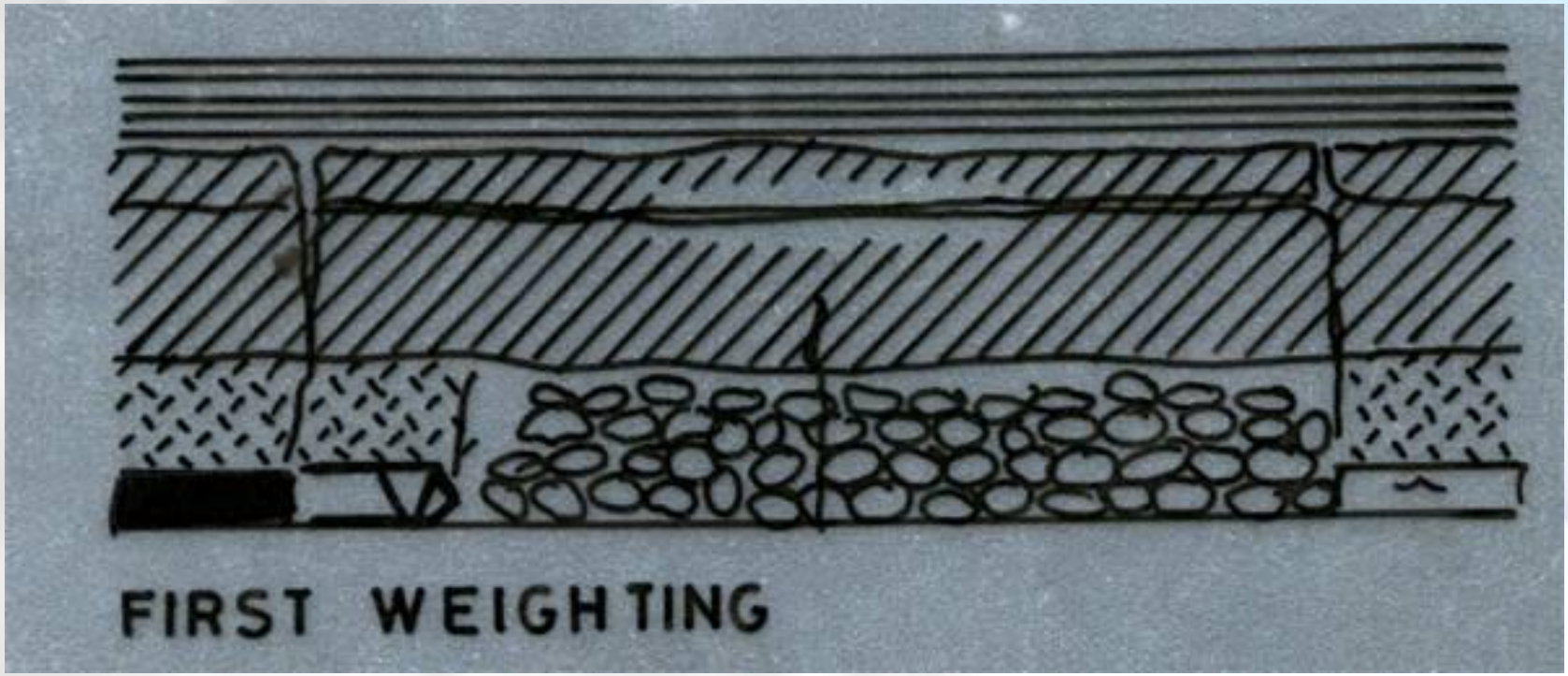
Longwall Caving

Cut after cut, shear after shear the AFC & subsequently Chock shield supports will be advanced and the immediate roof rock above caves in.

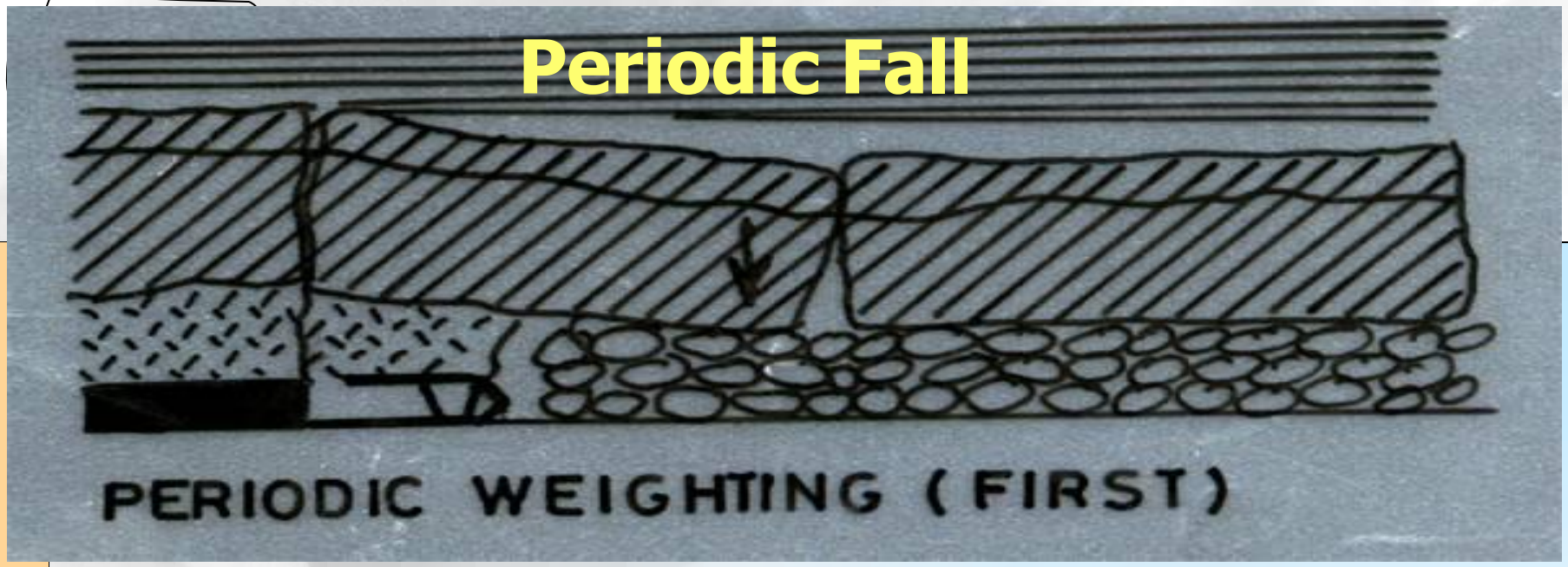


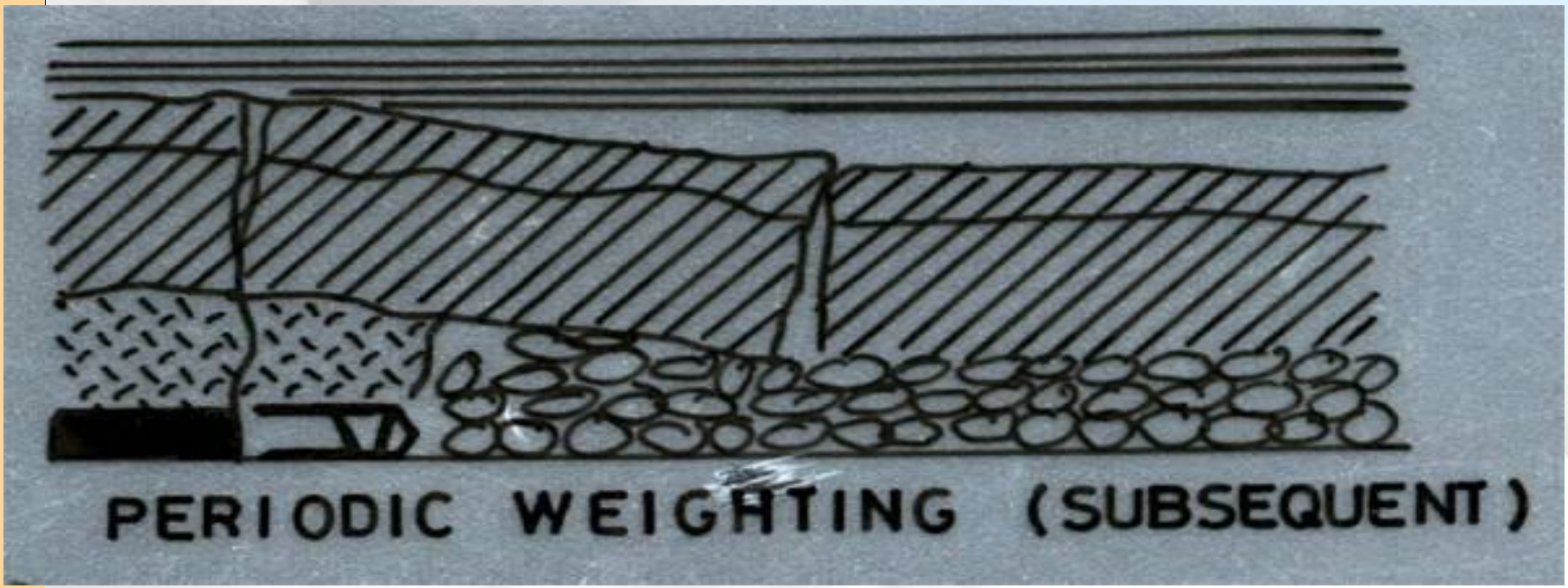
Main Fall

- As the retreat further proceeds substantial area of main roof rock forms a plate & caves in by imposing load on supports, known as main weighting.



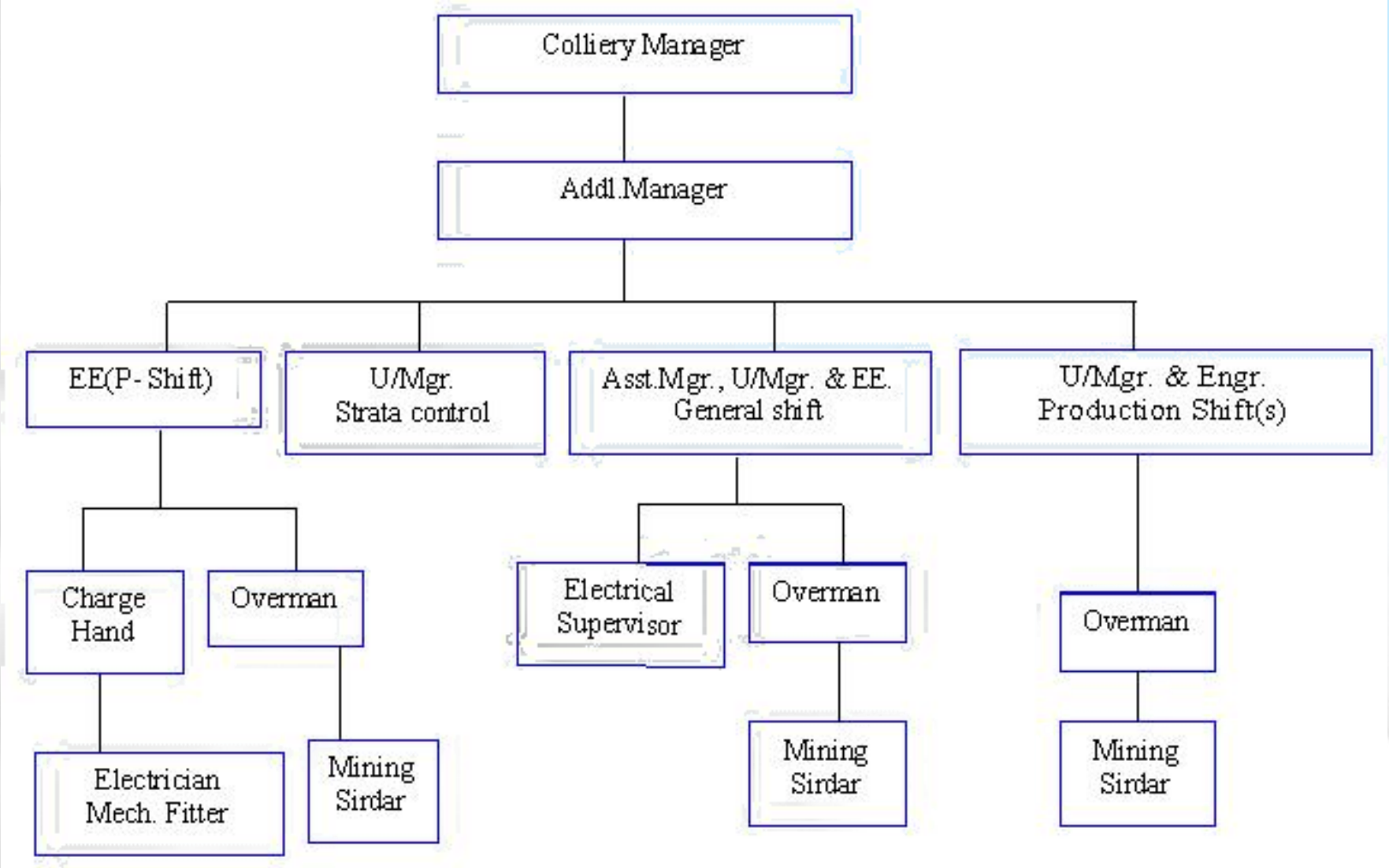
Periodic Fall





LONGWALL – ORGANISATION

Organisation Chart



MANPOWER

Pre shift

1.	EE/AE	1
2.	Mech. Charge Hand	1
3.	Overman	1
4.	Mining Sirdar	1
5.	Shearer	F+3
6.	AFC & BSL	F+5
7.	Power pack & Chocks	F+3
8.	Switch train & U/Frame Shifting	F+7
9.	GBC	F+4
10.	Miscellaneous	9

		40

General Shift

1.	Overman	1
2.	Mining Sirdar	1
3.	Gate Road Support	6
4.	Face Supporting (Bamboo bolting & Fore polling etc.)	8
5.	Face Cleaning	10
6.	Slush Tanks cleaning along M.G.	6
7.	Material transport	6

		38

MANPOWER

Production Shift

1.	Under Manager	1
2.	Engineer	1
3.	Overman	1
4.	Mining Sirdar	1
5.	Shearer Operator	2
6.	Multi Job Workmen	9
7.	Face fitters	3
8.	Face Electricians	1
9.	Outbye belt Fitters	1
10.	Outbye Electricians	1
11.	Helpers	6
12.	Conveyor Operators	6
13.	Misc/cleaning	4

		37

LONGWALL – FACE TRANSFER

MESHING

- Wire meshing is laid in roof from 12 to 15m behind the face stop line with individual roof bolts for 5 to 8m and later on along with W-straps/Channel for balance portion at 1m interval.
- Maximum height will be extracted for the last 8m from face stop line, sothat enough clearance is there for PRS passing underneath the line supports.
- After stoppage of the face, meshing and bolting is done to the face also.

DISMANTLING

- All the equipment in the face are dismantled except chocks and loaded on to the GMT (Gyro Machine Trolley) and transported to surface of new face.
- Shearer is dismantled into two parts for easy transport.
- AFC pansets were dismantled in such a way that 5 pansets together forms a unit for loading onto GMT.
- Similarly BSL, Belt sections are dismantled and loaded on GMT.

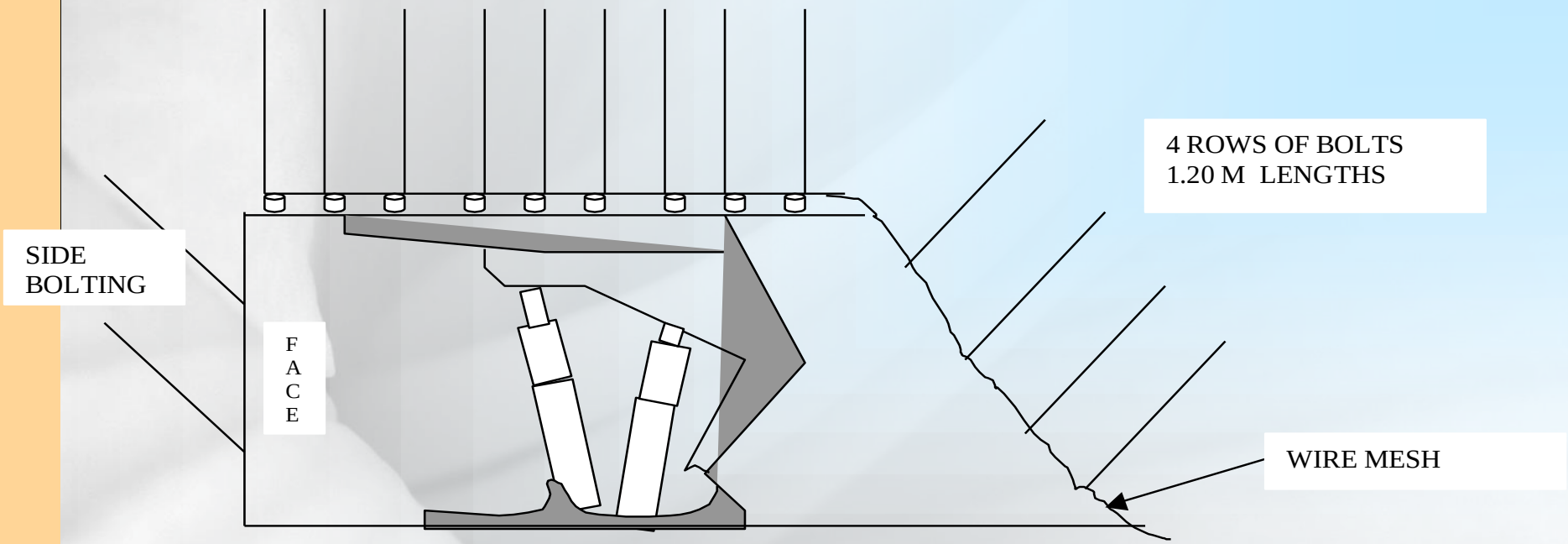
CHOCKS TRANSPORT

- PRS turning is done generally from dip to raise and 2 buttress supports are used as goaf edge supports at dip most point of the face.

- PRS are being marched with self hydraulic power upto loading station and shifted on to GMT for further transport to surface or to new face.

SALVAGING OPERATIONS

9 ROWS OF BOLTING WITH W-STRAPS (1.8M LENGTH)

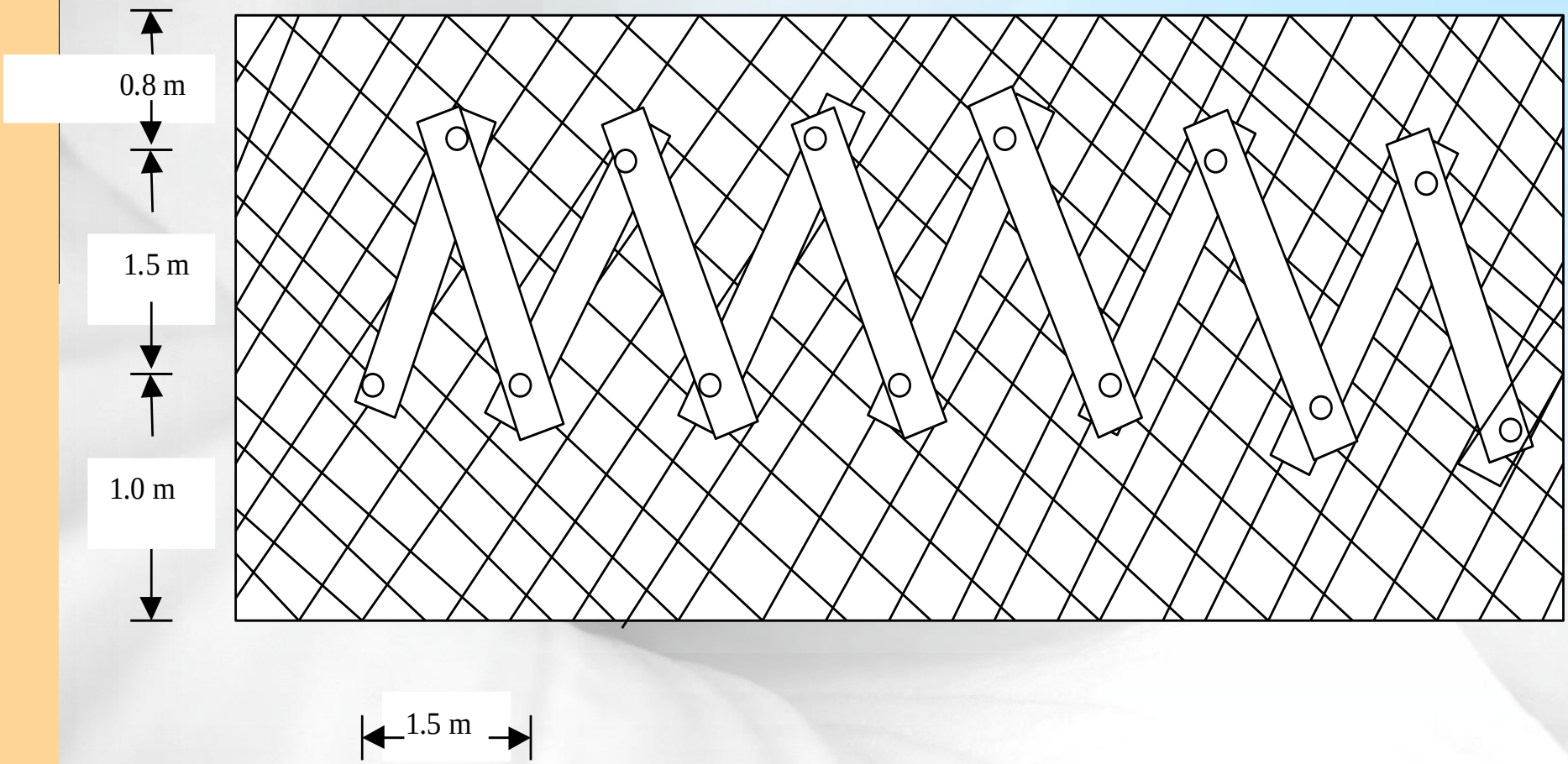


1. 1st 6.50M length 4 rows bolting (1.5M) at 2.0M interval with point anchoring with one capsule per bolt.
2. 2nd 6.5 M length 8/9 rows bolting (1.8M) with W-Straps full column grouting 3-4 capsules per bolt.
3. 30CM mesh overlapping,

(not to scale)

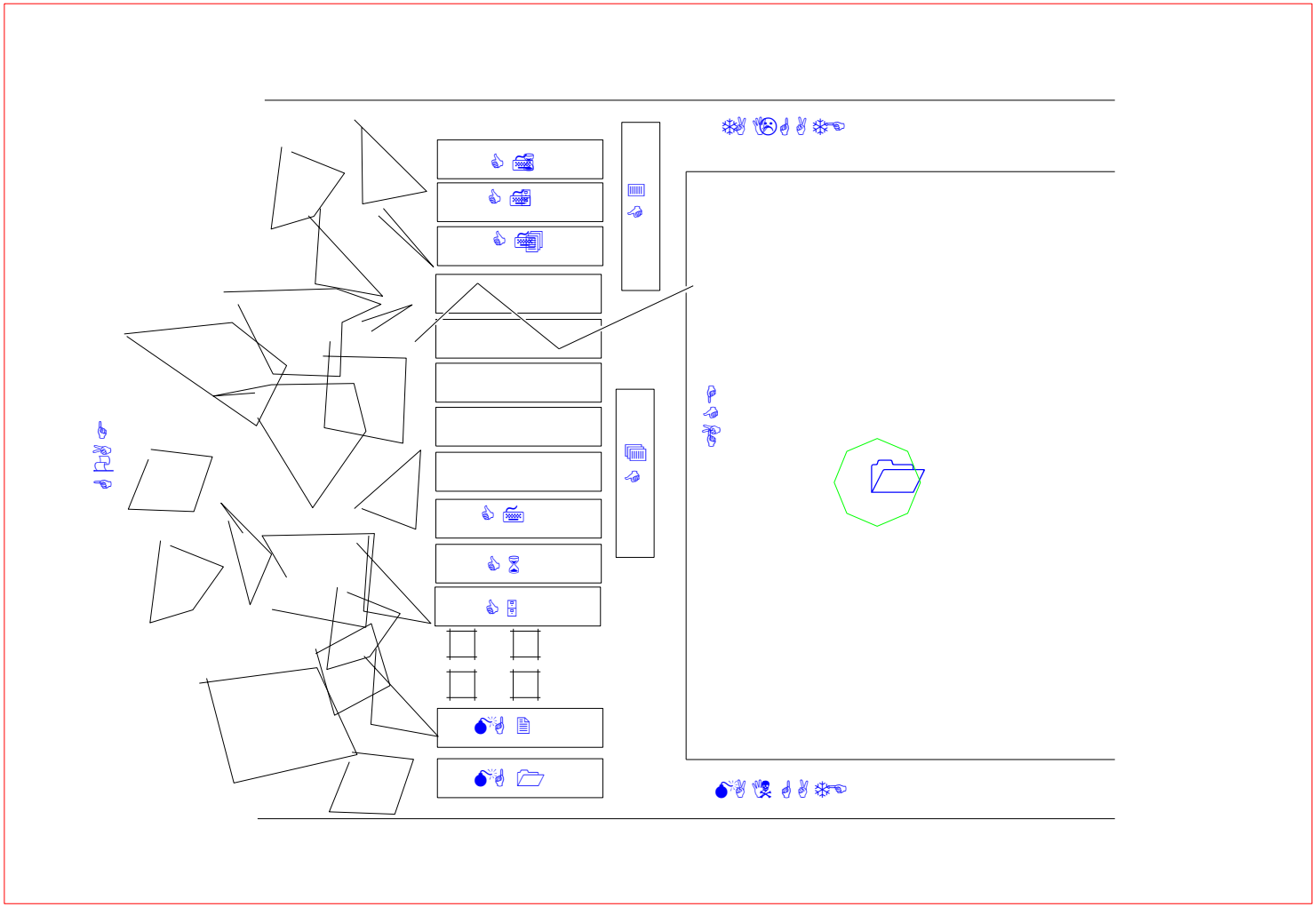
FACE SIDE MESHING WITH W-STRAPS

1. 2 rows of bolting (1.8M, inclined) at 1.5M interval.
2. Interval between rows 1.5 M
3. Mesh with W-straps

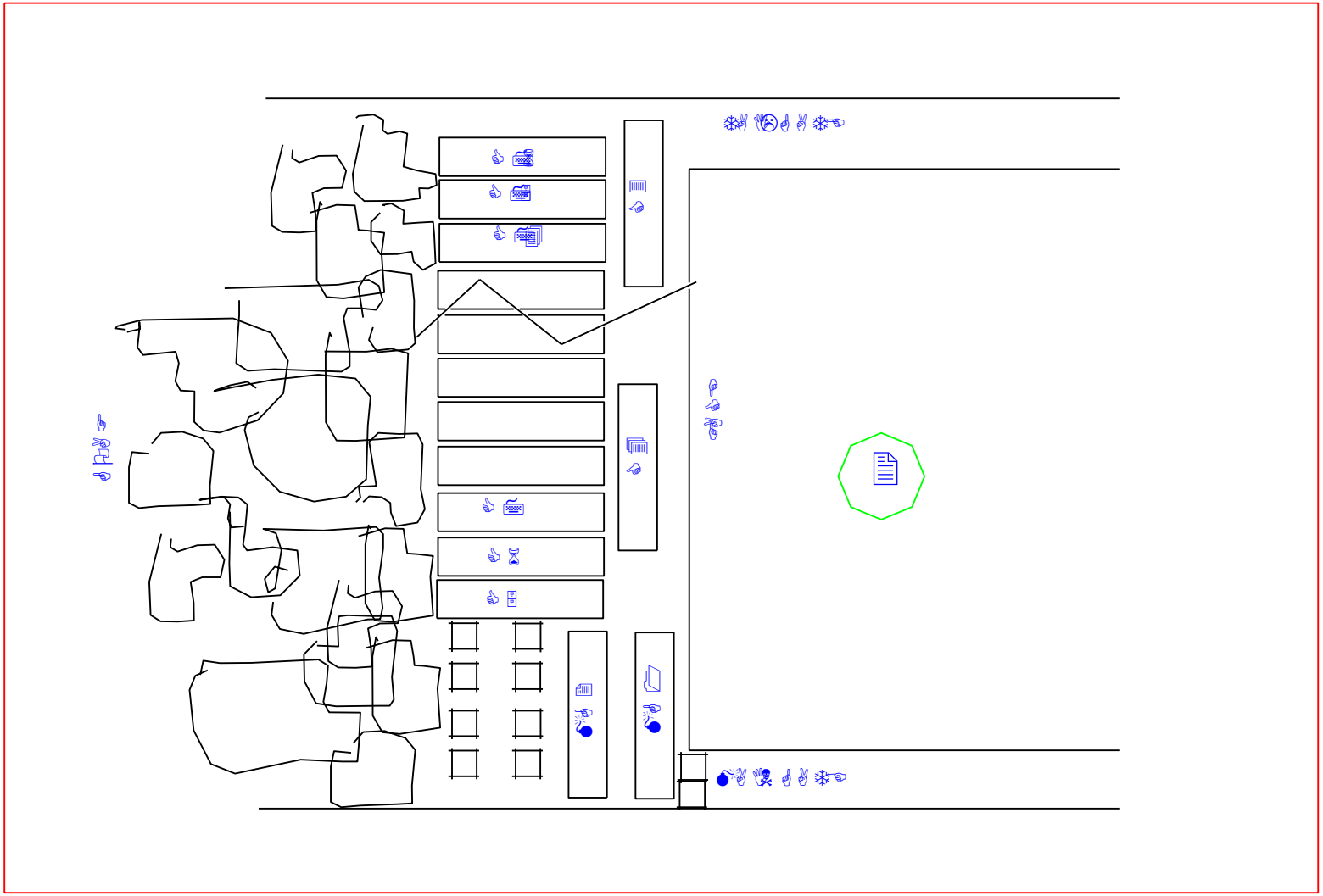


(NOT TO SCALE)

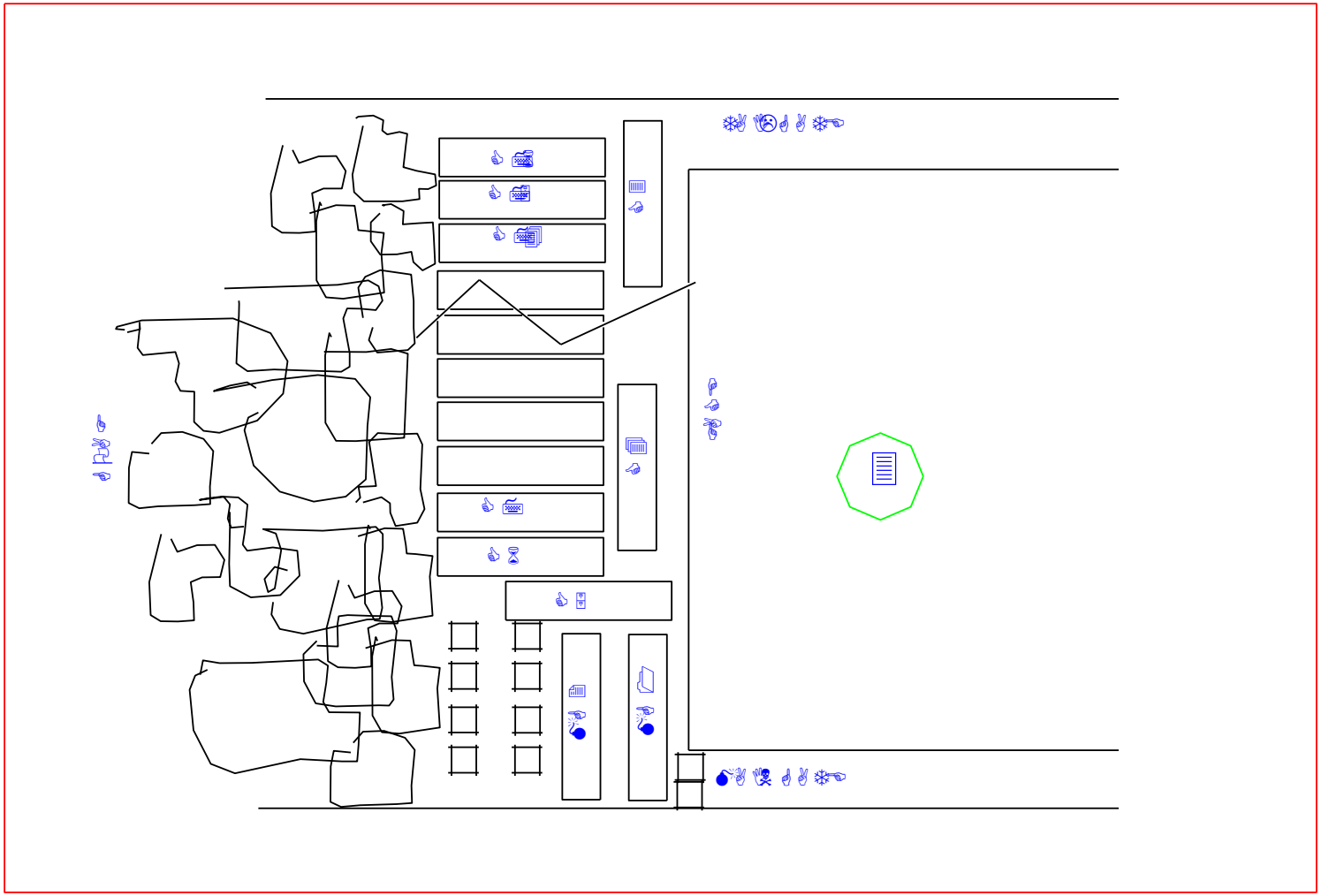
CHOCKS TURNING -- POSITION NO.1



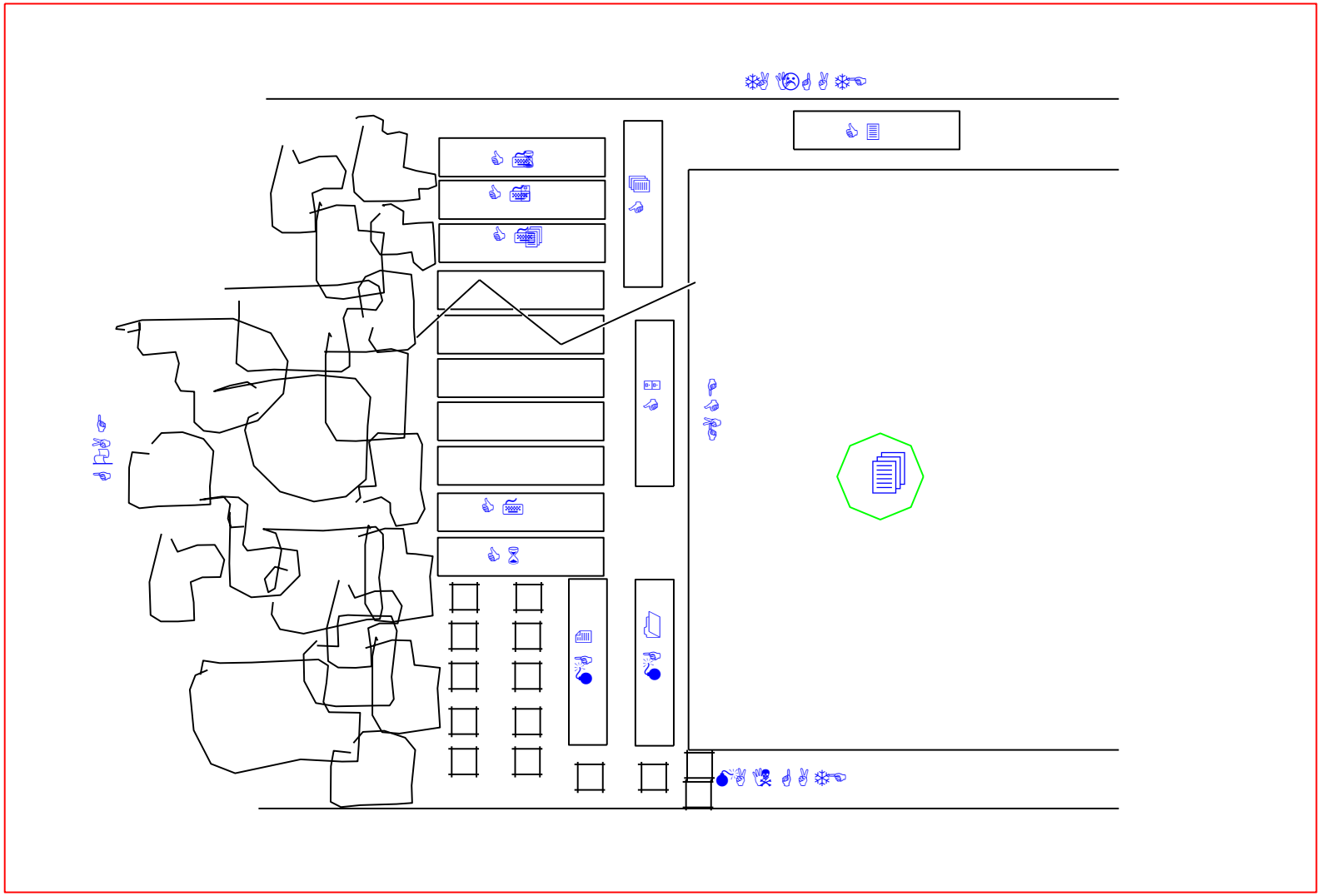
CHOCKS TURNING -- POSITION NO.2



CHOCKS TURNING -- POSITION NO.3



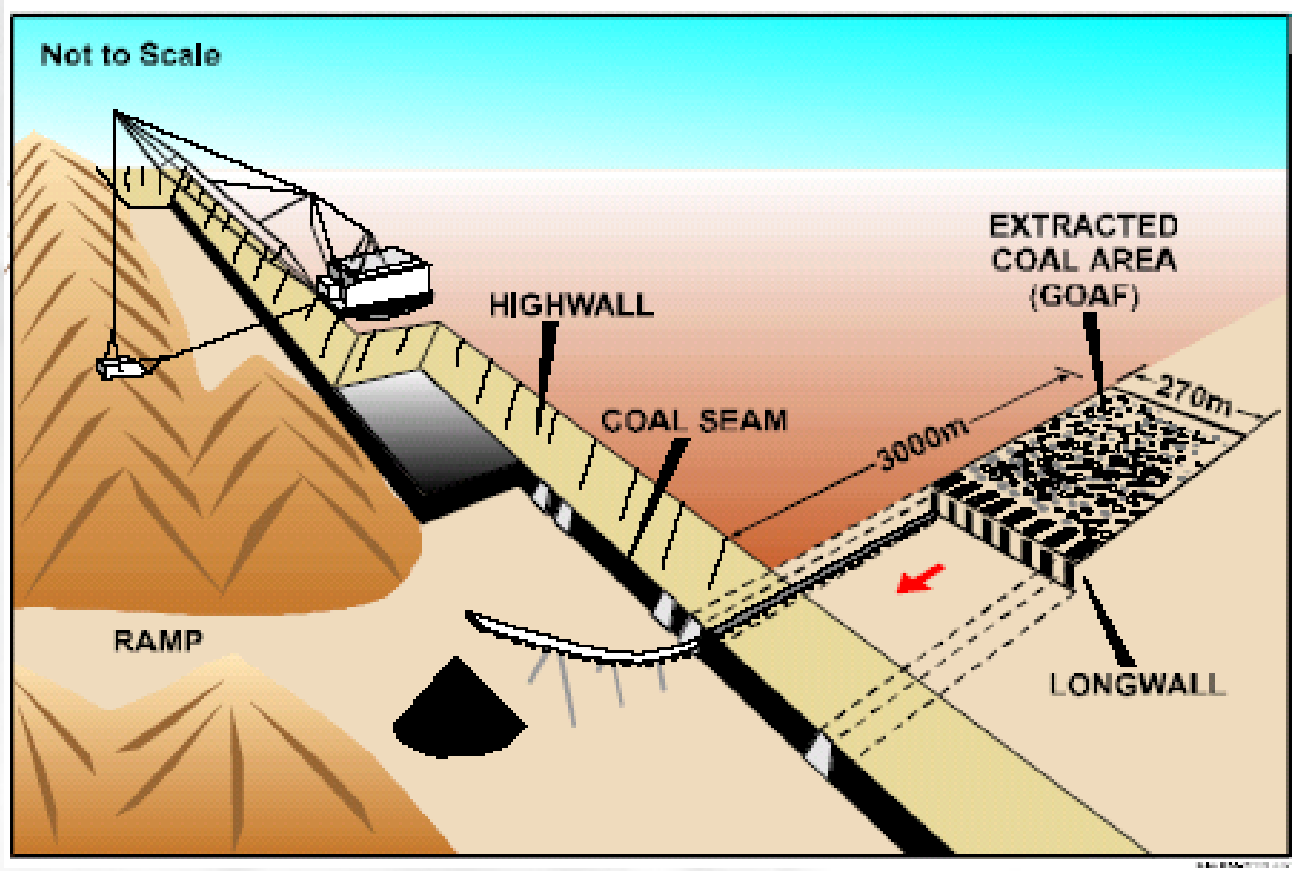
CHOCKS TURNING -- POSITION NO.4



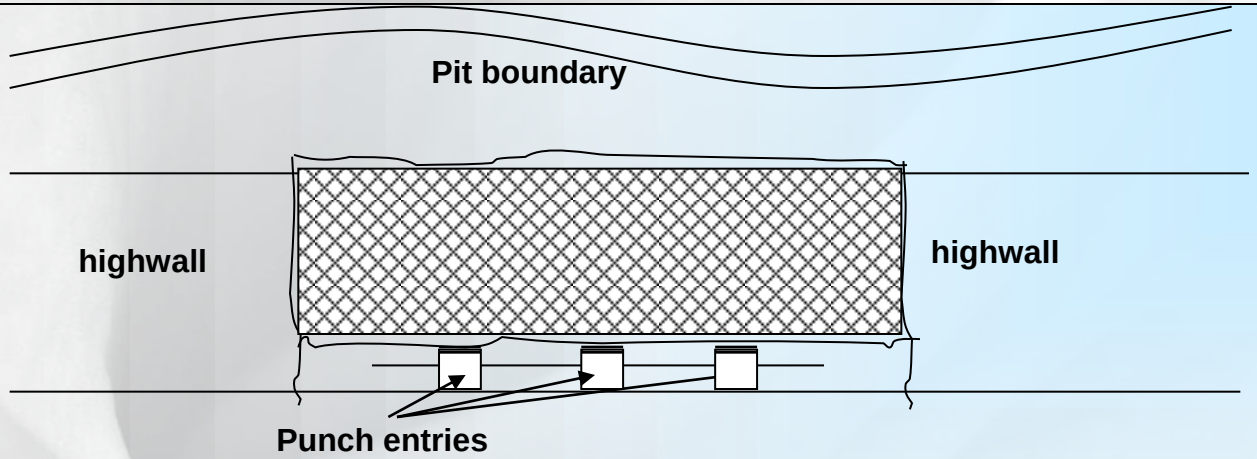
Variants of Longwall Mining (NEW CONCEPTS)

Punch Longwall

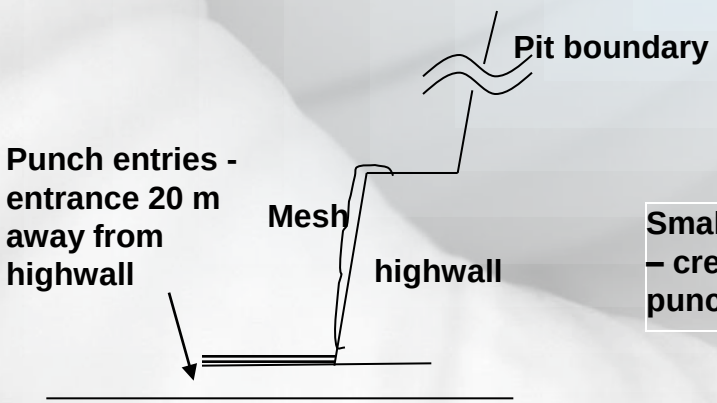
- Developing longwall panels directly off high walls of OC



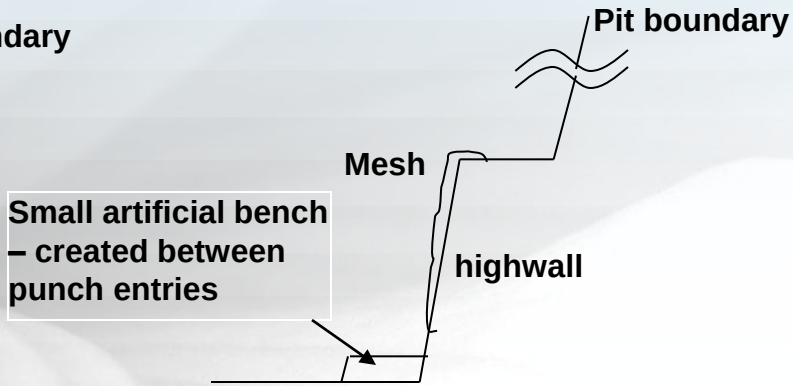
Punch Entries Design Principles



Front view along the highwall



Section near punch entry



Section between punch entries

Punch Longwall Mining ~ Beltana

Punch Longwall Mining ~ Broadmeadow

PUNCH ENTRIES

Beltana Mine, Australia

PUNCH ENTRY
ADRIYALA PROJECT
GDK 10A INCLINE
RG-III SCCL.

Punch Longwall

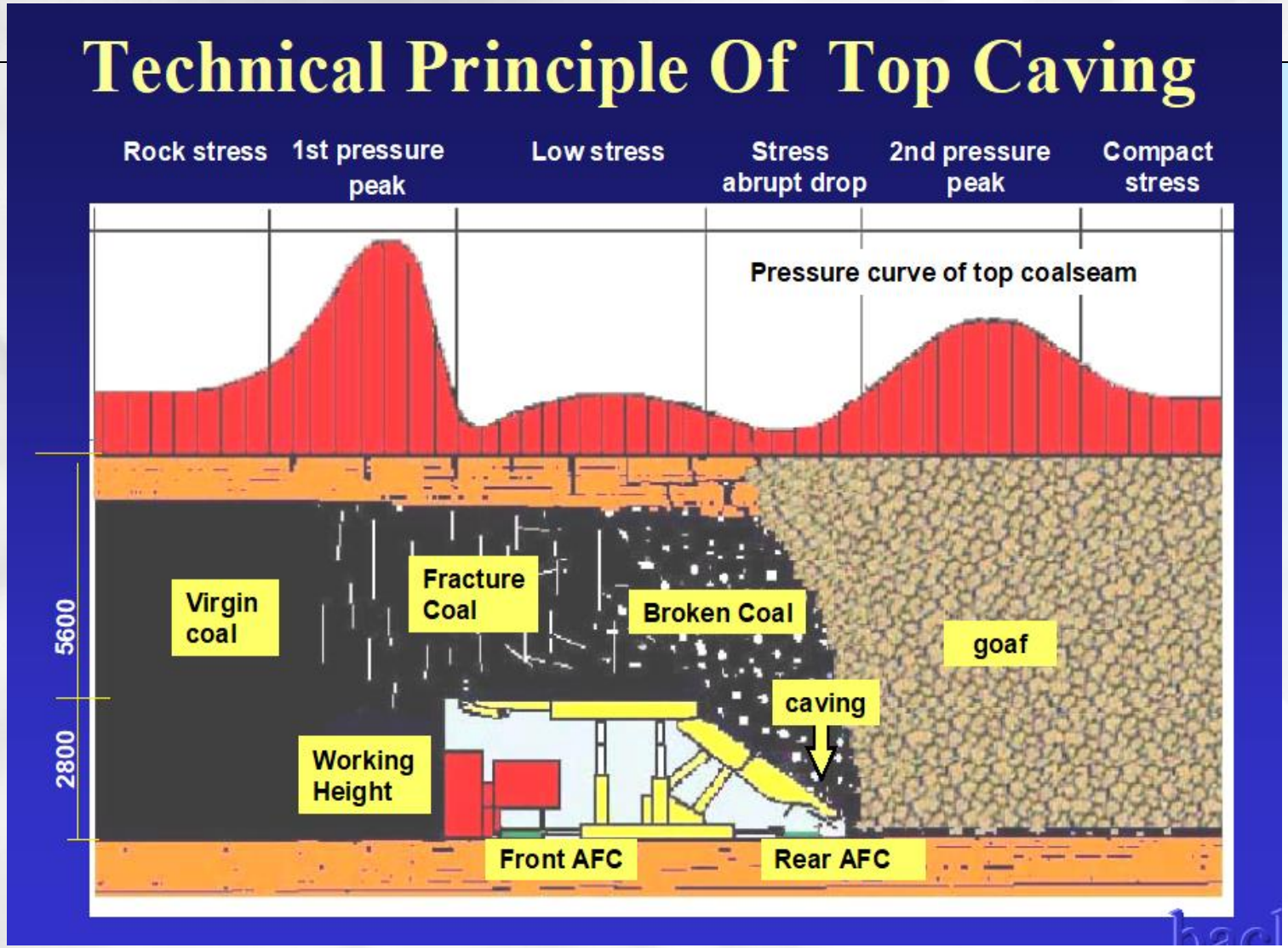
Advantages

- Step change in cost and productivity
- More production capacity
- High productivity & low cost
- Longer term and higher % of reserves extraction
- Easy logistics – near surface
- High gate road development rates feasible
- Higher and faster returns on investment
- Total investment ~ $100 million – compared with > $300 millions UG

LONGWALL TOP COAL CAVING

- This Method is similar to Longwall. It is more popular in China and recently introduced in Australia.
- Suitable for thick seams up to 10.0m
- Extraction by Longwall is done in bottom section up to 3.0m height.
- Top coal is taken after advancing the supports on to another Chain Conveyor at the rear.

Longwall Top Coal Caving (LTCC)



Longwall Top Coal Caving (LTCC)

Longwall Top Coal Caving (LTCC)

Advantages of LTCC

- Increased resource recovery in thick seams (> 75%)
- Lower face working height (better face control)
- Improved spontaneous combustion control
- More efficient capital utilisation/ financial performance
- Reduced operating costs
- Improved production consistency
- Less gate road development requirements
- Some dust and gas issues

LONGWALL – INDIAN PERFORMANCE

INDIAN LONGWALL

- **PAST EXPERIENCE:**
  - Introduction of advanced technology system in Indian coal mining industry marked a major step with the installation of first mechanized Longwall Powered support face at Moonidih in August 1978.

  - In between 1978 to 1985, a major number of first generation Longwall faces started through out India in various mines of CIL such as Moonidih, Jhanjra, Seetalpur, Dhemomain and Pathakhera Colliery and in SCCL at GDK-7 & VK-7 Incline.

INDIAN LONGWALL

- **PAST EXPERIENCE:**

  - Churcha Longwall face failed due to dynamic loading.
  - Jhanjra with shallow depth Longwall working face ran into acute spares problem.
  - Kottadih face failed after successful completion of two Longwall panels due to dynamic loading and underrated capacity of supports.
  - GDK.11A failed due to underrated capacity of supports.

LONGWALL- SCCL

- **PAST EXPERIENCE:**

Longwall technology was introduced in Seven mines of SCCL. Their performance has been:

- GDK-10A, JK-5 and VK-7 Incline gave consistently good results, and
- The other four mines GDK-7, GDK-9, GDK-11A and PVK suffered mainly due to non availability of sufficient geological data.

INDIAN LONGWALL

MAIN REASON :

Insufficient geo-technical investigations resulted in surprises by encountering major geological disturbances while working the longwalls. Thus effecting the performance of Longwalls to the maximum extent.

INDIAN LONGWALL

- **PRESENT & FUTURE :**
  - With the likely reduction of contribution from Open cast and the more or less stagnant production from Underground by Conventional methods, it is time that an impetus is given to boost Long wall Technology to able to meet the future energy needs of the country.
  - On the positive side, coal companies have now gained sufficient experiences right from senior executive level to front line workforce to be able to plan, execute and work longwall faces. **What are required are proper geo-technical investigations for effective layout of longwall panels.**

NEED FOR LONGWALL

- Coal deposits amenable for opencut mining in India are depleting at a faster rate.
- Mechanized underground mining is becoming important as substitute to opencut mining due to:
  - Increasing stripping ratios,
  - Environmental restrictions,
  - Problems in diverting forest land
  - Rehabilitation and resettlement issues.
- Semi-mechanisation with Side dump loaders, Load Haul Dumpers or Continuous Miner is difficult in seams steeper than 1 in 4 ($>14^0$)
- Longwall is the proven underground bulk production technology for deep and steep seam conditions.

REASONS FOR POOR PERFORMANCE OF LONGWALL

- Large expansion in opencast mining in the past two decades provided cheaper and safe method for bulk coal production and as a result long wall had to take back seat.

- Clear strategies were not pursued for its sustenance as there was mixed results from long wall in the early years of its introduction.

REASONS FOR POOR PERFORMANCE OF LONGWALL

- Long walls were introduced mostly in the blocks left over by working Bord and pillar method. Clean and extensive blocks have not been identified. Even the smaller blocks, which were identified, were of inferior grade coal.
- Long wall had to co exist with the conventional mining in most of the mines, which caused management problems.
- There were some deficiencies in the imported spares management and the supplies were not reaching in time.

REASONS FOR POOR PERFORMANCE OF LONGWALL

- Coal companies were sensitive to the failures of a few long wall faces and were not prepared to risk huge investments.

- Development could not keep pace with the extraction of Long wall panels, slow progress in dip has delayed the formation of Long wall panels and affected the performance.

FUTURE REQUIREMENTS

- Longwall should be promoted as a technology mission.

- A high level thrust group could be constitute at national level to promote, coordinate and interact different aspects related to Longwall technology.

FUTURE REQUIREMENTS

- Huge investments incurred on different operations for extraction of coal from greater depths in future can be attained by imposing a special cess on present OC production or from other sources.

- R&D efforts are to be doubled.

- Efforts are required by the policy makers to transform ideas into actions.

FUTURE REQUIREMENTS

- Foreign participation is required for extraction of thin seams and steeply inclined seams.
- The manufacturing companies of India such as MAMC and Jessop are to be reconstructed/ re-organized.
- More number of longwall blocks are to be identified to assure the market for manufacturers.