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Coal Mine Mechanization - A Need of the Day

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Abstract: ***India being a developing country cannot afford to restrict its growth on account of supply of energy. Coal, being the prime source of energy in India with a broader reserve base, has to take the major onus of increased energy supply. Responsibility of fulfilling the coal supply requirement of the country primarily rests on Coal India Limited (CIL) being a biggest coal producing company in India. Further, this dominant status of CIL is likely to continue in foreseeable future. As the coal demand is going on increasing, the gap between the demand and indigenous availability of coal in the country is rising. Presently, coal import of about 99 Mt is being made. The import requirement is projected to be 265 Mt by 2016-17 under 'business as usual scenario' and about 185 Mt under 'Optimistic scenario'. This gap is likely to widen further leading to requirement of hefty import. In order to restrict the requirement of coal import, to the extent possible, in coming years, CIL has to raise its production level to maximum level by all means. For starting Coal production CIL has to first get data of geological survey/exploration, availability of coal reserves, then get competent approval, possess land, solve R&R problems, get Environmental and Forestry clearances and provide infrastructure for production and dispatch. Additionally, issues like faster exploration & production/dispatch activities, it has to make capacity augmentation, enhancing pace of projectization for existing and new coal blocks, emphasis on coal production from opencast & underground mines, are required to be addressed for stepping up its production. Additionally, this calls for meticulous identification of coal blocks suitable for mechanization, increasing the level of mechanization in existing mines, introduction of state-of-the-art machines from overseas, establishing indigenous equipment manufacturing capacity, ensuring optimal utilization of the equipments as per international standards, improving the working culture, etc. Manpower planning & development needs and other requirements like skill development would also have to be made effective to motivate the workforce for growth requirement.***

Mechanization is an important strategy in the design and operation of modern mines. The objectives of mine mechanization are varied, but typically include improved safety, working conditions and productivity, and a reduction in direct mining costs. The successful application of mechanization typically results in fewer people being employed directly in the mining process although the actual overall impact on employment is complex. Work processes and work team dynamics also change significantly, requiring novel approaches to the design and management of production. Although there has been a concerted effort, over the past few decades, to convert traditional mining methods to more mechanized methods, and these efforts have been met with varying degrees of success. This paper reviews technology change create an impact on production augmentation by introduction of mechanization and up gradation of technology on coal mining scenarios. The paper indicates that by introduction of the technologies / methods, and by using to develop a framework and utilizing its resources CIL has increased coal production to meet coal demand to the extent possible.

I. INTRODUCTION

In the global scenario, Mechanized coal mining got its start about the year 1923, under economic conditions similar to those that exist today. The trend toward full mechanization of the coal industry, as we know it today, began during a postwar period of sustained heavy demand for coal, which prevailed up to the time that depression

struck the nation with full force in 1930. As a result of wartime demands upon the industry, its capacity had become tremendously over-expanded. There had also been a corresponding over-expansion of the mine labor force. This was an all time high level of employment in the coal mines. Faced with the situation of high labor costs, declining prices and increasingly severe competition, the coal industry had to find means of increasing operating efficiency and cutting costs. Getting a higher rate of productivity for the payroll cost was the only way out. Mechanization of the industry was the answer to the problem. Today, the incentive for mechanization is more pronounced than ever. Diminishing export markets, the rising tide of foreign residual oil imports, and oil and gas competition, have reduced demand for coal to the point where drastic readjustments have become an urgent necessity. The coal must continue to pay the fare wages in the country. It's the same old story all over again. High costs, low prices. The industry is meeting today's problem with a further intensification of the mechanization program, thus assuring the consumer of a continued supply of the most economical fuel.

Mechanical aids to coal mining had been employed long before the mechanization trend got underway. However, these earlier aids to mining merely supplemented the miner's pick and shovel, whereas mechanization as we know it today aims at supplanting manual labor to the fullest extent possible. The early aids to coal mining consisted of cutting machines and electric haulage, locomotives. Cutting machines eliminated the arduous pick work that was involved in breaking down coal from the face. The electric locomotive increased the speed and efficiency of underground transportation by eliminating animal haulage in part. Drilling was done mostly by hand and use of the shovel prevailed 100 percent.

The first step toward mechanized mining was replacement of the miner's shovel by the mechanical loading machine. This was accompanied by improvements in cutting machines to match the capacity of the newly developed loading machines. Electric drills replaced the hand drill and mechanical haulage displaced the mine mule. From that point, progress in mechanization has continued through the years until today practically all of the coal that is produced is mined mechanically. In recent years, means have been developed for completely mechanizing all phases of mining operations. Today, machines that eliminate entirely the need for cutting, drilling and blasting the coal are being used in increasing numbers. These machines, known as continuous miners, perform the whole job of mining and loading in a single operation.

For development & poverty reduction measures, Energy plays important role and hence it is described as “the backbone of civilization”. It is presumed that World's population would increase from six billion, currently, to over eight billion by 2030. With this explosion of population and particularly, with the emerging dynamic new economies, the pursuit of quantity-wise and quality-wise affordable and reliable source of energy is presenting unprecedented economic, social and environmental challenges. Finding ways to provide energy, those will lift emerging nations’ economies, provide employment and boost quality of life across the globe, and to do so in a way which is within the means of the common mass, is the major challenge before the energy providers. Worldwide, coal is an extremely important fuel as it is most abundant and widely distributed fossil fuel source and energy from coal is cheaper. About 29.6% of primary energy needs are met by coal (source: BP Statistical June, 2011) and 39% of electricity is generated from coal. About 70% of world steel production depends on coal feedstock.

The energy dependence on coal is more pronounced in case of developing countries like India and China. In India, coal is currently the prime source of energy as it provides about 52% of the commercial energy and about

67% of the electricity generation is coal based. The dominance of coal as energy provider is likely to continue in foreseeable future. It is estimated (as per Integrated Energy Policy of Planning Commission of India-Aug, 2006) that requirement of power generation capacity of 8 lakh MW by 2031-32 in the country will translate into a massive need for coal availability to a level of over 2 billion tonnes / annum based on domestic quality of coal. Even in the least coal dominant scenario with enhanced contribution from renewable, nuclear and hydroelectric sources, the coal demand has been estimated to be about 1582 Mt (632 Mtoe). Against the backdrop of this mighty coal demand, the availability of lesser amount of coal indigenously, forcing increasing import of coal with time, is a matter of concern and this in turn, would remain the prime driver of all initiatives for increasing the coal production in the country. Moreover, the burgeoning coal demand supply gap necessitates, Coal India Limited, the Maharatna Public Undertaking and the largest coal producer company in the world, having the mandate to meet the country's coal requirement under the National Coal Distribution Policy, to come up with further initiatives for stepping up coal production and meeting up the gap even through import of coal. This necessitates pro-active strategies for bridging the gap to the extent possible.

India is the world's third largest coal producing country and the fourth largest coal importer. The country continues to significantly rely on coal for electricity generation, and this abundant and affordable fossil fuel accounts for 69 percent of the country's electricity output. As coal will continue to power a large and possibly even increasing share of the Indian economy in the foreseeable future, managing the negative side effects of the coal industry should be seen as a continued priority.

II. STATISTICS – INDIA'S SCENARIO IN RESPECT OF COAL

India has very large fossil fuel resources, but there is significant uncertainty in quantifying the precise amount of coal reserves. The statistics regarding reserve, production, consumption in respect of India is appended below:

Proved recoverable coal reserves of Anthracite & bituminous coal in India is estimated as 56100 million tons and for Lignite coal it is 4500 Mte, i.e. total 60600 Mte which is 7% of world's reserve.

At the current rate of **production**, it is presumed that it will be consumed in 103 years.

2003	2004	2005	2006	2007	2008	2009	2010	2011	India's Share of production (Global)	Reserve life(Yr)
375.4	407.7	428.4	449.2	478.4	515.9	556.0	573.8	588.5	5.6%	103

The **consumption** of coal is as under: (In Million te)

2008	2009	2010	2011	India's Share of consumption (Global)
641	705	722	788	9.9%

Although, there is higher trend in production level i.e. from 375 Mte in 2003 to 588 Mte in 2011, due to increase in demand, coal is being imported. From 2006 till 2010, following quantity of coal was imported.

2006	2007	2008	2009	2010	India's Share of coal import (Global)
52.7	29.6	70.9	76.7	101.6	8.6%

From above statistics it is evident that the increase the production by all possible means is required from indigenous sources rather than depending on import.

The average mechanized mine in India had an out-put of 3.8 tons per man-shift in 2008, while manual mines operate on levels of 0.4 tons. In comparison, the United Colliery in Australia reports to achieve an output per man shift of 65 tonnes. In order to increase productivity it requires a shift towards large scale open pit mining where the heavy mechanization is applied. In 2005 around 80 per cent of coal production in India came from open-cast mining, this compares to 20 per cent in 1971. On contrary, the underground production declined from 50.56 to 43.54 million tonnes during the period 2001 to 2008.

The imports of coal increased rapidly over the last three years, from 70.9 million tonnes in 2008 to 76.7 million tonnes in 2009 and to 101.6 million tonnes in 2010. Total coal production in India rose from 30 Mt in 1945 to 72 Mt in 1972 (before nationalization) to 89 Mt in 1979, 200 Mt in 1992, 345 Mt in 2001 and 526 Mt in 2011 Mt (out of which 430 Mt contributed by Coal India Limited). Regarding work force, the estimated official work-force before nationalization (1951) was 350,000 and in 1972 it was 1100,000. The permanent workers in CIL were reduced gradually from 700000 in 1981 to 380000 in 2011 in spite of increase in production.

Table 1

YEAR	PERMANENT WORKERS
1981	700,000
2003	650,000
2008	450,000
2011	380,000

Above statistics indicates the effect of introduction of mechanization at opencast and underground coal mines.

III. Coal Demand, Availability and Production

The Integrated Energy Policy (IEP) document of Planning Commission (Aug., 2006) presented several alternative scenarios of energy mix to sustain a GDP growth rate of 8% till 2031-32 where the requirement of coal based energy has been projected to vary from 1022 Mtoe (2555 Mt) for a coal dominant scenario to 632 Mtoe (1580 Mt) in the scenario considering utilization of full potential of nuclear, hydro and renewable resources along with all energy conservation measures.

The 'Working Group on Coal and Lignite for XII Plan period' in its report has projected a coal demand of 980.5 Mt by the terminal year of XII Plan i.e. 2016-17 as indicated in Table-2.

Table – 2: Projected Coal demand in XI and XII Plan (in Mt)

Particulars	Demand in Terminal year of XI Plan i.e. 2011-12			Projected demand in terminal year of XII Plan (16-17) as per the WG for XII Plan period (draft report)
	Original estimate	Mid Term Appraisal	Actual	
Total (Mt)	731.10	713.24	634.35	980.5

Customer/Sector-wise break up of assessed coal demand for 2016-17 is indicated in Table-3.

Table – 3: Customer / sector-wise break up of assessed coal demand for 2016-17

Customer / sector	**Demand assessed (Mt)**	**Demand in % of total demand**
Power Utility	682	69.6
Power Captive incl. fertilizer	56.36	5.7
Cement	47.31	4.8
Sponge Iron	50.33	5.1
Others	77.3	7.9
Total non-coking	**913.3**	**93.1**
Coking	**67.2**	**6.9**
Total	**980.5**	**100**

3.1 COAL PRODUCTION IN INDIA

Following Table– 4 indicates the coal production during the X and XI plan periods -

Table-4: Coal Production in India (Figs. in Mt)

Coal Producers	Actual production during X plan		Actual production during XI plan	
	2002-03	2006-07	2007-08	2011-12
CIL	290.69	360.91	379.46	435.83
SCCL	33.23	37.71	40.60	52.21
Other PSUs	1.51	1.77	2.11	2.71
Total PSUs	**325.43**	**400.39**	**422.17**	**490.75**
Tata Steel & Captive Blocks	11.44	24.65	28.38	41.98
Meghalaya	4.40	5.79	6.54	7.21
Total Others	**15.84**	**30.44**	**34.92**	**49.19**
ALL INDIA	**341.27**	**430.83**	**457.08**	**539.94**
UG	63.16	57.75	58.90	51.83
OC	278.11	373.08	398.18	488.11
Total	**341.27**	**430.83**	**457.08**	**539.94**
Coking	30.19	32.08	34.46	51.65
Non-Coking	311.08	398.75	422.63	488.29
TOTAL	**341.27**	**430.83**	**457.08**	**539.94**
	CAGR 5.6% in X Plan period		**CAGR 4.35% in XI Plan period**	

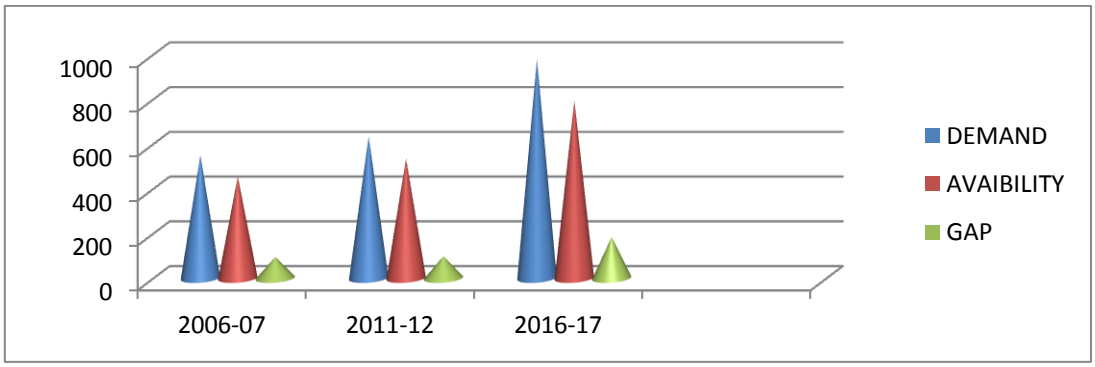
Projected coal production (Mt), in terminal year of XII Plan i.e. 2016-17, under 'Optimistic Scenario' would be 795 Mte.

Delivering of requisite clearances within specified time schedule and addressing issues affecting land acquisition, R&R, law & order and infrastructures for coal evacuation, effectively, in a time bound manner have been spelt out as the conditions under the Optimistic scenario for the envisaged production of 795 Mt by 2016-17. Contribution from CIL in this projected production would be 615 Mt. However, it has also been projected that the production may reduce to a level of 715 Mt in the country by 2016-17 if the requisite clearances and issues affecting land acquisition, R&R, law & order and infrastructures for coal evacuation are not delivered in time. CIL production in such condition (Business as usual) would be about 556 Mt.

3.2 PROJECTED DEMAND-AVAILABILITY GAP FOR COAL

Exhibit–1 illustrates the widening of coal demand & availability gap over plan periods

COAL DEMAND vs AVAILABILITY FROM INDIGENOUS SOURCES



Exhibit–1.

Production under the 'Optimistic scenario' would result in a demand-indigenous availability gap of about 185 Mt which may rise to level of about 265 Mt in the Business As Usual scenario as shown in Exhibit-1.

Furthermore, the demand-indigenous availability gap projected for 2016-17 would rise further during successive plan periods. This necessitates immediate strategy to augment the coal production to the extent possible to reduce the gap and import requirement. CIL, being the major coal producer and supplier of over 40% of the commercial energy of the country has to come out with pro-active strategies for enhancing its coal production level.

IV. Strategy For Stepping up Coal Production in CIL

Production achievement by CIL during XI Plan was at a CAGR (Compound Annual Growth Rate- The CAGR calculator is a useful tool when determining an annual growth rate on an investment whose value has fluctuated widely from one period to the next) of 5.6 % which came down to 4.4 % during XII Plan. Enhancement of coal production from a level of about 435 Mt during 2011-12 to a level of 615 Mt under 'Optimistic Scenario' by 2016-17 would entail CAGR of 7.2%. Moreover, achievement of 615 Mt by 2016-17 by CIL would not be enough to limit the increasing import of coal in the country and the country would have to resort to growing import to meet the requirement of various consumers in the country. To restrict the import to the extent possible by augmenting the coal production level, the strategies would involve the following steps:

OPERATIONAL INITIATIVES BY CIL

4.1 ENHANCEMENT IN THE PACE OF EXPLOATION

CMPDI, the Mini-Ratna subsidiary of CIL, is the agency entrusted with the job of proving the coal resources through detailed drilling. To sustain the program of detailed exploration beyond XII Plan at an enhanced rate of drilling of over 10 lakh meter per annum will need the commensurate enhancement in the efforts on Regional/Promotional exploration.

4.2 FASTER PROJECTISATION OF NEW BLOCKS

Apart from necessity of maximizing production availability from the existing coal blocks of CIL, from where 615 Mt of coal production has been envisaged by 2016-17, additional blocks including the 119 nos. allowed to be retained by CIL recently, should be considered for development at the earliest as soon as the exploration in such blocks are over. These 119 blocks have been tentatively estimated for a total capacity of about 240 Mty. Out of these, 45 blocks will have opencast mines and 57 blocks will have underground mines whereas as the balance 17 blocks will be with mixed mines. Early development of these blocks will provide CIL a comfort in meeting the demand-supply gap.

4.3 DEVELOPMENT OF PROJECT THROUGH MDO ROUTE

Introduction of Development Operators in the infra-structure development in the country has been of help in enhancing its pace of development. Though outsourcing plays a major role in CIL's performance in terms of coal production and OB removal, development of the mine similar to development by MDOs **(MINE DEVELOPMENT OPERATOR)** is being practiced only in few mines like Rajmahal OC of ECL.

Nonetheless, CIL has no option but to try again for engagement of MDOs in underground mine development through various initiatives and relaxations. Also, considering the delay in land acquisition, law and order and other problems associated with open cast project development, wider engagement of the Development Operators for open cast mines/projects might result in crashing the activities of mine development and early realization of the production from such mines. Realization of the gains of engagement of MDOs in some of its projects would also set the trend in respect of wider engagement of the MDOs.

4.4 UNDERGROUND MINE CAPACITY ENHANCEMENT

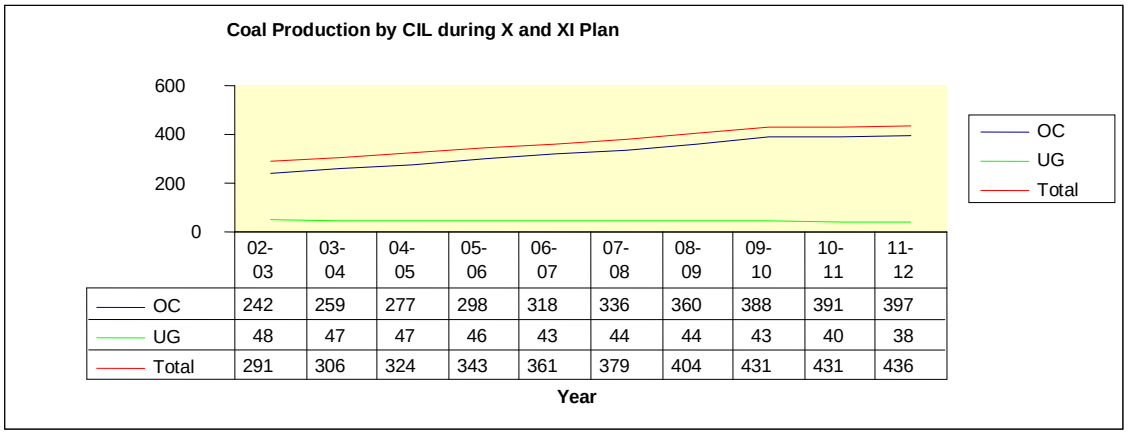
Opencast mining method dominates the mining scenario in CIL as it produces over 91 % of the coal produced by CIL. The reasons are growing demand, easier mining method where geo-mining adversities have much lesser impact, availability of bulk handling machineries, etc. All of this has put the underground mining in the back stage. However the actions have been taken to mechanize UG mines in CIL as detailed below.

V. Actions Taken for Mechanization by CIL

Exhibit-2 indicates the reduction in importance of underground mining in CIL in the total production scenario where the underground performance has dwindling trend over the years. However, the limited shallow depth reserves amenable to opencast mining are likely to be exhausted in foreseeable future (may be after 25-30 years) and the production from opencast coal mines in CIL

may reach a plateau. The resulting imbalance in production cannot be set right as large scale production suddenly is not possible from underground mines. Also, the gestation period in case of underground mines is generally more in case of underground projects

Exibit-2



	02-03	03-04	04-05	05-06	06-07	07-08	08-09	09-10	10-11	11-12
OC	242	259	277	298	318	336	360	388	391	397
UG	48	47	47	46	43	44	44	43	40	38
Total	291	306	324	343	361	379	404	431	431	436

The reply lies in introduction of bulk production technologies in underground mines on urgent basis as planning, execution and adaptation will take considerable time. Though, the efforts in late 1970s and early 1980s of introduction of Power Support Longwall in CIL mines on a large scale could not be successful due to various reasons, it became very successful in China. In comparison to 400 longwall faces and an estimated 2.5 million tonnes of coal production per unit per annum in China, India has only a few longwall faces with a very low production. Statuses of initiatives taken by CIL for mechanization and production enhancement efforts in the recent past are indicated below:

- Continuous Miners (CMs) have been presently deployed 7 mines of CIL with a total capacity of 2.78 Mty.
- At present, two types of the bidding routes, namely “Risk-gain sharing basis” and “Hiring basis” are being followed for deployment of CMs. except Pinuara and Rani Atari in SECL; all other Continuous Miners have been deployed on the basis of “Risk-gain sharing basis”.
- Also, 19 Underground Projects with Continuous Miner Technology with a total capacity of 11.69 Mty have been approved.
- Continuous Miner (8nos) can be deployed on hiring basis (potential blocks but further study is needed prior to finalization) are given in below:
- Work orders have already been issued to MDOs to operate five mines (Jhanjra in ECL, Kapuria, Moonidih (both XV & XVI seam), and Muraidih in BCCL) by **longwall technology**. Likely capacity addition from these mines will be around 8.9 Mty. Several such mines are in pipe line.
- Efforts are also being made to identify suitable prospective sites for application of **Highwall Mining** which is a mining method to extract coal from an exposed coal seam at the terminating line of an opencast mine. Coal is extracted by driving a series of parallel entries from the high wall up to a significant depth within the coal horizon. This technology allows recovery of coal blocked in the batter in opencast projects. At present, this technology has been implemented in **Sharda Opencast project** of SECL.

Continuous miner technology will drastically increase the production, productivity and safety in the underground mining. It is convenient with both caving as well as non-caving method of mining. Using continuous miner technology high production can be achieved. It can be utilized for development as well as depillaring of developed pillars. It can give an average of 74- 75% of extraction. The machine has worked for an average of only 54.78 %.The machine can give good production rates if we can increase the working hours. This technology promises greater safety. The proper utilization of the equipments can give greater

production rate. The reliability analysis shows that the machine is reliable about 95.56% where as probability of failure is only 4.45% .this indicates, it is more reliable.

Geo-mining condition of Indian coal deposits has been the major reason responsible for this lackluster performance in coal production from UG mines. Apart from the successful implementation of the aforesaid actions by CIL, a deeper assessment needs to be made in finalization of the strategies which may include the following points –

- Planning of all new mines with higher degree of mechanization i.e. with Longwall, Continuous Miners, etc. wherever applicable.
- Preparation and adherence to Time-bound technology plan including introduction of new technology to improve productivity.
- Preparation of road map with engagement of MDOs.
- Separate cadre in CIL for Underground mining with attractive avenues to motivate for performance.
- Preparation of Infrastructure development plan including prioritization of construction of rail/road/railway siding and faster development of infrastructure for UG mines.
- Creation of machinery manufacturing facilities to support mechanization.

VI. Enhancing Coal Evaluation Capacity Through Infrastructure Development

Infrastructure development (rail, road & power) in coalfields, particularly in new emerging coalfields, though call for considerable investment, is essential to augment the evacuation capacity of coal from its existing level. Necessity of establishing and expanding the infrastructure facilities (rail, road and power) in new emerging coalfields like IB Valley, Talcher, Mand Raigarh and North Karanpura coalfields can be established from the future production assessment from these coalfields as indicated below (source Master-plans prepared in 2010).

Considering the necessity of infrastructure development in the coalfields in entirety, there needs to be a mechanism of joint sharing of the investment requirement in these infrastructures between CIL and the existing and future captive producers. There may be a case where CIL can invest initially and which may be shared at later stage by other users including captive parties.

OTHER STEPS INCLUDING POLICY INITIATIVES BY THE GOVERNMENT

In order to maximize production of coal, the various limiting factors, deterrent to increasing production and severely faced by the coal sector, need to be addressed by the Government. The Government has to take certain initiatives in this regard. The issues are:

1. Labour Laws
2. Land and R&R
3. Environment Clearance (EC) and Forst Clearance (FC)

VII. Impact of Mechanization of the Coal Industry

When the socio-psychological factors associated with new technology are not thoroughly understood, then expected improvements are unlikely to be achieved and very often there are losses rather than gains.

A proposed new method of work organization was identified; the composite work method. This method developed as a result of understanding that the primary task of a face system is the daily completion of the production cycle and not the maximization of tons produced. It was found that by using a conventional work organization approach, workers were encouraged to maximize their part of the cycle, often to the detriment of the cycle as a whole. Production was optimized by changing to an approach that maximized cycle completion. It is a shift towards machine-centered work culture.

The principles of the composite work method are based on task continuity and the ability of the team to be flexible and adapt their work to ensure cycle completion. It is acknowledged that in the mining environment the conditions in which workers operate are constantly changing and that rigid tasks, cycles and methods are often unable to cope with this. In the composite work method, workers are structured in teams. Each team comprises experienced and competent workers who need not be competent in every task but the team as a whole must be competent in the entire cycle. Teams are also formed across shifts, which encourages teamwork across shift boundaries and ensures that cycles of production are not optimized on a shift by shift basis. A composite remuneration package complements the work organization. This includes a basic component and an incentive component that all team members (from all shifts) share equally based on production tons. As a result of this work method, workers developed systematic methods for the rotation of shifts and tasks. Having experienced all phases, workers are more readily able to evaluate the state of the cycle and adjust work pace and pattern of deployment to each situation. Workers also become acutely aware of the consequences of sub-standard work on other phases within the cycle or subsequent shifts. Another key feature of the composite work organization related to management and responsibilities. In a conventional work organization overall cycle responsibility was taken at a level three hierarchical steps in managerial rank from the face, with supervisors and foreman having only shift responsibilities. This once again reinforced a sub-optimized approach not focused on overall cycle completion. The composite work organization moved the responsibility of cycle completion to the face workers. Maximum machine running time depends on rapid and effective ways of redeploying people and adapting activity to changing demands, which requires a self-regulating team with decision-making authority and formal communication systems within the team. Team leaders were then the link between their own team, other team leaders and the management of the face.

As a result of the interdependence of different aspects of the cycle, anticipation and counteraction became more critical skills required by team leaders and management. As production became more continuous, managers became more focused on providing conditions that permit faces of high potential productivity to achieve maximum output. The managers could no longer be supervising the detail of the work of face groups. It was also observed that critical to the success of mechanization was the actual implementation process of the technology change. A move towards mechanized mining is inherently complex, particularly regarding the structuring of shifts and tasks. It was therefore important that teams developed a learning ability through experimentation and that they were able to disseminate the experience gained. The implementation of new technology also needed to be approached and protected as an operational experiment until technical success and social adaptation had been successfully achieved. Mechanization was not successful when treated as an ordinary training and development project working under the stress of a demand for full production. Teams needed to be carefully selected and planned and populated with the most experienced and skilled people. These teams were then used to coach upcoming teams. And finally, for successful change, it was found that continuous and active leadership was required from the highest level within the organization.

VIII. CONCLUSION

An in-depth understanding of the drivers for increased mechanization is important to ensure that mechanization is adopted for the reasons that are proposed for increased productivity, improved safety and reducing the incidence of low-skilled work. Increased productivity improving overall productivity (not just labour productivity) is probably the most important driver for increased mechanization.

Mechanization of the coal industry contributed to the rapid industrialization of this nation. During each phase of development, problems were addressed by more innovative mechanization and creative miners who encountered these problems. The main goal of mechanization is to raise labour productivity and free labour from heavy labor intensive, dangerous and fatiguing operations. Mechanization of coal production promotes rational and economical use inputs and reduction of prime cost and improvement of production quality. In addition to improvement and replacement of better equipment and production processes, mechanization of production is closely linked to rise in the level of workers skill, safety and production organization and to the use of methods of scientific organization of labour. Mechanization of coal production is one of the main avenues of

technical progress for production increase to a level of our need. It ensures development of production forces and serves as the material base for raising the efficiency of coal production which is being developed by intensive methods.

From the above, it can be construed that the appetite for energy in the world is growing, particularly in developing countries like India, as it is fast on course to industrialization and urbanization. Onus of fulfilling the coal supply requirement of the country primarily rests on CIL. CIL is likely to remain as a dominant player in Indian coal industry in foreseeable future also. In order to restrict the gap between demand and indigenous coal availability to further rise, the extent possible, in coming years, CIL has no option but to raise its production level to a great extent by mechanization. Apart from mechanization, Coal production cannot be started without possession of land, solving R&R problems, the socio-psychological factors, getting Environmental and Forestry clearances as well as addressing the coal evacuation problems. Additionally, issues like faster exploration requirement including drilling capacity augmentation, enhancing pace of projectisation for existing and new coal blocks, emphasis on coal production from underground mines, etc., are required to be addressed by CIL for stepping up its production.

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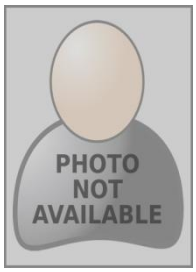
List of abbreviations

CIL- Coal India Limited, BCCL- Bharat Coking Coal Ltd, CCL- Central Coalfields Ltd, ECL- Eastern Coalfields Ltd, WCL- Western Coalfields Ltd, SECL- South Eastern Coalfields Ltd, MCL- Mahanadi Coalfields Ltd., CMPDI- Coal Mining Planning & Design Institute, CIMFR- Central Institute for Mining and Fuel Research, Mtoe- Million Tonnes Oil Equivalent, Mt- Million Tonnes, PSU- Public Sector Undertaking, IEP- Integrated Energy Policy, GDP- Gross Domestic Product, CAGR- Compound Annual Gross Rate, MDO- Mine Development Operator, EC- Environment Clearance, FC- Forest Clearance

AUTHOR(S) PROFILE



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