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Shri Prabir Kumar Raychaudhuri
Director & Chief Regional Coordinator

Date: 25.07.2018

MESSAGE

It is a great pleasure for me to know that Indian Mining & Engineering Journal organizing National Workshop on "Safety Management of Mining Machinery" on 28-29th July,2018 at Ranchi.

Events of such nature are very important for Mining Industry. I hope that, this Workshop will bring great benefit to the Mining Community.

I would like to extend my Best Wishes to the Organizers for success of the Program.

(Prabir Kumar Raychaudhuri)

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Special Number on
Safety Management of Mining Machinery

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"My life is my life" - Paradigm towards Enhanced Safety

Naveen Kumar* Ranjan Gaurav*

ABSTRACT

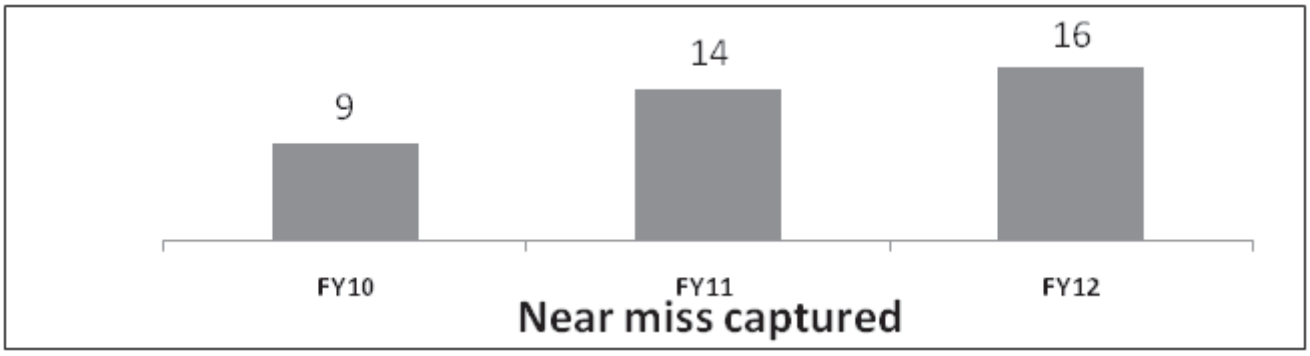
A risk assessment should be performed to develop an appropriate isolation scheme.
Positive isolation at Tata Steel is a method to totally isolate equipment or a section of the plant from a live process where in no leakage is tolerated due to the risks involved. This assessment should consider the task of performing the isolation together with what the isolation is required for.
1. To properly apply this procedure in all circumstances, one must understand the intent of the procedure, which is to ensure the safety of personnel who will be performing the work. Operating and maintenance work shall be done without injury to personnel, equipment damage or causing environmental damage.
2. Personnel using this procedure must assume responsibility for their individual safety and that of fellow employees and always remember that doing the job in a safe manner is more important than such things as saving time, avoiding effort, increasing convenience or increasing production.
Positive isolation while performing maintenance or repair activities on process facilities means that,

- ***All the hazardous energy sources must be identified***
- ***All hazardous energies must be isolated at the source***
- ***Residual energies must be eliminated.***

INTRODUCTION

As the above figure depicts the detailed journey of safety at West Bokaro as how it has gradually evolved over the years. ByFY12,data of near miss against failure in shutdown processes continuous rise triggered focused approach towards positive isolation implementation which can be depicted in the graph as near miss category.

*West Bokaro Division, Tata Steel Limited



Detailed plan for implementation of Positive Isolation have been made among the group of departmental Heads and safety professionals which started with identification of responsible persons to carry out positive isolation activities, training plan, provision of locking arrangement in all equipment's, locks distribution to all concern in a phased manner.

Implementing Positive Isolation in West Bokaro Mines

RESOURCE MANAGEMENT

A.Human Resource Management

a. For each discipline like Electrical/Mechanical/ Operation etc persons should be identified who will be responsible for executing the Isolation jobs.

- Each Department identified the Accredited/Authorized Persons for every type of job. Only these persons were Authorized to do energy isolation for doing the job. These persons shall be defined as Isolating Persons.
- The general guidelines for approving authorized persons was given in detailed positive isolation procedure. Based on the guidelines departmental Hods approved the list of Authorized persons for each category of jobs for all disciplines of the department.
- The list of Authorized persons for each category of jobs maintained in the department register and was approved by departmental Chief/Head. This document was a Quality system document and was auditable.

b. All employees (who shall work in the field after taking the work permit) of the department and All the Contractor's workers & supervisors were given training for the "Training Level-1" covering basic elemental concepts which made them qualified as Protected Person.

Training in specific Isolation tasks were the responsibility of the department. Records of person trained were kept by the department.

- Isolation Planners, completed Isolation Training Level-2.
- Protected Persons completed Isolation Training Level-1.
- Isolating Persons completed Isolation Training Level-1A.

c. For each discipline like Electrical/Mechanical/ Operation etc few senior and knowledgeable officers were identified; These persons shall be responsible for making the "Energy source Identification" document for each discipline and preparing the Procedures for Complex Isolation.The Energy Source identification is a document contained the following details about Isolation for each maintenance job

1) List of Isolation points,
2) Method of Isolation,
3) The locking points.

- The purpose of this document was to have an established and approved procedure for all energy Isolation so that no deviation occurs in the method of Isolation and locking points by different persons. Format in the Annexure.

B. Material Management:

- Each department assessed and planned to arrange the requisite number of Locks of each category. Altogether four types of locks were used for the four different purposes and were identified through their distinct color.

a) Red Color Lock —— Self-protection Tata Steel Employees
b) Blue Color Lock —— Contractor's supervisor shall put for himself & on behalf of his workers
c) Black Color Lock —— Group lock
d) Yellow color Lock —— Equipment Lock

- The requirement for the boxes for storing the Equipment Locks and Group Locks was assessed and procured through stores. These boxes were kept in the MCC shifts who are responsible for issuing the work permit.
- The requirement for the number of Group Isolation Boxes was assessed.
- Suitable locations for the Group Isolation Boxes was identified and these Group Isolation Boxes were installed there.
- The necessary number of scissor locks of various sizes were drawn for the various section of the department.

The Tag for the Group lock shall bear the following information: —

a) Name of Equipment
b) Isolated by:
c) The Group Isolation Box

• The Tag for the Equipment lock shall bear the following information: —-

a) Name of Equipment
b) Isolated by
c) The Group Isolation Box No (if any)

C. Document Management:

Each department shall maintain records as mentioned below: —-

a. Responsible persons list (list of protected persons, isolating persons etc.)
b. Records of person trained were kept by the department.
c. ESI document, control stop documents etc.
d. Audit and its compliance Records.

METHODS OF ISOLATION

General: There are four methods of Isolation
a) Control Stop Isolation;
b) Individual Isolator Isolation;
c) Group Isolation;
d) Isolation for working alone

Control Stop is a method of stopping Equipment (where Isolation is not used) for the performance of short duration, low risk routine tasks.

Where Control Stop can be used: Control stop system shall be applied to routine tasks where full isolation of energy is impractical to implement.

Where Control Stop can NOT be used: Control Stop System shall not be applied to, nor exemptions granted for the following job which are:

Control Stop Indication

How to achieve control stop:

- Routine Task
- Short duration task
- Low level of Consequences

Procedure for the Control Stop

The executing agency which wants Control Stop shall request the Isolating Agency (Electrical/Mechanical/ Operation etc) for Control Stop and indicate the details of the job for which the Isolation is being demanded.

LIFE SAVING RULES RELATED TO POSITIVE ISOLATION

- Any deviations from this Positive Isolation Procedure were reported and investigated immediately. The responsibility for the investigation and follow up lies with the supervisor of the people involved, the Supervisor of the Equipment and their managers.
- Investigations of deviations to this Procedure were reported in accordance with the current Accident and Incident reporting system.

VIOLATIONS OF POSITIVE ISOLATION RELATED RULES

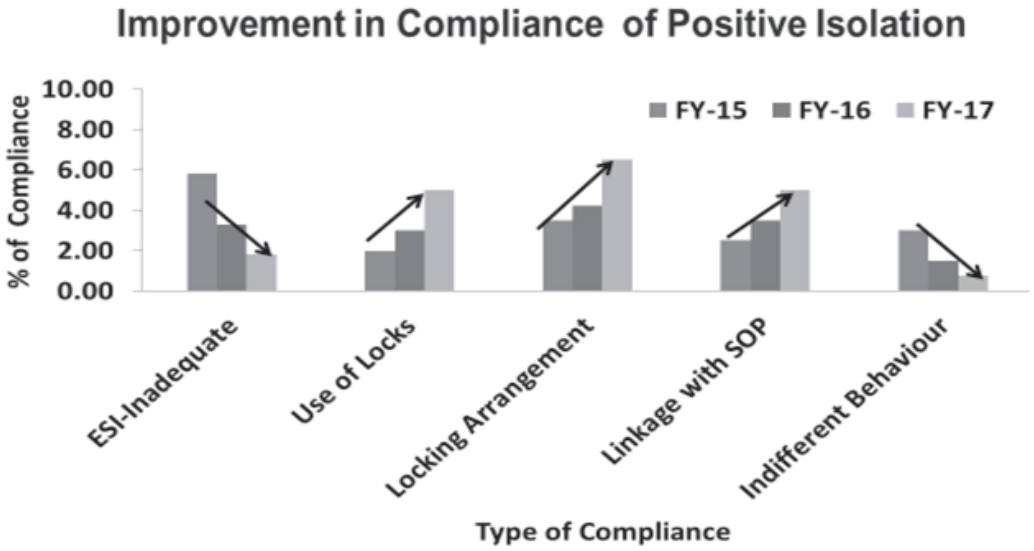
Disciplinary action in respect of violation of Positive Isolation related rules were as follows:

A) Offences that might lead to an employee being liable for dismissal:
- Intentionally removing another person's Personal Lock without following the steps defined in this procedure.
- Intentionally energizing and/or operating Equipment that has an Isolation lock attached.
- Intentionally working on Equipment that has not been Isolated and for which Positive Isolation is required as per the procedure.

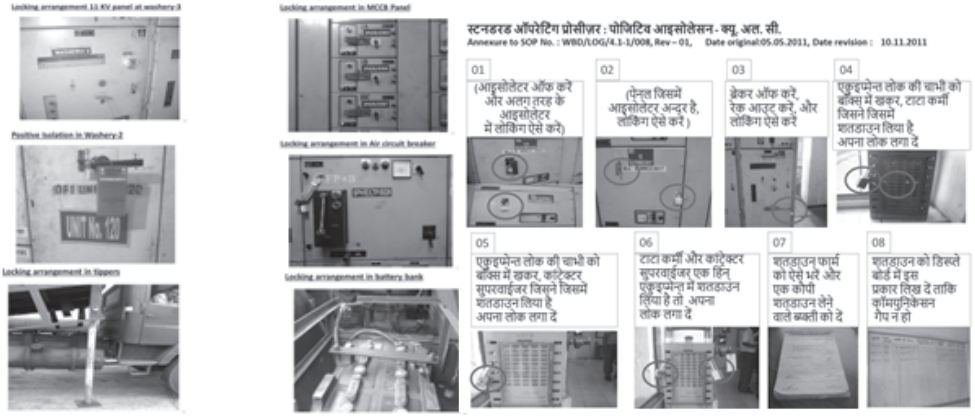
B) Offences that may lead to an employee being liable for disciplinary action:
- Failure to remove one's own Personal Lock at the completion of job or at the end of the shift.

- Intentionally working on Equipment that has been Isolated but not Locked.
- Repetitive incidences of misplacing Isolation Locks/ keys.

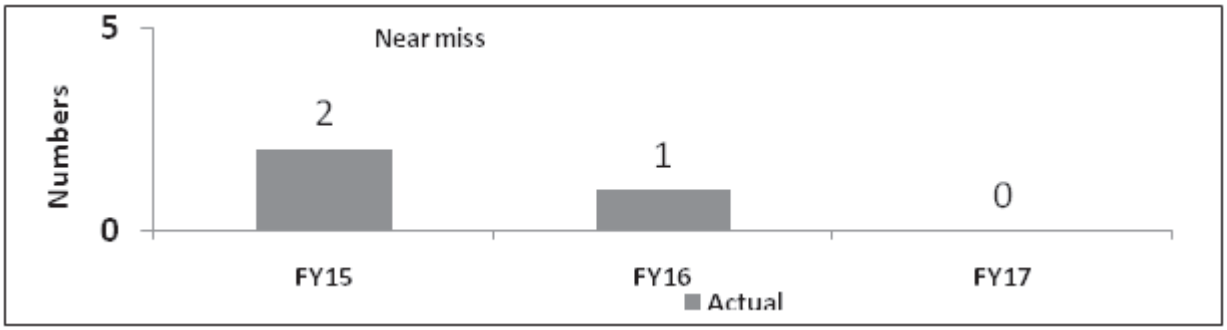
With these above initiatives and continual review of the plan and its compliance through internal audit team of safety personals and Heads of the department, with regular training of all employees and contract workers improved the compliance level of positive isolation across the department. Below is the internal audit team compliance report as depicted:



Below are few of the pictures depicting positive isolation system implemented at department level.



After the implementation part of positive Isolation number of near misses has the significant drop from FY15 onwards. Below graph depicts.



CONCLUSION

The primary objective of positive isolation is to provide a safe environment for performing maintenance, repair or replacement operations on process facilities.

Standard are made to effectively to make a workplace a safe place. A risk assessment should be performed on continual basis to develop an appropriate isolation scheme with introduction of new equipment's or area.

Annexures

Definitions

Complex Isolation: Complex Isolation is when more than three Isolators or more than two types of Energy Sources are involved. All complex Isolation shall have a written procedure.

- Control Stop: Control Stop is a method of stopping Equipment (where Isolation is not used) for the performance of high frequency, short duration, and low risk routine tasks. A separate Control Stop procedure is to be developed. Control Stop procedure shall not be used for High voltage system.
- Energy Source: Any source of electrical, mechanical, hydraulic, pneumatic, chemical, thermal, radioactive, gravitational, potential, Moving locomotive, EOT crane or other energy.
- Energised: Equipment connected to an Energy Source or containing process material or stored energy.
- Equipment: All process machines and service systems including units such as pumps, compressors, and piping systems such as refrigeration Equipment, heating and ventilation systems, lighting, tools, instrumentation and circuit breakers etc.
- Equipment Lock: A lock attached by an Isolating Person to an Isolator in the safe position to prevent accidental or inadvertent movement. Colour-Yellow.
- Group Isolation: This is a preferred system of Isolation when a number of people are involved and/or a number of Isolators are to be locked.
- Group Lock: A lock attached by the equipment owner who is issuing the working clearance to a Group Isolation Box and to secure Equipment Lock keys. Colour-Black
- Group Isolation Box: A box that is used exclusively for Group Isolation and is considered identical to an Isolator when used with this Standard.
- Interlinking of Group Isolation Box: When the situation demands for use of more than one Group isolation box for a particular job (suppose two Group isolation box A and B), both the Group isolation boxes should be interlinked.
- High voltage: A voltage exceeding 650V (This does not include 650V) under normal conditions however the percentage variation as per IE rules is allowed.
- Isolator: A device which positively separates or blocks the Energy Sources to Equipment, the device is not capable of remote operation whilst in the Isolation position. Devices such as push buttons, emergency stops, Limit switches, and rail wedges are not Isolators.
- Isolating Device: A mechanical device that physically prevents the transmission or release of energy. The following are examples but not exhaustive, of an Isolating Device
- Isolation: Separating or blocking the energy and removal of residual energy beyond the energy block, and control measures taken to prevent unauthorized removal of the energy block.
- Isolating Agency: A department or unit which is authorized to execute Isolation of the Equipment such as particular section Mechanical /Electrical
- Isolation Boundaries: This describes the extent or coverage of the Isolation where people are protected by their Personal Locks.
- Isolating Person: A person who performs Isolation and who is Authorized under this Procedure. Each Department shall identify the Accredited/Authorized Persons for every type of job. Only these persons shall be Authorized to do the energy isolation for doing the job. These persons shall be defined as Isolating Persons.
- Isolation Planners: These persons shall be normally senior persons of the department/section. Isolation planners shall be responsible for preparing and maintaining the isolation procedure for the complex isolation and energy source identification document for particular discipline of the department.
- Isolation Procedure: A document which defines what Equipment is to be isolated and how the Isolation shall be done. This document is used when the Isolation is being performed.
- Protected Person: Those who will attach their personal lock to a isolator or a group isolation box for Tata Steel Employees or those contractor's workers on whose

behalf their supervisor has placed the lock along with the list of workers.

General Guidelines for devising Unique Equipment number for Electrical /Mechanical equipment.

- The number shall have the format xxx / yyyy /zzz/ nnnn. Here the x, y and z shall be English alphabets while n shall be digits.
- The "xxx"shall indicate Plant Like Washery-2, Washery-3,Coal Handling Plant respectively.
- The "y" shall be necessarily E indicating that the Equipment is under electrical Department. Similarly, M may be used for Mechanical.
- The "zzz" shall indicate the section in particular department.
- The "nnnn" shall be four digit number and this number shall be unique across the particular Plant.

Annexure-1

Format for Energy Source Identification (Having Single type of energy source)

Department: **Section:**

S No	Equipment Details		Type of Job	Details of Positive Isolation			Remarks
	Equipment Name	Equipment Number		Method of Isolation	Location of Isolation locks		
					Panel No / Valve no.	S/S or MCC location / Valve location	

Note:

1) In the Method of Isolation the details of Isolation (Like breaker to be racked out, discharging to be done, permanent earthing to be done at particular location, Valve to be closed etc.) .
2) The type of job may be categorized based on the basic philosophy which may affect the method of Isolation method. Like the jobs which may not require or require direct exposure to electrical parts.
3) No column shall be left blank. If some column is not applicable in a particular case then "NA" shall be written to ensure that it is not simply a miss but a considered view.
4) If the single source energy is electrical then panel no/MCC or S/S should be mentioned other than that Valve no, location or any other details giving information about the location should be given.

Prepared by **Approved by**

(Level#2 trained officer of a particular Energy Source) **(Departmental Head: Owner of the particular Energy Source)**

Annexure-1B

Format for Control Stop

Department:

Section:

S No	Equipment Details		Job Description	Isolation Details			Control Stop Procedure no.	Remarks
	Equipment Name	Equipment No.		Method of Isolation	Switch/ Valve no.	Location		

Note: 1. In the Method of Isolation the, details of Isolation (Like control stop switch to be made off, valve to be closed) shall be mentioned.
2. No isolation lock is required for control stop.

Prepared by **Approved by** **Approved by**

Chief/ Head of operation **Head/ Sr Manager of Safety**

REFERENCES

SAFETY STANDARD –**Positive Isolation Procedure** SS/GEN-26, Version-10

Benchmarking Study For RAJMAHAL Project of Eastern Coalfields Ltd

Ashish Kumar*

ABSTRACT

Located in Godda district of Jharkhand, at a distance of 120 KM. from Jashidih via NH 133, Rajmahal Project is the largest project of Eastern Coalfields Ltd in terms of volume. The project delivers power grade coal.. The mine management has been putting efforts in various ways to improve efficiency in operations under various areas. In this paper, an attempt has been made to highlight the methodology adopting to take up 'benchmarking study'. This study was conducted on departmental activity which is as of now limited to removal of OB, where the specific consumption of HSD for OB removal has been concluded at 1.115 lits/m^3.

INTRODUCTION

The Rajmahal coalfields comprises several small isolated patches of lower Gondwana rocks aligned in a North-South direction along the western flank of the Rajmahal Hills. The exposed coal-measure rocks which cover an area of nearly 325 sq.km are distributed mainly in five coal basins, viz,- Hura, Chauperbhita, Pachwara, Mahuagarhi and Brahmi. Rajmahal Coal Mines Project of Eastern Coalfields Ltd. Is located in Godda district of Eastern Jharkhand and situated in Hura Basin. The project was started in 1985 with initial annual capacity of 5 million tonne.

Salient features

Total geological reserve of the mine	:	493 MT
Total mineable reserve of the mine	:	468 MT
Land required for the project	:	1978 hectare
Grade of Coal	:	G 13
Average stripping ratio	:	1 : 1.57
Total life of present mining block	:	48 yrs
Annual coaltarget as per PR	:	17 MT
At present max depth of Mine	:	180 Mtr
Present dimension of mine	:	Length - 5 km and Width - 5 km
Annual departmental production	:	10.5 Million Te (Composite) (approx)
No. of Shift	:	Three
Annual Diesel Consumption	:	12,600 Kilolitres (approx)

METHOD OF MINING

Coal seam in Rajmahal is very thick and occurs upto 160M depth. The coal is hard by nature and has specific gravity of 1.7 Te/m^3. Around 30% of the overburden is soft and does not require blasting. For blasting 311 mm dia. drill holes areused in OB and 160 mm (diesel) drills used in Coal. Currently Coal excavation is done contractually. A portion of the OB removal is done departmentally. The project is linked to two Thermal Power projects of NTPC; Farakka and Kahalgaon. Farakka has two units of 500 MW each and 3 units of 200MW each. Kahalgaon has 4 units oof 210 MW each and 3 units of 500 MW each.

(a) Shovel - Dumper : The method of working is with shovel-dumper combination. OB & Coal Seams are extracted by various capacities Shovels & Dumpers.
(b) Drilling : Electric 311 mm dia drills are used for drilling in O.B. & Diesel 160 mm dia drills are used for drilling in Coal.

To study the fuel consumption of the equipment used for removal of overburden in the project.Guiding the workmen regarding fuel saving practices to be followed.

METHODOLOGY

A visit to the site was made prior to undertaking the job. A meeting was held with the concerned officials of the department to arrive at the process to be followed for this study.The study would essentially be a sample study involving a representative quantity of overburden removal. Some of the equipment which could be dedicated for the sample study would be studied for fuel consumption of the equipment. The other equipment which are used for the entire project would be considered for appropriate loading based on their consumption pattern obtained from historical data.

The exact quantity of overburden removed would be ascertained by survey of the quantity pre and post study. The method of survey would be same as is adopted for ascertaining production quantity for management reporting.

*Sub-Regional Officer, PCRA, Ranchi

The study would be conducted for three days. The first survey would be prior to commencement of study. The second survey would be done after two days of working. The third survey would be done at the end of three days. All fuel quantities measured would be through calibrated fuel dispensers.

Sample areas for removal of overburden was earmarked after due discussion with the Operations team. These were two different areas of the project not very far from each other where such work was already in progress. It was decided at the starting the study that 4 Nos 170 Ton dumpers and 8 Nos 100 Ton dumpers would be dedicated for removal of OB from the electric shovel No 14 and 15 and 4 Nos 100 Ton dumpers would be used for removal of OB from the hydraulic shovel " Vishwakarma". Fuel for these dumpers would be topped up in the fuel tank from the fuel depot near maintenance shop. As and when these are refueled (normally A shift or B shift), they would be again topped up and fuel quantity noted. The quantity thus ascertained would be added up for the study period.

It was agreed in principle prior to commencement of study that during the study period dumpers other than designated ones would not be used for this work. Further, the designated dumpers would not undertake any other work during the study period as their fuel consumption was being measured for a specific quantity of work. By and large the instructions were followed by the operating staff except three trips of non designated dumpers in the whole of study.

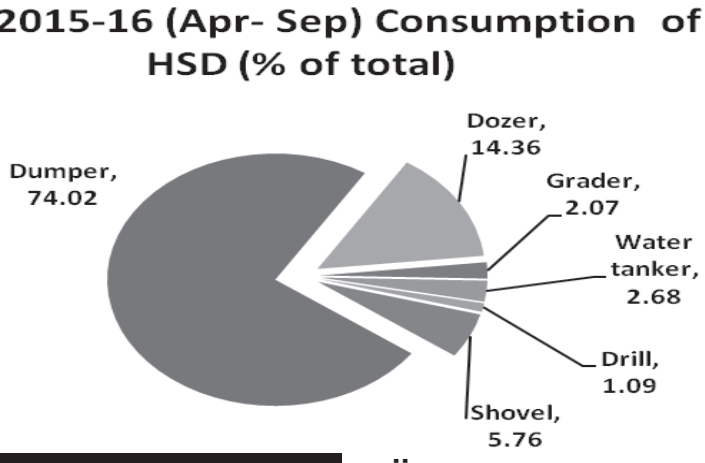
BASELINE DATA

The historical Diesel consumption pattern for Departmental excavation is as follows :

FUEL CONSUMPTION SUMMARY - RAJMAHAL OCP

	Year 2013-14		Year 2014-15		Year 2015-16 (Apr- Sep)	
	% of total	Fuel (Lits)	% of total	Fuel (Lits)	% of total	Fuel (Lits)
TOTAL		**12,600,623**		**12,655,381**		**5,434,894**
Shovel	7.50	944,814	7.24	915,757	5.76	313,297
Dumper	70.49	8,882,542	71.44	9,041,464	74.02	4,022,645
Dozer	16.29	2,052,430	15.86	2,006,738	14.36	780,381
Grader	1.88	236,331	1.68	212,433	2.07	112,740
Water tanker	1.83	230,961	1.96	247,755	2.68	145,632
Drill	1.98	250,030	1.76	222,570	1.09	59,361

The current trend, i.e. for the year 2015-16 (Apr-Sept) % consumptions have been considered for loading of associated equipment to arrive at Specific consumption



COAL&OBR PRODUCTION REPORT (2013-14)

Month	Dept. Coal (T)	Dept. Coal (M^3)	Dept. OBR(M^3)	Dept.(Coal Rehand)T	Dept.(Coal Reh.) M^3	Dept.(Obr Rh.(M^3)	Total(Prod.+Reh.)M^3
April 2013	0	0	792872	0	0	0	**792872**
May 2013	18747	11028	732697	54237	31904	0	**775629**
Jun 2013	0	0	606227	214794	126349	0	**732576**
July 2013	0	0	611175	250123	147131	0	**758306**
Aug 2013	0	0	466741	93678	55105	0	**521846**
Sep 2013	5073	2984	648037	43754	25738	0	**676759**
Oct. 2013	0	0	766173	18462	10860	0	**777033**
Nov. 2013	70542	41495	1017741	13968	8216	0	**1067453**
Dec. 2013	1083	637	1176089	570	335	0	**1177061**
Jan. 2014	0	0	1115944	8664	5096	0	**1121040**
Feb. 2014	551	324	858588	47889	28170	52855	**887082**
Mar 2014	**0**	0	1217420	6270	3688	18443	**1221108**
Total	**95996**	**56468**	**10009704**	**752409**	442594	**71298**	**10508766**
% of total		**0.54**	**95.25**		**4.21**		

COAL&OBR PRODUCTION REPORT.(2014-2015)

Month	Dept. Coal(T)	Dept. Coal (M^3)	Dept. Obr(M^3)	Dept (Coal Rehand)T	Dept. (Coal Reh.) M^3	Dept.(OBR h.(M^3)	Total(Prod.+ Reh.)M^3
Apr 2014	48312	28419	1010161	20955	12326	0	**1050906**
May 2014	5472	3219	1013676	139689	82170	0	**1099065**
Jun 2014	0	0	1044233	14136	8315	0	**1052548**
July 2014	0	0	813807	18654	10973	0	**824780**
Aug 2014	18186	10698	960120	27127	15957	0	**986775**
Sep 2014	10773	6337	971686	23769	13982	0	**992005**
Oct.2014	0	0	1138278	20709	12182	0	**1150460**
Nov.2014	53979	31752	1128648	855	503	0	**1160903**
Dec.2014	55584	32696	1061228	5073	2984	0	**1096909**
Jan.2015	0	0	1034621	0	0	0	**1034621**
Feb..2015	0	0	1039911	0	0	0	**1039911**
Mar.2015	99975	58809	1058557	0	0	0	**1117366**
Total	**292281**	**171930**	**12274926**	**270967**	**159392**	**0**	**12606248**
% of total		**1.36**	**97.37**		**1.26**		

COAL&OBR PRODUCTION REPORT.(2015-2016)

MONTH	DEPT. COAL(Te.)	DEPT. COAL (Cu.M)	DEPT. OBR(Cu.M)	DEPT.(COAL REHAND)Te.	DEPT.(COAL REH.) Cu.M	DEPT.(OBR RH.(Cu.M.)	TOTAL(Prod.+ Reh.)CuM
APR 2015	65481	38518	999677	30894	18173	0	**1056368**
MAY 2015	6897		1035346	26505	15591	0	**1050937**
JUN 2015	4047	2381	847064	61773	36337	0	**885782**
JULY 2015	0		680782	90636	53315	0	**734097**
AUG 2015	0	0	658788	44086	25933	0	**684721**
SEPT 2015	3021		743843	30294	17820	0	**761663**
OCT.2015	16365	9626	1029780	11229	6605	0	**1046012**
NOV.2015	129019		955548	0	0	0	**955548**
DEC.2015							
JAN.2016							
FEB.2016							
MAR.2016							
TOTAL	**224830**	**50525**	**6950828**	**295417**	**173775**		**7175128**
% of total		**0.70**	**96.87**		**2.42**		

Sample Study

Since there was no COAL production by the department during the study period, two separate spots were chosen for study of OB removal. In one case two electric shovels were deployed and 12 dumpers assigned to that. In another case one hydraulic shovel was deployed with three dumpers assigned to that.

Lead and Lift for Shovel 14&15 (electric)

Lead =	1.5 km	
Dump RL =	-8.34	m
Toe RL =	12	m
Lift =	20.34	m

Lead and Lift for Shovel Vishwakarma (Hydraulic)

Lead =	1.3 km	
Dump RL =	-52	m
Toe RL =	12	m
Lift =	64	m

EQUIPMENT TAKEN UP FOR STUDY

Equipment type	Machine No.	Make	Model	Yr of Comm.	Engine Make	Engine Model	Engine BHP
Dumper (100 Te)	320	BEML	BH100	2013	CUMMINS	QST30-30	1050
Dumper (100 Te)	321	BEML	BH100	2013	CUMMINS	QST30-30	1050
Dumper (100 Te)	322	BEML	BH100	2013	CUMMINS	QST30-30	1050
Dumper (100 Te)	323	BEML	BH100	2013	CUMMINS	QST30-30	1050
Dumper (100 Te)	324	BEML	BH100	2013	CUMMINS	QST30-30	1050
Dumper (100 Te)	326	BEML	BH100	2014	CUMMINS	QST30-30	1050
Dumper (100 Te)	327	BEML	BH100	2014	CUMMINS	QST30-30	1050
Dumper (100 Te)	328	BEML	BH100	2014	CUMMINS	QST30-30	1050
Dumper (170 Te)	76	KOMATSU	630E	1993	CUMMINS	KTTA50-C	1800
Dumper (170 Te)	77	KOMATSU	630E	1994	CUMMINS	KTTA50-C	1800
Dumper (170 Te)	78	KOMATSU	630E	1991	CUMMINS	KTTA50-C	1800
Dumper (170 Te)	86	KOMATSU	630E	1991	CUMMINS	KTTA50-C	1800
Dumper (100 Te)	329	BEML	BH100	2014	CUMMINS	QST30-30	1050
Dumper (100 Te)	330	BEML	BH100	2014	CUMMINS	QST30-30	1050
Dumper (100 Te)	318	BEML	BH100	2011	CUMMINS	KTA38-C	1020
Hyd Shovel	HS29	LIEBHERR	R994	2006	CUMMINS	KTTA38-C	1125

FUELLING OF EQUIPMENT

Date : 08.12.15	**SHIFT-A**			**SHIFT-B**		
Dumper No.	time	Hr Meter	fuel (lit)	time	Hr Meter	fuel (lit)
320				15:40	6347	0
321	8:35	11494.4	Top up	15:30	11500.4	376
322	8:00	9799.8	Top up	14:55	9805.1	385
323	8:38	11924.3	Top up	16:20	11929.6	304
324	7:50	10464.6	Top up	20:10	10476.6	377
326	7:45	7039.3	Top up	19:15	7048.7	515
327	9:10	8665.9	Top up	19:45	8675.5	346
328	7:35	9343.3	Top up	15:00	9352.3	374
76	8:25	269.1	Top up			
77				15:40	9358.1	Top up
78	7:30	9778.1	Top up			
86	9:00	90.8	Top up			
329						
330						
318						

Date : 09.12.15	**SHIFT-A**			**SHIFT-B**		
Dumper No.	Time	Hr Meter	fuel (lit)	time	Hr Meter	fuel (lit)
320				15:45	6367.3	956
321				17:10	11504.5	112
322				16:55	9825.2	913
323				16:15	11950.6	929
324				15:35	10493.7	842
326				21:05	7064	818
327	8:05	8686.2	466			
328	7:50	9366.2	635	20:35	9377.2	589
76	12:00	294.1	1803			
77				16:35	9381.3	1290
78	10:15	9797.8	1261			
86				19:45	107.6	1122
329	9:00	1048.3	Top up	19:20	1057.6	377
330	8:10	7595.5	Top up	19:25	7604.7	420
318	8:00	22904	Top up	16:50	22908	347

Date : 10.12.15	**SHIFT-A**			**SHIFT-B**		
Dumper No.	time	Hr Meter	fuel (lit)	time	Hr Meter	fuel (lit)
320	10:11	6381.4	740	19:45	6388.5	389
321	9:25	11515.4	532	19:15	11523.9	392
322	10:20	9841.9	902	21:15	9849.4	419
323	11:26	11965	744	20:30	11972.9	396
324	7:25	10508.2	905	20:40	10518.8	516
326				17:30	7080.6	784
327	8:45	8702.1	520	19:30	8710.8	282
328	9:30	9389.1	724			
76				19:00	311	1150
77				15:45	9399.6	1170
78						
86						
329				16:25	1074.1	608
330				18:15	7621.8	712
318	9:13	22922	540	20:25	22932.7	469

DUMPER FUELLING SUMMARY

		SHIFT-A		SHIFT -B		SHIFT -A	SHIFT -B		SHIFT-A	SHIFT-B		SHIFT -A			
	Date	Initial Hr Meter	fuel (lit)	fuel (lit)	Date	fuel (lit)	fuel (lit)	Date	fuel (lit)	fuel (lit)	Date	Final Hr Meter	fuel (lit)	Net Running Hours	Total fuel (Lit)	Fu (Li Hc
0	08.12.15	6347		0	09.12.15		956	10.12.15	740	389	11.12.15	6396.2	345	49.2	2430	
1	08.12.15	11494.4	0	376	09.12.15		112	10.12.15	532	392	11.12.15	11533.1	337	38.7	1749	
2	08.12.15	9799.8	0	385	09.12.15		913	10.12.15	902	419	11.12.15	9857.2	284	57.4	2903	
3	08.12.15	11924.3	0	304	09.12.15		929	10.12.15	744	396	11.12.15	11981.9	266	57.6	2639	
4	08.12.15	10464.6	0	377	09.12.15		842	10.12.15	905	516	11.12.15	10527.4	288	62.8	2928	
6	08.12.15	7039.3	0	515	09.12.15		818	10.12.15		784	11.12.15	7092.5	473	53.2	2590	
7	08.12.15	8665.9	0	346	09.12.15	466		10.12.15	520	282	11.12.15	8710.8		44.9	1614	
8	08.12.15	9343.3	0	374	09.12.15	635	589	10.12.15	724		11.12.15	9391.4	90	48.1	2412	
6	08.12.15	269.1	0		09.12.15	1803		10.12.15		1150	11.12.15	320.7	640	51.6	3593	
7	08.12.15	9358.1		0	09.12.15		1290	10.12.15		1170	11.12.15	9413.1	863	55.0	3323	
8	08.12.15	9778.1	0		09.12.15	1261		10.12.15			11.12.15	9797.8		19.7	1261	
6	08.12.15	90.8	0		09.12.15		1122	10.12.15			11.12.15	126.7	1098	35.9	2220	
9		1048.3			09.12.15	0	377	10.12.15		608	11.12.15	1086.6	459	38.3	1444	
0		7595.5			09.12.15	0	420	10.12.15		712	11.12.15	7631.8	318	36.3	1450	
8		22904			09.12.15	0	347	10.12.15	540	469	11.12.15	22940	322	36.0	1678	
t			**0**	**2677**		**4165**	**8715**		**5607**	**7287**			**5783**			

FUELLING OF SHOVEL

Shovel Vishwakarma was topped up before commencement of work on 9.12.16

Shovel Vishwakarma was again topped up after completion of work on 11.12.16

Net fuel = 1947 lit

Following data was capture from the computerised tracking system

Working details for Vishwakarma per shift for 9th and 10th Dec

Date	Activity	Shift-A (working hrs)	Shift-B (working hrs)	Shift-C (working hrs)	TOTAL	%
09.12.15	Cleanup	0.07			0.1	
	Loading	1.3	2.48	1.92	5.7	
	Shovel wait	3.61	3.27	2.83	9.7	62.7
10.12.15	Cleanup					
	Loading	1.78	2.05	1.25	5.1	
	Shovel wait	4.58	4.43	5.68	14.7	74.3
TOTAL	Total Hours	11.34	12.23	11.68	35.3	
	Loading Hrs	3.08	4.53	3.17	10.8	30.6
	Wait Hours	8.19	7.7	8.51	24.4	69.2

Note :

The wait time for the shovel is very high about 70%. The engines are running during idling. 30% of the fuel consumed is used for loading. The reasons could be fewer number of dumpers deployed than optimum. Some corrective action would result is better fuel performance of the Shovels

ACTUAL TRIPS of DESIGNATED DUMPERS (From Electric Shovels)

Date	Dumper	Shift	Shovel- 14	Shovel - 15	Total
08.12.15	320	A	9	2	11
		B	10	1	11
		C	11	6	17
	321	A	8	5	13
		B	4	0	4
		C	0	0	0
	322	A	14	1	15
		B	6	1	7
		C	12	3	15
	323	A	6	7	13
		B	10	2	12
		C	3	12	15
	324	A	10	7	17
		B	4	2	6
		C	14	4	18
	326	A	2	13	15
		B	6	4	10
		C	0	0	0
	327	A	0	0	0
		B	0	0	0
		C	0	0	0
	328	A	6	8	14
		B	11	1	12
		C	8	9	17
	76	A	4	11	15
		B	4	6	10
		C	3	14	17
	77	A	0	0	0
		B	7	5	12
		C	0	16	16
	78	A	3	0	3
		B	1	6	7
		C	6	8	14
	86	A	1	10	11
		B	9	5	14
		C	0	0	0
			192	169	
Bank Cubic Metres		A	1820	2190	
		B	2327	1279	
		C	1711	2619	

Trips by Dumpers at Surveyed Location

Date	Dumper	Shift	Sh14	Sh15	Total
09.12.15	320	A	1	6	7
		B	9	7	16
		C	9	4	13
	321	A	0	0	0
		B	2	0	2
		C	4	8	12
	322	A	0	19	19
		B	8	6	14
		C	10	8	18
	323	A	18	0	18
		B	2	9	11
		C	9	5	14
	324	A	11	6	17
		B	11	9	20
		C	6	13	19
	326	A	10	6	16
		B	3	10	13
		C	5	9	14
	327	A	1	2	3
		B	0	0	0
		C	0	0	0
	328	A	17	0	17
		B	10	8	18
		C	12	4	16
	76	A	5	0	5
		B	2	9	11
		C	1	8	9
	77	A	8	0	8
		B	3	8	11
		C	0	10	10
	78	A	0	11	11
		B	0	0	0
		C	0	0	0
	86	A	0	0	0
		B	3	1	4
		C	4	0	4
			184	186	
Bank Cubic Metres		A	2162	1827	
		B	1584	2138	
		C	1724	2193	

Date	Dumper	Shift	Sh14	Sh15	Total
10.12.15	320	A	5	3	8
		B	12	6	18
		C	4	2	6
	321	A	10	2	12
		B	11	8	19
		C	0	4	4
	322	A	9	5	14
		B	11	2	13
		C	6	0	6
	323	A	11	0	11
		B	15	4	19
		C	2	4	6
	324	A	6	4	10
		B	2	9	11
		C	1	4	5
	326	A	5	5	10
		B	7	7	14
		C	4	5	9
	327	A	0	0	0
		B	0	0	0
		C	0	0	0
	328	A	6	1	7
		B	0	0	0
		C	0	0	0
	76	A	3	2	5
		B	2	5	7
		C	5	0	5
	77	A	8	1	9
		B	5	9	14
		C	0	5	5
	78	A	0	0	0
		B	0	0	0
		C	0	0	0
	86	A	1	0	1
		B	0	2	2
		C	4	0	4
			155	99	
Bank Cubic Metres		A	1954	680	
		B	1895	1695	
		C	864	741	

Actual trips of designated dumpers (From Hydraulic Shovel)

Date	Dumper	Shift	Vishwakarma
09.12.15	318	A	11
		B	12
		C	10
	329	A	10
		B	13
		C	10
	330	A	11
		B	11
		C	11
	309	B	1
	314	B	1
	302	B	1
			102
Bank Cubic Metres		A	874
		B	1065
		C	864

Date	Dumper	Shift	Vishwakarma
10.12.15	318	A	10
		B	15
		C	5
	329	A	10
		B	11
		C	6
	330	A	12
		B	12
		C	7
			88
Bank Cubic Metres		A	874
		B	1038
		C	491

SURVEYED QUANTITY OF OB REMOVAL (M^3)

Dates	Rs 14 & 15	HS 29 - Vishwakarma
8-10/12/15	23655	
10-11/112/15	8337	
9-11/12/16		4850
Total	**31992**	**4850**
Grand total	**36842**	

Specific diesel consumption
OB EXCAVATION

Fuel Consumption	% of dumper consumption	Fuel (Lits)
Dumpers (Actual)		34234
Hyd Shovel (Actual)		1947
Dozer	19.4	6641
Grader	2.8	959
Water tanker	3.6	1239
Drill	1.5	505
TOTAL fuel (Lits)		**45526**
Survey Quantity (CuM)		**36842**
Specific Fuel (Lits/ CuM)		**1.236**

Note :

It assumed here that the Motor Graders, Water Tankers, Drill are used exclusively for removing overburden. However, that is not the case. As seen from the historical departmental production data approximately 5% of the total excavation volume is coal including coal rehandling. Hence 5% of fuel consumed by auxiliary equipment is to be reduced while loading their impact on the overall.

During top up operation it has been observed that during every top up of HSD there was spillage of minimum 5 lits. Considering an average of 5 lits wastage in every fill, for 60 times fill up operation there was a wastage of 5 x 60 = 300 lits. This is not to be considered for Specific fuel calculation.

The number of trips made by 170 T dumpers is on the lower side although the running hours is comparable with smaller dumpers. These dumpers are very old and quite prone to breakdown as observed.

The Hydraulic shovels used for the Study are very old and being somehow maintained in operating condition.

Applying further correction

Considering 300lit less for dumper consumption and reducing 5% from other auxiliary equipment which are used for Coal re-handling also as departmental activity		
Fuel Consumption	**% of dumper consumption**	Fuel (Lits)
Dumpers (Actual minus 300 LIts)		33934
Hyd Shovel (Actual)		1947
Dozer (19.4 - 5%of 19.4)	18.4	6254
Grader (2.8 - 5% of 2.8)	2.7	904
Water tanker (3.6 - 5% of 3..6)	3.4	1167
Drill (1.5 - 5% of 1.5)	1.4	475
TOTAL fuel		**44681**
Survey Quantity (CuM)		**36842**
Specific Fuel (Lits/ CuM)		**1.213**

As seen from the historical data on Diesel consumption for the year 2014-15 (Ref Pg-9), Dozers consume a good 16 % of the total fuel. These machines push material back and forth as and when required and wherever required. The fuel consumption of these machines depend on quantity of material they push as well as the extent of movement from one location to another. However, their activity does not add to the volume of excavation.

Considering that the activity of the dozer adds up a nominal 5% to the overall production volume, the net excavation volume assessed by pre and post surveys is being increased by 5%.

Hence the Specific Fuel consumption for OB

Fuel Consumption	**% of dumper consumption**	Fuel (Lits)
Dumpers (Actual - 300 Lits)		33934
Hyd Shovel (Actual)		1947
Dozer (19.4 - 5%of 19.4)	18.4	6254
Grader (2.8 - 5% of 2.8)	2.7	904
Water tanker (3.6 - 5% of 3..6)	3.4	1167
Drill (1.5 - 5% of 1.5)	1.4	475
TOTAL fuel		**44681**
Survey Quantity (CuM)		**38684**
Specific Fuel (Lits/ CuM)		**1.155**

GENERAL REMARKS

It was observed that the supervisors are very conscious about the possible energy saving measures whether it is Diesel for the vehicles or electricity being used in the offices. The diesel depot maintains close monitoring of the fuelling of each and every vehicle being used in mining activity and the same is reported on daily basis. The dispensing units being used are having valid calibration certificate by Legal metrology. The Diesel Bouzer that is being used to fuel equipment in the field should maintain a calibration record in the controlling office. During topping up of fuel at the fuel depot considerable spillage was observed. Efforts should be made to minimize this.

Awareness about necessity for environmental protection is found to be quite encouraging amongst the staff and operator of the project. During a special training session conducted on environment protection, driving habits and maintenance tips at shift office, good interest was shown by the operators. It was repeatedly insisted that idling of heavy vehicles to be minimized.

New Technologies in Mining Machinery for Improving Safety

Paritosh Kr Paras* K. Ramakrishna* Hemang Trivedi* Amit Raj*

ABSTRACT

Indian mining operations are very conventional even today with limited penetration ofmodern technology. Mining is currently experiencing a rapid growth in the development and uptake of automation and other new technologies (such as collision detection systems). This paper presents a review of the technologies currently available or upcoming soon and their benefits in enhancing safety. Technologies for efficient production are available globally however, for their adoption in India massive investments are required. A few emerging trends in mining machinery are: Operational Ergonomics, Equipment size and capacity, Automation and Equipment operating systems, Use of alternate power sources, Equipment control and tracking systems, Equipment management systems and Equipment safety features. These will enhance productivity, make the operations safe and environment sustainable.

OPERATIONAL ERGONOMICS

Modern mining machinery are provided with ergonomically designed cabins with controls involving very little effort to the operator which minimizes fatigue. Operator alerts also help in minimizing the monotony in operations. Efforts by DGMS also improved the conditions for operator comfort.

Equipment size and capacity

Industry is moving towards larger capacity equipment as to optimize its operations

- Deployment of large capacity excavators, haul trucks, etc. result in significant improvement in productivity and operational cost efficiency.
- The following are the expected gains from larger fleet of equipment
    - Higher economic Life
    - Better productivity
    - Reduced operational costs
    - Reduced pit congestion
    - Enhanced pit safety

The mammoth measuring over 20 m front to back and 8 m across carries 450 t of payload in its tipper. The BelAZ 75710 is the latest creation to be launched by the Belorussian manufacturer Belaz and has been put through its paces at the Chernigovez Coal mine in Siberia. Fully laden, it rumbles purposefully towards its destination at 40 km/h.

Mega Excavators for future mining

The world is moving towards heavy application excavators such as the mammoth BUCYRUS RH400. The equipment is in use for surface mining project at Alberta Oil sands, Canada. The shovel on the excavator has the capacity to hold 45m³ of rock in a single scoop. The arm crowd force and the breakout force of the shovel are up to 3,300kN and 2,400kN, respectively.

Advantages

Enhanced productivity and tonnage of excavation.
Faster development of mine faces for ore production.

Tata Steel Limited

Automation in Equipment Operation

Many industries are adopting new technologies worldwide that are helping them to drive down costs, improve productivity and optimise safety. Mining engineering is no different and there have been several exciting developments in the sector over the last few years that could transform how projects are carried out in the future.Mining technology aimed at increasing productivity and safety has seen a rapid increase in adoption over the last few years and many of the large mining houses are showing an interest in the significant benefits of automation. A totally autonomous mine may be the end objective for some, however for most of the operations there remains an opportunity to capitalise on the ability of existing mining technologies that have been used extensively for over 10-years.

Autonomous haulage vehicles

Pioneered by Rio Tinto in Pilbara, Western Australia, driverless haulage is becoming increasingly common since its inception ten years ago. Equipped with a GPS, an obstacle detection system and vehicle controllers, these unmanned trucks increase mine safety, lower operating costs and reduce wear and tear on tyres.

Challenges

Investment in infrastructure to support autonomous hauling technology
Difficulty in dynamic scheduling of operations in unprepared areas.
Acceptance of technology in man-power intensive industry

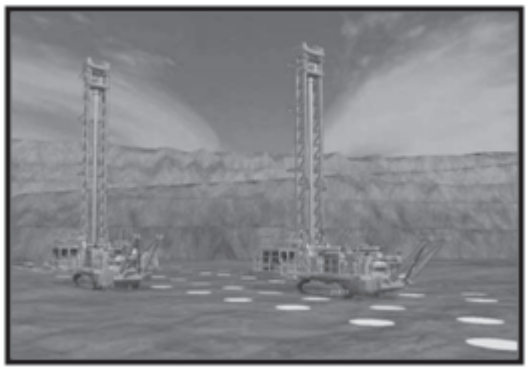
Advantages

Enhanced production with continuous operations.
Enhanced safety of operations.
Better cost effectiveness.
Enhanced performance of fleet.

Automated drilling systems

The easy-to-use GPS-based 3D navigation system provides hole accuracy within five centimetres, both for hole location and drilling depth, giving improved bench quality. The actual drilling data is immediately available in the command centre, to be utilized in downstream processes.

Rio Tinto & BHP have successfully trialled the Autonomous Drills developed by Atlas Copco in their iron ore mines in Australia. Other OEMs such as CAT, Sandvik etc. are also coming up with such technologies for their surface drilling machinery.



Challenges

Upgradation of existing fleet for new technology.
Skill development for off-machine operations

Advantages

Enhanced production with continuous operations.
Accurate drilling for quality compliance.
Enhanced safety of operations.
Better cost effectiveness and fuel economy.
Enhanced performance of fleet.

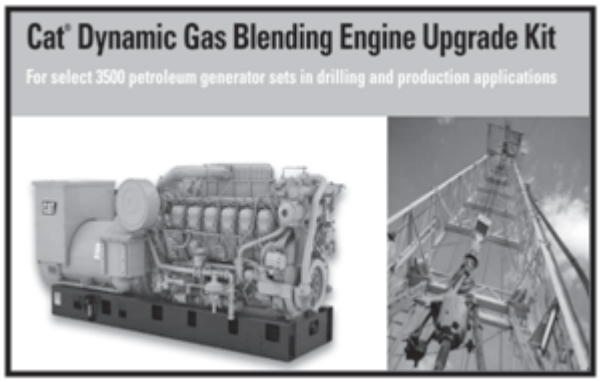
Alternate Power Sources

Environmental protection initiatives remain a hot topic with the upcoming introduction of Stage V emission regulations, and future options for diesel fuel alternatives have risen as a result. Whileenvironmental protectionimprovements are the major catalyst for change, cost and the profitability for machine users will be the deciding factor in determining the viability and success of a mainstream alternative.

When compared to the on-road sector, diesel alternatives that have the potential for acceptance on a large scale are limited for the heavy-duty non-road mobile machinery market, where it is necessary to take into consideration high load factors, on-site fuelling and high power density, combined with huge machine variety and low market numbers.

LNG as fuel for off-highway Equipment: The innovative duel fuel upgrade kit from CAT offers use of Liquified natural gas as alternate fuel for existing diesel engines.

Cat® Dynamic Gas Blending™ is optimized to handle variations in fuel quality and engine operating conditions. You save fuel and your diesel power and transient performance is consistently maintained.



Challenges

Upgradation of existing engines and testing suitability in Indian mining/off-highway conditions.
Ensuring robust supply of LNG

Advantages

Reduction in diesel consumption by up to 60%.
Reduction in carbon foot print and C02 emission
Lower operating costs

Electricity powered off-highway Equipment

Lithium Storage GmbH and Kuhn Schweiz AG disassembled the 45 Ton Komatsu 605-7 and replaced the diesel engine with a synchronous electric motor capable of 590kW (800hp) of continuous power and up to 9,500 Nm torque, they managed to fit 700 kWh of energy capacity on the chassis of the vehicle by using 1,440 prismatic NMC cells for a total battery pack weight of 4.5 tons.

What is interesting about electrifying dumper trucks is that they are often used to carry ore up and down mines. While diesel trucks burn fuel even on their way down a mine, there's a great opportunity for electric vehicles to gain energy on their way down thanks to regenerative braking. The prototype that they are now completing will be used in a quarry operated by Ciments Vigier SA on the slopes of the Chasseral in Switzerland.

Advantages

Massive Reduction in diesel consumption by up to 60%.
Reduction in carbon foot print and C02 emission

Challenges:
Upgradation of existing engines and testing suitability in Indian mining/off-highway conditions.
Cost effectiveness of the concept design

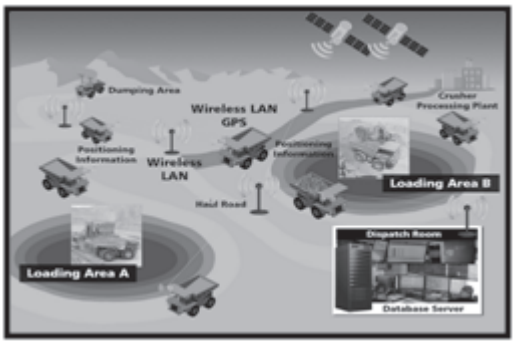
Equipment Management Systems

With advent of Internet of things, robotics and artificial intelligence for business processes, the mining industry is catching up with the technological advances very rapidly. Over the years, off-highway equipment have seen progress towards hybrid concepts and technologies. Additionally, the mining industry is rapidly moving to integrated solution for mine to mill operations.

Current technology trends lead to integration of mining operations with Fleet Management System and digitizing systems and automating processes.

Integrated Fleet Management System: Various mines in worldwide and across India have adopted integrated Fleet Management System (FMS) and are getting benefits out of automated processes and IOT connected heavy machinery operations. End to end solutions are commercially available from OEMs such as Wenco Mining, etc.

The different solutions and packages available within standard Fleet Management and control modules are discussed in the next slide. All information is obtained from Wenco Mining solutions.



Challenges

Upgradation of current fleet to make it ready for IOT capable systems Integration of different systems and technologies with single layer of operational control. Development of system/process capability to sustain technological upgrade

FMS Solutions Offered

Turn raw data into actionable data with FMS Reporting, our suite of reporting tools. Web-based dashboards show real-time data to highlight relationships among your mine's KPIs. Historical reports track that data, how it changes over time. Together, these tools add context to your data so one can make smart decisions for your operation.

Control all equipment with a simple drag-and-drop tool. Fleet Control gives dispatchers command over equipment, show real-time activity of your haul cycle, payloads, locations, assignments, and more.

Fleet Control

Data reporting and Analysis

FMS-solutions offered

Mine Vision

MineVision offers a real-time map of your whole operation, highlighting equipment location and activity. Dispatchers point and click to adjust haul roads, set detours, review equipment interactions, and more

Event Monitoring

Onboard Insight

Onboard Insight taps into equipment's OEM sensors to collect details about machine health. As equipment conducts its tasks, maintenance personnel receive updates about units' condition and performance. Customizable alerts keep your crew aware when issues occur, pointing out areas for improvement.

Event Monitor notifies staff as issues occur involving vehicles, operations, or systems. Priority levels range from log only to full-scale warnings, keeping the most vital information in front. Link custom alerts to your most essential KPIs. E-mail functions alert support staff, mechanics, IT, and shift supervisors of situations that need their specific attention.

MDT

The Mobile Data Terminal (MDT) shows operators the information they need at a glance. Machine status, current assignments, load tracking, and other details appear on the onboard touchscreen.

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Technology Innovation & Safety in Mining Industry:Eqpt Maint,Noamundi

CONCLUSION

To achieve safe mining systems and operations, sound management techniques, such as risk management,must be applied right from the feasibility stage, through to the entire ongoing mining operation. Similarly, as newtechnologies are applied, they must be scrutinized by a thorough risk assessment process and then appropriaterisk-based management plans developed for their application.

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Application of Wireless Sensor Network for Remote Monitoring of Underground Mine Condition for Improved Safety

Raghunath Rout[1] JitendraPramanik[2] Dr. Abhaya Kumar Samal[3] Dr. SingamJayanhu[4]

ABSTRACT

In some typical underground mine conditions before accidents/disasters leading to loss of life and equipments, characteristics of work environment in underground coal mines become unsafe with some precursors/warning of the adverse situations due to presence of poisonous and flammable mine gases, improper condition of the mining equipment etc. This paper presents an attempt for experimental study of a mine environment and proposes works to be carried out to promote safe working condition for the miners and provide suggestion for the deployment of an early warning system along with critical review of applicability and limitations of available wireless sensor networks (National and International Scenario) to monitor the underground condition of mine environment and can be extended to study the condition of the mining equipment. Emphasis is made on urgent requirement of application of trans-disciplinary research and study the underground mine conditions including online monitoring of mine atmosphere and mine equipment by application of wireless sensor networks and IoT devices for improved safety.

Keywords:Coal Mine, WSN, Real-Time, Mine Gases, Mine equipment, Sensors, Zigbee

INTRODUCTION

The production, productivity and safety of men and machinery of underground coal mines are mainly dependent on the environmental condition of the mines. Underground mining equipment such as cutting machines, shearers, continuous miners, loading machines (LHD, SDL etc), transporting equipments (AFC, Shuttle car, etc), perform more efficiently under certain geo-mining conditions. In adverse conditions of mine atmosphere, there is a possibility of malfunction of the equipment, which can be monitored online by recently developed wireless sensor networks and may be used as pre-warning of fire, spontaneous heating, explosions, and also as online health monitoring of the equipment. Airflow, temperature, humidity, dust and gases are the primary factors that influence the environmental condition in the underground. Coal mining operations are inherently associated with the generation of various poisonous and inflammable gases, such as hydrogen sulphide (H_2S), carbon dioxide (CO_2), sulphur oxides (SO*x*), nitrogen oxides or nitrous fumes (NO*x*), carbon monoxide (CO), methane (CH_4), etc. The other major hazards associated with underground coal mining are mine fires and explosions, which are mainly caused due to spontaneous combustion of coal and ignition of firedamp (methane-air mixture) and coal dust, respectively.

The near surface coal seams are getting exhausted rapidly and in order to extract the deep seated coal deposits, the underground mining activities are moving towards the deeper horizons of the earth. As a consequence, the environmental condition of the mines lying at greater depth gets worsens due to poor ventilation and generation of large amount of heat (also due to large capacity electric or diesel operated mining equipments), humidity, poisonous and explosive gases associated with dust. Moreover, the high level of mechanization adopted in mines to meet the demand for higher volume coal production results in deterioration of the environmental condition in the mines atmosphere. Hence, continuous monitoring of the complex and hazardous coal mine environment is indeed an essential need for ensuring safe and healthy working environment for the miners, and mining equipments.

The monitoring of underground coal mine environment is widely done using different monitoring devices including data loggers. However, it does not provide high spatial and temporal resolutions as the system works online. In order to improve upon this problem, on-line monitoring was

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adopted in advanced countries in order to keep track of the environmental condition of the underground coal mines. However, this system making use of wired communication approach suffers from many shortcomings, viz. damaging of communication cables, high fault rate, inconvenient system maintenance, etc. Therefore, on-line monitoring of underground coal mines using wireless sensor network has become the common practice. As a result, wireless underground sensor network (WUSN) has emerged as an essential technology for continuous monitoring of the workplace environments in underground coal mines. It can be realized by deploying sensor nodes in appropriate locations of underground coal mines to gather environmental data and detect possible occurrences of hazards like fires, explosions and roof failures.

The underground environment in typical Blasting gallery/ Long wall panels differs from most other surface systems and requires non-trivial solutions embedded in a sensor network system. Some typical conditions including equipment such as Hydraulic props, Load haul dumpers, Chock shields etc in underground coal mines are presented in Fig 1 and 2. Underground excavation of minerals causes disturbance in earth surface. Therefore mine strata needs to be supported by means of artificial support systems. These support systems are of two types, Active and Passive. Active support system consists of props, chocks, roof bolts etc whereas Passive support systems include mesh, straps, concrete, and steel sets etc. The active supports i.e. props, chock, roof bolt need continuous monitoring as these are of certain capacity. If the pressure coming upon the roof supports exceeds its capacity, it can cause failure of roof supports and this can lead to disturbance of roof which may also lead to roof fall. To avoid these accidents, condition of the roof supports should be monitored time to time with reference to the variation of load on the support at different stages of extraction of mineral. For this purpose, load monitoring of roof support systems is necessary. There are different types of Props, such as Hydraulic, Friction, and Wooden. According to load measurement arrangements, Props are also classified as Open circuit and Close circuit Props. The images of various support systems used in Blastign gallery panel and Longwall panel at SCCL mines are shown in Fig 1 and 2, respectively. In Longwall mining method close circuit supports are used, these are of hydraulic in nature. These supports have in-built load measurement arrangement. Fig 2 shows a typical hydraulic chock shield with inbuilt pressure gauge.

Open circuit props are monitored using load measuring gauges. These are known as load cells. In earlier days there was no technology to monitor load on supports. It was done manually by observing visible changes such as crack on wooden props, subsidence of roof etc. It was an unhealthy practice as it could not predict the failure of the support system within a safe time period. Thus there was a need for monitoring of load coming upon the support. This is why load cells were introduced into underground mine support system. There are different types of load cells, such as Hydraulic, Mechanical, Strain gauge, Vibrating wire type (Jayanthu, 2012, 2013, 2014, 2015, 2018).

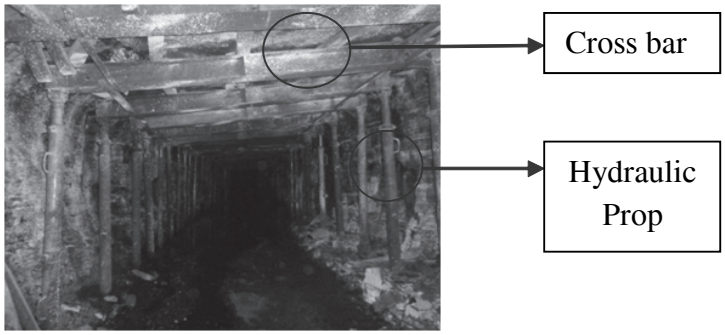

Fig 1: Support systems of an underground coal mine[Jayanthu, 2018]

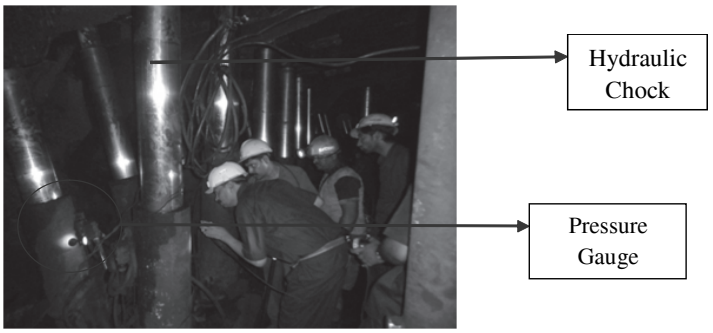

Fig 2: Hydraulic chock shield with inbuilt pressure gauge[Jayanthu, 2015]

In underground mines, load cell is placed above a wooden prop to measure the load of roof. The reading of these cells is extracted by connecting a readout unit with it. There are three coils and each of the coils is connected at a time with the read out unit to extract reading. It takes time as well as calculations to be done afterwards. Vibrating Wire type load cells of 20 to 50 T capacities are generally used in underground coal mines for measurement of load on supports and for evaluation of behaviour of the supports. A person go to the mine and collect the load readings by connecting the different red green yellow wires with readout unit one by one and then these readings are

averaged to get the exact load. This is done in different shifts. It is a Time taking process and have to carefully note down the readings. Therefore, wireless systems may be applied for online monitoring of the equipments including supports-hydraulic props, chock shields, loading and cutting equipments and associated machinery.

INTERNATIONAL SCENARIO

There have been several works by various investigators on application of sensors for monitoring of mien conditions. Cheekiralla [2001] on tunnel monitoring proposes utilizing electro level systems to measure the structural variations and Load on underground tunnels. The "smart infrastructure" proposed by Cambridge University explores the usage of fiber optics to monitorpossible deformations on tunnel structures. Their system benefits from the advantagesof fiber optics, including the insensitivity to electromagnetic interference, durability.

Tan *et al.*[2007]designed a system, which is applied for mine safety monitoring. They called the system WSN based Mine Safety System. This system is capable of real time monitoring of the mine environment and provides the early-warning for the fire or explosion to occur in immediate near future. Lin-Song Weng*et al.*[2009]planned a framework, which is viably observing all circumstances in mine, particularly for the wellbeing of mineworkers. They named the system the real-time mine auxiliary monitoring system (RMAMS), which is embraced for a real-time mine-monitoring system. Mine auxiliary sensor system (MASS) consists of an intelligent activity sensor and repeater and arrives at decision to resolve the procedure of processing.

Zhang Xiaodong*et al.*[2014]presented the problems and faultiness of current coal mine monitoring system. They examined the plan and implementation of a platform to remotely monitor and control coal mine production processes over Industrial Ethernet based on the embedded engineering. Integrated with each lower computer terminal are S3C2410 microprocessors that can be utilized for linking up to the monitoring network effectively. Ge Bin *et al.*[2011]suggested a method for monitoring coal mine using Zigbee technology. This system measures the various safety factor of production such as gas, temperature, humidity and other environmental indicators.

NATIONAL SCENARIO

These are the previous research work on different systems using different technologies for ensuring the work-place safety in the mines environment. Rajkumar Boddu *et al.* [2012] designed a coal mine monitoring system using Zigbee based on GSM technology. The degree of monitoring safety can be improved using this scheme and reduce misfortune in the coal mine. They purposed a solution suitable for mine wireless communication, and safety monitoring using this scheme.Mohit Kumar *et al.*[2013]proposes a wireless control and monitoring system for an induction motor based on Zigbee communication protocol for safe and economic data communication in industrial fields, where the wired communication is more expensive or impossible due to physical conditions. This system monitors the parameters of induction machine and transmits the data. A microcontroller based system is used for collecting and storing data and accordingly generating a control signal to stop or start the induction machine wireless through a computer interface developed with Zigbee.

Kumarsagar *et al.*[2013] designed a wireless sensor network with the help of MSP430xx controller, which is monitor the smoke, gas, temperature and humidity in an underground mine. This system also controls the ventilation demand to miners depending upon the monitoring data from the mine. This system utilizes a wireless Zigbee transceiver for remote logging of data at a central location to control the environmental state with the assistance of a motor and valve control circuitry.

UNDERGROUND MINE ATMOSPHERE

The air of the atmosphere is a mixture of several gases and its composition is practically constant over the whole surface of the earth. Because air is mixture and not a chemical substance, the components can be separated.

Mine Gases

In mine, gases are released during mining operations. It will be observed that return air is depleted in oxygen content and contaminated by mine gases. Impurities come from exhalation by men, blasting, and underground fires, burning of lights, bacterial action and gases given off from strata. It also contains moisture and dust of coal and rock.
There are five fundamental sources of hazardous gas in mining applications.

1. Gasses from Blasting
Blasting generates toxic and harmful gases. These harmful gasses include carbon monoxide and nitrogen dioxide. As

a result of the utilization of oxygen in any such impact, oxygen deficiency might likewise be an outcome.

2. Methane from Coal Beds

Profoundly flammable methane (CH4) or firedamp, as it is brought in numerous coal-fields, is framed in the last phases of coal arrangement, and due to the profundities and weights, it gets to be imbedded in the coal. As unearthingis made, methane gas is freed into the air. Gas is transmitted from the purpose of unearthing, as well as from the coal being transported to the surface.

3. Vehicle Exhaust

Vehicles are also generated various toxic and poisonous gases. These poisonous gases are an after effect of the operation of burning motors.

4. Penetrating into Stagnant Water

Pockets of stagnant water can contain a lot of hydrogen sulfide (H_2S) coming out essentially due to the breakdown of pyrites

Underground Mine Gases

Underground mining gases are divided into two general categories[Kumar et al, 2013]:

1. Combustible gases
2. Toxic gases

A typical gas sample analysis report of goaf atmosphere after sealing of blasting gallery panel in a typical underground coal mine is presented in Table 1.

Table 1: Underground Gas Sample Analysis Report

Gas Name	Concentration	Units	Normalised
Helium	12.35	ppm	0.0012 %
Hydrogen	4153.42	ppm	0.4121 %
Oxygen	14.8989	%	14.7839 %
Nitrogen	80.4590	%	79.8382 %
Methane	0.1138	%	0.1130 %
Carbon Monoxide	3238.66	ppm	0.3214 %
Carbon Dioxide	3.6122	%	3.5843 %
Ethylene	76.10	ppm	0.0076 %
Ethane	184.83	ppm	0.01 83 %
Acetylene	0.00	ppm	0.0000 %
Argon	0.9272	%	0.9200 %

1. Combustible gases

Combustible gases are hazardous based on the three criteria as follows:

i. Type of gas
ii. Ignition temperature of gas
iii. Likelihood of gas being present in flammable concentrations.

Flammable limit gives the proportion of combustible gases in the mixture.

- *Lower Explosive Limit (LEL)*:

The minimum concentration of gas or vapour mixed with air (percentage by volume, at room temperature) that will cause the propagation of flames when it comes in contact with a source of ignition. In common terminology, mixtures below the LEL are too lean to ignite.

- *Upper Explosive Limit (UEL):*

The maximum concentration of gas or vapour mixed with air (percent by volume, at room temperature) that will cause the propagation of flames when it comes in contact with an ignition source. In common terminology, mixtures above the UEL are too rich to support combustion.

Toxic Gases

Toxic gases can cause harm in low levels if exposed for a period of time (chronic exposure) or in higher concentrations over a short period of time (acute exposure), different countries have established *threshold limit values* (TLVs) for poisonous gases in order to ensure protection of the miner by providing timely scientific information to occupational and environmental health professionals, as well as mining authorities and other stake holders.

TLVs of airborne substances refer to those concentrations within which personnel may be exposed without known adverse effects to their health or safety. The three types of TLVs are as outlined below:

a) Time Weighted Average (TWA) is the average concentration to which nearly all workers may be exposed over given hours of work shift/week without known adverse effects.

b) Short-Term Exposure Limit (STEL) is a time-weighted average concentration occurring over a period of not more than few minutes. It is also recommended that such circumstances should not occur many times.

c) Ceiling Limit (CL) is the concentration that should not be exceeded at any time. This is relevant for the most toxic substances or those that produce an immediate irritant effect

BASIC BUILDING BLOCKS OF WSN

There are several key components that make up a typical wireless sensor network (WSN) device shown in Fig. 3.

1. Low-power embedded processor:

The computational tasks on a WSN deviceinclude the processing of both locally sensed information as well as information communicated by other sensors.

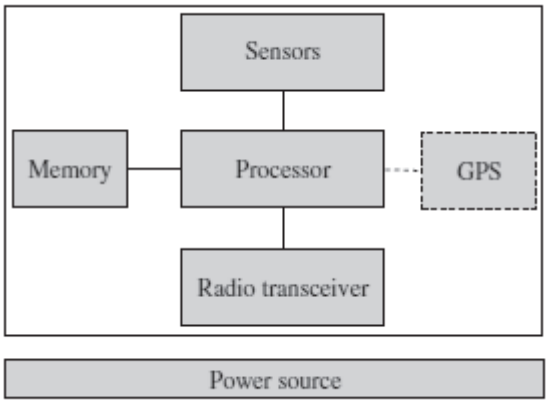

Fig: 3 Basic building blocks of a sensor node.

The embedded processors are often significantly constrained in terms of computational power (*e.g.*, many of the devices used currently in research and development have only an eight-bit 16-MHz processor). Due to the constraints of such processors, devices typically run specialized component-based embedded operating systems, such as Tiny OS.

2. Memory/Storage:

Storage in the form of random access and read-only memoryincludes both program memory (from which instructions are executedby the processor), and data memory (for storing raw and processed sensormeasurements and other local information). The quantities of memory andstorage on board a WSN device are often limited primarily by economicconsiderations, and are also likely to improve over time.

3. Radio Transceiver:

WSN devices include a low-rate, short-range wirelessradio (10–100 kbps, <100 m). While currently quite limited in capability too,these radios are likely to improve in sophistication over timeincludingimprovements in cost, spectral efficiency, tunability, and immunity to noise,fading, and interference. Radio communication is often the most powerintensive Operation in a WSN device, and hence the radio must incorporateenergy-efficient sleep and wake-up modes.

4. Sensors:

Due to bandwidth and power constraints, WSN devices primarilysupport only low-data-rate sensing. Many applications call for multi-modalsensing, so each device may have several sensors on board. The specific sensors used are highly dependent on the application; for example, they mayinclude temperature sensors, light sensors, humidity sensors, pressure sensors,accelerometers, magnetometers, chemical sensors, acoustic sensors, or evenlow-resolution imagers.

5. Geo-Positioning System:

In many WSN applications, it is important for allsensor measurements to be location stamped. The simplest way to obtainpositioning is to pre-configure sensor locations at deployment, but this mayonly be feasible in limited deployments. Particularly for outdoor operations,when the network is deployed in an ad hoc manner, such information is mosteasily obtained via satellite-based GPS. However, even in such applications, only a fraction of the nodes may be equipped with GPS capability, due to environmental and economic constraints. In this case, other nodes must obtain their locations indirectly through network localization algorithms.

PROPOSED WORK

An attempt is made at a typical underground mine to investigate the presence of toxic gases in critical regions and their effects on miners which can be extended for monitoring of health of the equipment. A real time monitoring system using wireless sensor network, which includes multiple sensors, is developed. This system monitors surrounding environmental parameters such as temperature, humidity and multiple toxic gases. This system also provides an early warning, which will be helpful to all miners present inside the mine to save their life and the equipment before any casualty occurs. The system uses Zigbee technology to establish wireless sensor network. It is wireless networking standard IEEE 802.15.4, which is suitable for operation in harsh environment.

The study of hazardous /combustible gases with wireless sensor network lacks real deployments [Somov et al, 2011], mostly because of several reasons (i) consumption of high power by gas sensors, (ii) sensor nodes must ensure safe and reliable gas detection meeting the safety standards, (iii) sustained operation over a pre-decided period of time without running out of power source, and (iv) operating in a fault-free manner despite deployment in adverse underground mine environment.

Fig.4 shows the conventional gas sensors fixed to the roof of a typical underground coal mine. Proposed work constituting design of reliable hazardous gas sensors for

underground mine installation to supply sensor data (Atmospheric and equipment conditions) and continuously 24x7 in real-time will be undergoing a pilot run evaluation in the proposed study area, in the blasting gallery of a typical underground coal mine.

Fig.3: Traditional Gas Sensors provided in the roof of a typical underground Coal Mine

CONCLUSION

In general, the conventional systems of monitoring condition of the mine including mine atmosphere and mine equipment are associated with personal observation and intermittent readings and offline analysis of the data. A person go to the mine working place (for gas analysis, load on supports, electrical parameters of mining equipment to assess the machine condition etc) and then these readings are analyzed offline. This time taking process is performed in different shifts and has to carefully note down the readings. Therefore, for improved evaluation of mine conditions, wireless systems may be applied for online monitoring of the mine atmosphere, and equipments including supports-hydraulic props, chock shields, loading and cutting equipments and associated machinery. The study of may remote monitoring of UG mining gases lead to autonomous decision in real time using ambient intelligence which provide better results than through common decision making based on intermittent tests and conventional procedures of sample collection and analysis in the laboratory. Emphasis is made on urgent requirement of application of trans-disciplinary research and study the underground mine conditions including online monitoring of mine atmosphere and mine equipment by application of wireless sensor networks and IoT devices.

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Case Study on Energy Efficiency & Conservation

S.S.Biswal*

PROJECT OUTLINE

Saving Natural Resource leading towards Eco-Friendly Environment is main sketch around which our case study has been framed.

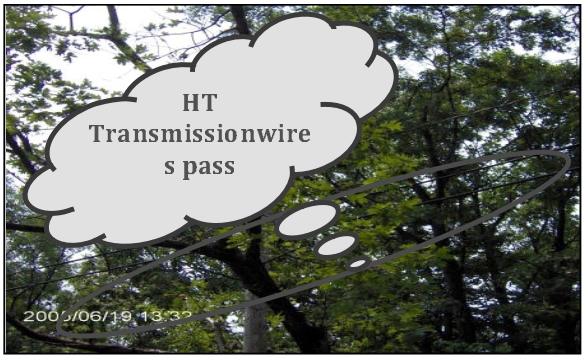
These days, the biggest concern before us is the fast depletion of natural resources such as natural gas, oil, petrol, diesel etc. Considering the issues related to "Conservation of Energy"which we all have been facing over the years, our Total Productive Maintenance (TPM) team named as "Sparta" has ventured in developing Kaizen under the theme "To eliminate the diesel loss due to Power failure" A joint case study prepared byKobetsu Kaizen (KK), Planned MaintenanceTeam).

The contour of the case study revolves around a 600 kVA DG Set whose performance has detoriated over the years and whose Overall Equipment Efficiency (OEE) figure has come down from 50% to 14%. Company management has decided to completely stop the 600 kVA DG Set, due to low efficiency, service problem from Original Equipment Manufacturer (OEM). After implementation of TPM (Total Productive Maintenance) our PM& KK team took the challenge to make obsolete machine workable, efficient, restore the DG Set by doing PM & KK Kaizens (Improvement)& parallelly started the Jishu Hozen (JH) concepts.

PROJECT DETAILS

Coming to the background of our case study, our unit(an iron mines) is located 840 meter above MSL & we get electricity from Western electricitySupply Company of Odisha (WESCO)& our HT conductors passes through dense forest.Thunderstorm & low cloudburst is a very common phenomenon throughout the year. So whenever lightning occurs insulator get punctured as well as trees fall on HT conductor. For these incidents our breakdown time due to power failure gradually increases. In order to maintain targeted production & smooth domestic life D.G is essential.

Our company procured a 600 kVA DG Set to meet our demand load during power failure but as the domestic load increases& it cannot meet the load requirement. So company procured a 200 kVA DG Set for domestic load then after our production target increases year by year. So higher capacity DG is required at the plant load increases. So, 1010 kVA DG Set was procured. In the mean time performance of DG Set was detoriated& OEE (Overall Equipment Efficiency)comes from 50% to 14%. So management decided completely stopped the DG Set, due to low efficiency, service problem from OEM .



After the implementation of TPM our KK team prepares the loss tree according to Man, Equipment & energy related losses considering all the 16 types of losses. From which it was found that energy loss is more & it is due to diesel consumption high due to underutilization of 1010 kVA DG Set is maintenance period as it comes from Pareto analysis. The CO_2 emission increased from 30263 KG to 246792 KG. So we take target to restore the 600 kVA DG Set. After getting management approval, we set BM (Bench Mark)&Target for availability, noise level, maintenance cost, &reduction of CO_2 emission. So our PM & KK team took the challenge to make absolute machine workable & efficient by doing. PM & KK Kaizens& parallel started by JH concepts then after analysis two types of problem arises i.e. Mechanical & Electrical.

*Manager (Electrical) ,M/s JSPL

Detoriated condition of 600 kVA DG Set

3 major mechanical problems comes i.e. Engine not taking load, overheat & unavailable of skill. Then, we do the cause & effect analysis taking in to consideration Man, machine, material& Method &prepared causes & countermeasures for each activity & target date was set to complete it. Further we do the skill mapping & given training to desired people & enhanced the skill level, providing appropriate tools & tackles.

In between one Bindash(working fear less) kaizen (Improvement) was done in which a separate pit was made for storing used lube oil to avoid ground contamination and installing a safety valve with lock for user-friendly activity &as a result 3hrs reduced for lube oil replace & two no's of manpower. Simultaneously lots of kaizen was done such as Proper illumination, easy accessibility, installing aquastic enclosure to minimise the sound level &lots of visual control developed for effective Cleaning, Lubrication, Inspection, Tightening & Adjustment (CLITA). Proper Illumination, easy accessible for radiator filling and lots of Kaizens (Improvement) done.

KAIZEN (Improvement)

BEFORE	AFTER

KAIZEN (Improvement)

BEFORE	AFTER

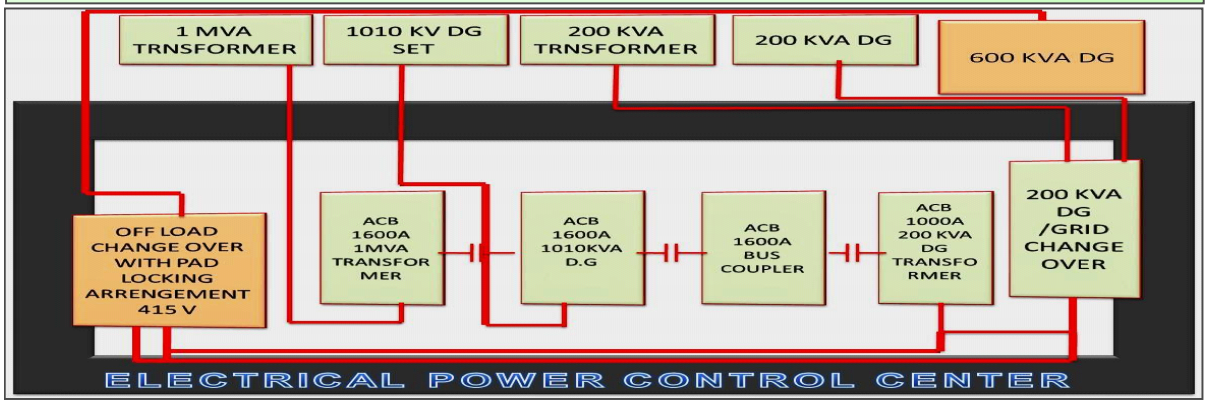
After the restoration of engine the real problem arrives form Electrical i.e how to connect the 600 kVA DG Set supply at the existing Power control centre (PCC) panel.In our power distribution system these are three no's of breakers i.e.1010 kVA, 1MVA, 200 kVA. So there is no provision in PCC panel. To overcome this problem lots of brainstorming season comes & lots of idea generated from which 4 no's idea selected for consideration. Idea-1 is to isolate the 600 kVA DG Set & as it is in workable condition Idea-1 is rejected, then Idea-2 is to provide domestic supply through 600 kVA DG Set & its costs comes around 8-10 lakhs , then Idea-3 is up gradation the PCC Panel consulting with manufacturers & its cost around 15-18 lakhs, finally Idea-4 to explore the possibilities to connect the 600 kVA DG Set supply with the PCC Panel by providing offload change over with interlocking arrangement between the supply of 600 & 200 kVA DG Sets.

After comparing Idea-2,3,4 on the basis of cost & lead time finally idea-4 is selected for amendment as it costs comes around 1.5 lakhs & lead time is 72 hrs, so after connecting the offload change over existing PCC Panel the power system gets synchronizes & we run the power sources as per load requirements. In the meant to enhance the safety and in the meantime the Breaker was replaced with another Breaker having all safety features.

Cost & Time Comparison between Ideas

Idea No.	Expected Cost in Lakhs	Expected Time of Completion
Idea : 2	₹. 09.33	2160 Hrs
Idea : 3	₹. 16.63	1440 Hrs
Idea : 4	₹. 2.27	408 Hrs

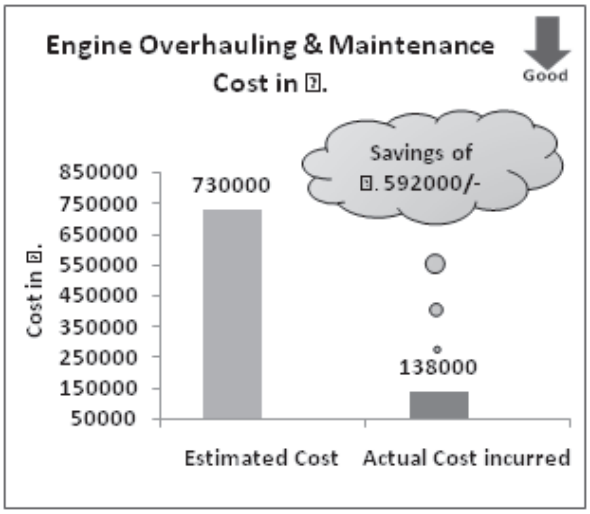
Idea-04 Implementation

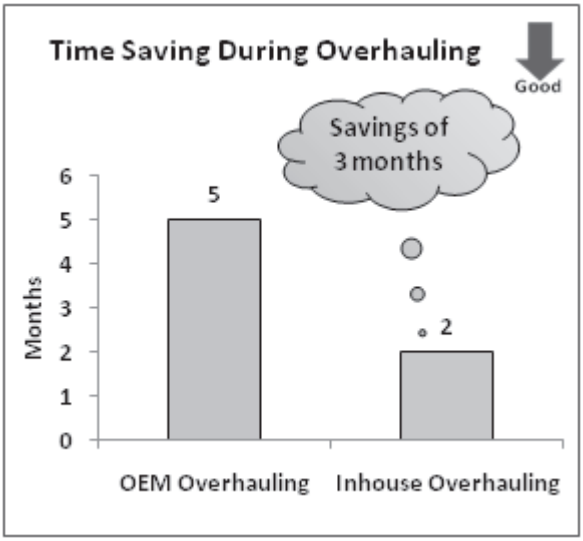


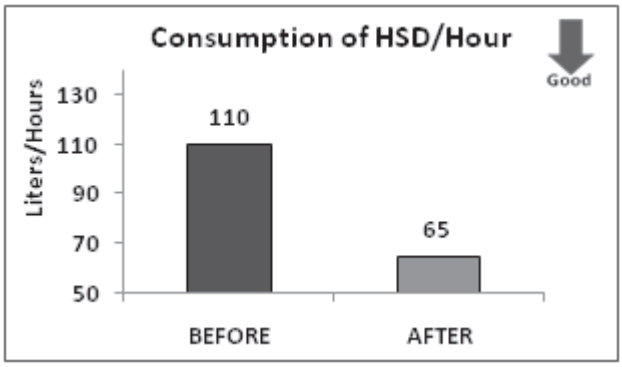
Installation of 1000 AMP Breaker with all Safety Features

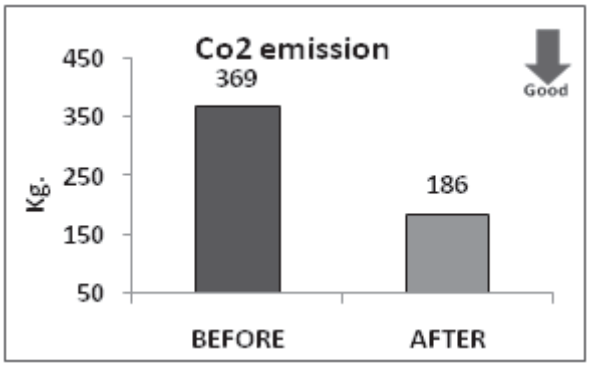
Savings &Benefits

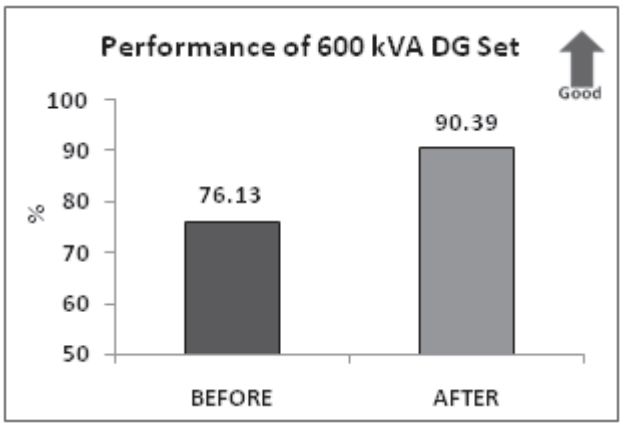
After complying, all the mechanical & electrical related problems the diesel consumption per hours 135 to 68 ltr. as well costs per hour comes fromRs.5441/- to Rs.2741/- & more importantly Co_2 emission reduced from 369 KG to186 KG per hour. In the result summery availability & performances increases, so that the OEE increases from 64% to 85%. In terms of saving & benefits 5.3 lakhs save in maintenance cost, skill level upgraded as well as overhauling time reduced to 50%, Parallely, JH concept implemented regularly for which follow-up & review sheet prepared ,lots of visual control developed resulting Cleaning, Lubrication, Inspection, Tightening& Adjustment (CLITA) time reduced to 61%.

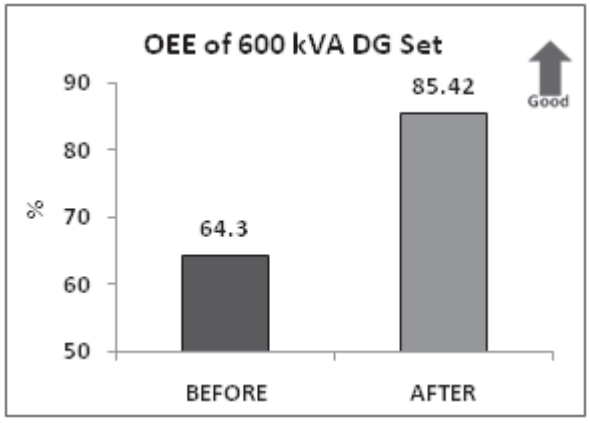












Conservation of Energy has been latest buzzword in the global scenario."Kaizen" meaning improvement and diesel which is a natural resource and getting extinct day by day needs to be preserved. Our Quality Circle (QC) Team has taken initiative in developing this kaizen for saving of energy.

600 kVA DG Set

BEFORE	AFTER

Augmenting the Illuminance to Standards in an Energy Efficient Way - West Bokaro,Quarry SE -A Case Study

Somnath Lahiri*

ABSTRACT

The illumination standards have been increased significantly as compared to previous thresholds by the DGMS.With respect to new standards illumination level in the mine was below par. It was decided to replace the High pressure sodium vapour lamps with LEDs to augment the lux levels.Anillumination survey of masjid area haul road was conducted in which horizontal illumination was recorded in grid passion to depict an increase in Lux level after installation ofLeds as compared to that of HPSV.This involved large number of measuring points to achieve better accuracy. Results of survey conducted athaul road having HPSV have also been provided for comparison.

MINE LOCATION AND DESCRIPTION

Tata Steel requires clean coal to fuel its blast furnace's operations at Jamshedpur Works. To ensure sustained supply of raw material (coke), West Bokaro Division was started as a captive coal mine.

West Bokaro is located about 70 kms from Ranchi, in the Ramgarh district of Jharkhand state.Total area of the leasehold is 4300 acres and it produces about 5 MT coal for Tata Steel plant's captive usage. Coal is transported through rail network from the loading station, at Chainpur, situated at 4 kms to the south of the lease.

Quarry-South Eastern constitutes one of the two captive coal mines of West Bokaro Division with an annual production capacity of 3 Million Tonnes of raw coal at 17-32% ash content. Mining is carried out by 100ton rear dumper and 14.5 CuM hydraulic shovel combination. Full-fledged mining operation started in the year 2003 (OB removal started in June'2003 whereas the first batch of raw coal was excavated in November'2003). The stripping ratio is about 4:1 and the pit depth on the eastern side varies from 130m to 160m whereas that of the western side is in the range of 110-140m.

Quarry South Eastern is a fully mechanized mine with state of the art facilities. From the electrical perspective, we have four Diesel operated and one 15 Cum Electrical operated Shovel (Hitachi Ex-2500 model with 900 Kw motor) drawing power from 6.6. KV HT line. To ensure mine dewatering at zero discharge, we have two 5000 GPM pumps run by electrical motors. In order to cater the mine lighting and power needs of various electrical equipment, we have a separate bay at mining sub-station of 11Kv in place and voltage is reduced to 220V for lighting purpose. At Quarry SE, we are committed to provide safe working environment with adequate glare-free lighting for optimum productivity and environmental friendly work culture. Lighting level adheres to statutory stipulations w.r.t horizontal and vertical conditions with innovative layouts for maximum energy efficiency. There have been regulatory changes for mine illumination on 08-04-2016 vide Circular No. 06 0f 2016 which require QSE to almost double the existing lighting facilities and hence the lighting load will also increase. It became a challenge to contain the power consumption for lighting within limitsconsidering the competitive market. Tata Steel is well known company for its corporate responsibilities and committed to sustain environmental requirements. To cater to the regulatory changes, save energy, environment and cost, QSE sought guidance from leading lighting solution provider and conducted a scientific study to introduce new lighting solution in mines.

BASIC TERMINOLOGY IN PHOTOMETRY

• Luminous Flux

Luminous Flux is the time flow rate of light energy.This is also known as Luminous power.Its SI unit is lumen and it is represented by Ö.

• Illuminance

Illuminance is the measure of density of luminous flux striking a surface.Its SI unit is lux or lumen/m^2. The lux meter used in illumination survey uses this quantity.

$$E = \frac{\Phi}{A} \quad \ldots 1$$

Where, E- Illuminance, Ö- Luminous Flux, A- Area

**Engineer, Q-SE, M/s TATA STEEL*

• Luminous Efficacy

Luminous efficacy is defined as the luminous flux of a lamp in relation to its power consumption and is therefore expressed in lumen per watt (lm/W). Luminous efficacy varies from light source to light source.

• Horizontal Illuminance:

The measure of brightness from a light source, usually measured in lumens, which is taken through a light meter's sensor at a horizontal position on a horizontal surface.

• Vertical Illuminance:

The measure of brightness from a light source, usually measured in lumens, which is taken through a light meter's sensor at a vertical position on a vertical surface.

• Uniformity Ratio:

It describes the uniformity of light levels across an area. This may be expressed as a ratio of average to minimum or it may be expressed as a ratio of maximum to minimum level of illumination for a given area.

• Glare:

There are two types of glare: disability glare and discomfort glare .Disability glare is defined as glare resulting in decreased visual performance and visibility. The cause is stray light which enters the eye and scatters inside. Discomfort glare causes fatigue and pain caused by high and non-uniform distributions of brightness in the observer's field of view. [1][2][3]

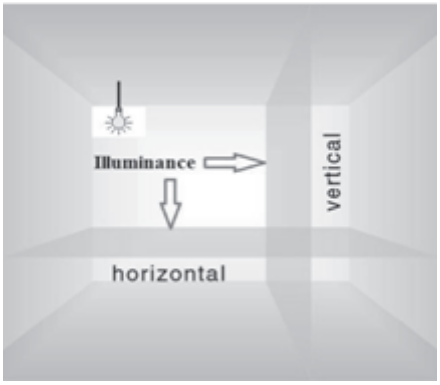


Fig. 1 Horizontal and Vertical Illuminance

Lighting Laws

- **Lambert's Cosine Law-** Lambert's cosine law states that the luminous intensity observed from an ideal diffused reflecting surface is directly proportional to the cosine of the angle è between the observer's line of sight and the surface normal. The representation of Lamberts Cosine Law is illustrated in the Fig 1.

$$I_1 = I \cos\theta \quad \ldots 2$$

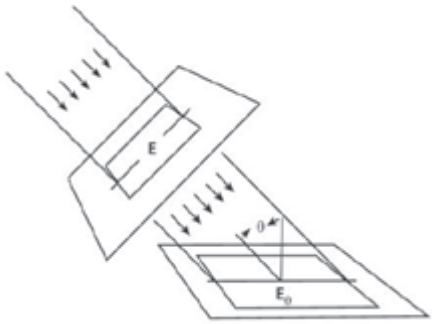


Fig. 2Depiction of cosine law

- **Inverse Square Law**

A problem common in lighting system design is determining the illumination on surfaces at various distances from a light source. This can be handled using the inverse square law. The equation relates illumination, intensity, and the distance between the source and light receiving surface is known as the inverse square law, given as:

$$\mathbf{E} = I/D^2 \quad \ldots 3$$

Where E is illuminance, I is Luminous Intensity and D is the distance between the source and light receiving surface.[4]

Luminaire design parameters

1) Mounting Height
2) Overhang
3) Boom Angle
4) Boom Length

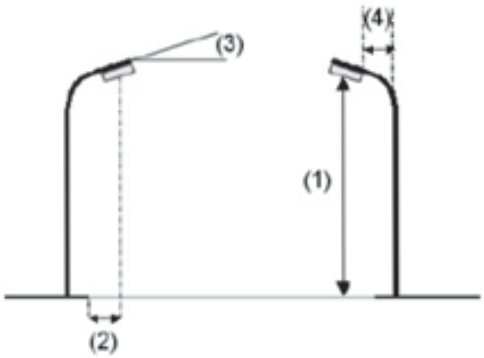


Fig 3 Fixture design parameters

Advantages of Led over HPSV

• **Life**

The average life of Led is 50,000 hours as compared to 12,000 hours of HPSV lamps. Also the rate of failure of led is less than 5% whereas that of HPSV is about 30-35%.

• **CRI**

CRI for LED is highly dependent on the particular light in question. That said, a very broad spectrum of CRI values is available ranging generally from 65-95.

High Pressure Sodium lamps are notorious for having the worst CRI values on the market. Typically they fall around 25 on a scale of 100 where 100 is the best possible.

• **Warm up Time**

LEDs have virtually no warm-up time. They reach maximum brightness near instantaneously.

High Pressure Sodium lights require a warm-up time that varies depending on the light. It can take up to 10 minutes to get the LPS or HPS lamp up to its normal operating temperature.

• **Dimming**

LEDs are very easy to dim and options are available to use anywhere from 100% of the light to 0.5% whereas HPSV lights can be manually dimmed through the use of different electric or magnetic ballast but the process changes the voltage input to the light and can consequently alter the light characteristics.

• **Efficiency**

LEDs are very efficient relative to every lighting type on the market. Typical source efficiency ranges 37 and 120 lumens/watt.

High Pressure Sodium lights are the only light whose source efficiency compares to LEDs (values range between 50 and 160 lumens/watt for LPS and slightly less for HPS). They lose out to LEDs in many cases because their system efficiency is often much lower due to losses associated with omnidirectional light output and the need to redirect it to a desired area.

• **Correlated Color Temperature**

LEDs are available in a wide range of colour temperatures that generally span from 2200K-6000K (ranging from "warm" yellow to light or "cool" blue).

High Pressure Sodium lights are well-known for their warm yellow glow (CCT values around 2200K). The downside is that there are very few options outside the narrow range to choose from. In other words, if you're not looking for a warm deep yellow light, you're going to have to use something besides High Pressure Sodium to achieve it.

• **Lifetime costs**

LED lighting has relatively high initial costs and low lifetime costs. The technology pays the investor back over time (the payback period). The major payback comes primarily from reduced maintenance costs over time (dependent on labour costs) and secondarily from energy efficiency improvements (dependent on electricity costs).

High Pressure Sodium lights are very cheap to purchase as well as fairly cheap to maintain. That said, although HPS bulbs have a long lifespan relative to most competitors, they still fall short of LEDs. HPS lights will still likely need to be purchased several times and the associated labour costs will need to be paid in order to attain the equivalent lifespan of a single LED light.

• **Shock Resistant**

LEDs are solid state lights (SSLs) that are difficult to damage with physical shocks. High Pressure Sodium bulbs are fragile relative to LEDs.

• **Directionality**

LEDs emit light for 180 degrees. This is typically an advantage because light is usually desired over a target area rather than HPSV which emit light in all 360 degrees around the bulb.This means they emit light for 360 degrees, requiring fixture housings or reflectors to direct a large portion of the emissions to the desired target area.

LIGHTING STUDY REPORT

A scientific study was conducted with a leading illumination expert for innovative lighting solutions. For this we conducted field illumination trials in our mine and subsequently numerical modelling was done to establish LUX levels for various Lumens. This was done to understand the adequacy of different lighting alternatives for spread, glare and optimizing the spacing between fixtures.

HAUL ROAD ILLUMINATION

Earlier the mine had HSPV with two sided arrangement, with fixtures at every 40 m. The width of the road illuminated by this fixtures is 28m(light vehicle road(7m) + haul road

(28m)). On survey it was found out that the illumination levels were significantly lower than the DGMS standards. The 6*6 grid survey of haul road with HSPV lamp is depicted below.

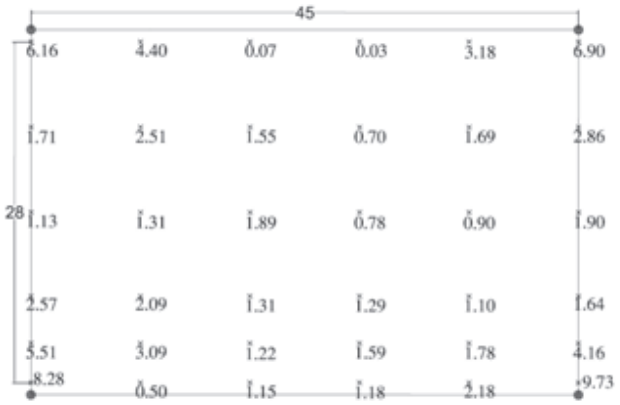


Fig 4. 6*6 Grid Illumination Survey of Haul Road with HSPV.

Then the management went for two sided arrangements with LED lamps, the illumination level increased significantly but still fell below par at spots on the road. A survey of haul road with led lamps on both the sided is shown in the figure below. It was a 14*6 grid survey of a 35m wide haul road with fixture spacing of 40m.

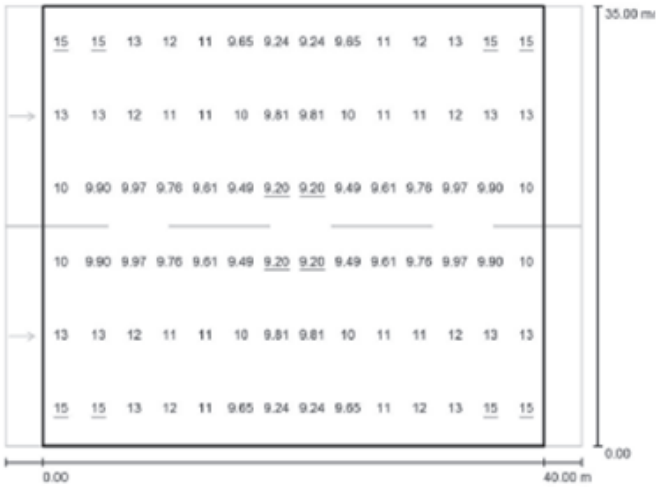


Fig 5.14*6 grid survey with two side fixture arrangement (LED lamps)

The insights derived from field study and numerical modelling were utilized for designing energy efficient solution offering optimum illumination.Accordingly LED lights (120W, 150 W & 200 W) were mounted at various strategic locations for illuminating the entire stretch of the haul roads spanning 2.5 KM. These fixtures are fitted preferably on middle divider of the main haul roads (permanent in nature) at a distance of (25m or 22m) from each other. 2 lamps are fixed on each fixture such that it illuminates both the lanes.

Arrangement along the middle divider was preferred over two sided arrangement as it significantly reduces the cost of fixtures. Also the illumination levels were significantly increased with this arrangement.

Below the data depicts illumination level depicts lux level around a fixture on the haul road where fixture spacing is 25m and each lamp's wattage is 120W.Each lane's width at this fixture is 15m.

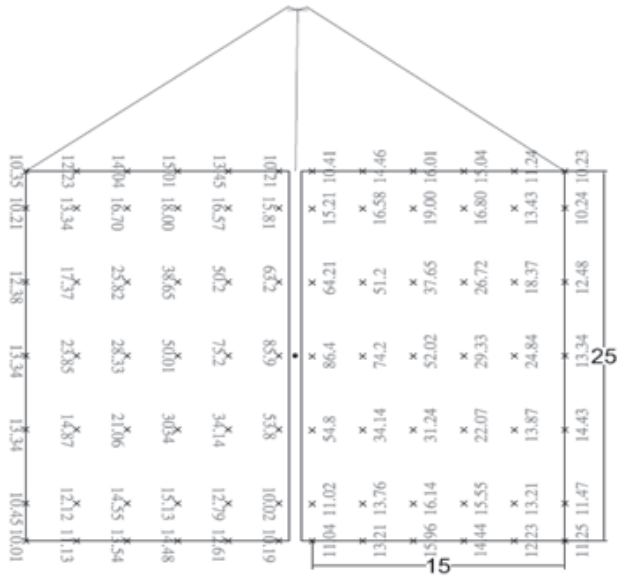


Fig 6. Grid Illumination survey of masjid area haul road

OTHER WORKING PLACES

10 Portable DG lighting towers are used to provide illuminations for dynamic working faces and dumping stations. Apart from these, HEMM have its own lighting arrangements to provide adequate illumination level and these are also replaced with comparable LED fixtures. Maintenance and workshop areas are also provided with energy efficient LED fixtures and solar lights at vantage points. After fixing the lighting towers at a spacing of 20m the lux level has increased to 12-14 Lux. A summary sheet mentioning illumination requirement and present illumination level is depicted overleaf.

To further augment and optimise the illumination it is decided to replace the remaining HSPV lamps with LEDs which will bring along with it all the previously mentioned benefits.

Fig. 7 Panoramic View of LED lit haul road at QSE West- Bokaro

Fig. 8 Uniform Lighting at OB Dump yard at OSE West -Bokaro

Sample report of different working Areas in Quarry SE-West Bokaro

Location	DGMS Recommendation	Actual Value
Haul Road	10 H	14H
Work Place of HEMM	25 V,15H	28V 20H
Parking Yard	50 H	55H
Coal stock Yard	15 H, 25V	20H, 30V
Rest Shelter	30 H	40H
Coal Hopper	40 H	45H
Drill Face	15 H	25H,38V
Dump Yard	15 H ,15V	15H,20V

ECONOMIC BENEFITS

Use of proper LED lights has brought down the lighting load by 45% whereas it has increased the illumination level by 120%. Moving forward, with increasing haul road length and deployment of more no of HEMMs, QSE will continue to look for innovative lighting solutions to sustain mine illumination levels.

FUTURE PROSPECTS

It is not certain that Led will not be able combat foggy conditions. We haven't yet experienced it in our mines as winter is yet to arrive since the installation of LED. In case Leds under perform in foggy conditions we have a B plan to fix Led and Hpsv in alteration along the Haul road and other operational places.This may increase the energy consumption a bit(still less than the cost of original HPSV arrangement) but it is better than to compromise with the safety of the workers.

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Leveraging Wireless Technology for Industrial Applications

Joydeep Dasgupta*

INTRODUCTION

Wireless communication is transfer of information from one device to another without use of any physically wired conductor. This incorporates all procedures and forms of connecting and communicating between two or more devices using a wireless signal through wireless communication technologies and devices. Wireless communication generally works through electromagnetic signals that are broadcast by an enabled device within the air, physical environment or atmosphere. The sending device can be a sender or an intermediate device with the ability to propagate wireless signals. Communication between two devices occurs when the destination or receiving/intermediate device captures these signals, creating a wireless communication bridge between the sender and receiver device. Today's wireless communication has various forms, technology and delivery methods including Satellite communication; Mobile communication; Wireless network communication; Infrared communication; Bluetooth communication. Although all these communication technologies have different underlying architecture, they all lack a physical or wired connection between their respective devices to initiate and execute communication.

RADIO FREQUENCY AND TECHNOLOGY CLASSIFICATION IN INDIA

The device needed to establish wireless communication is known as Transmitter/Receiver/Repeater and in broader terms they are called "Radio".
The frequency band in India can be broadly demarcated into:-

- Licensed frequency Band – VHF (136- 174 MHz) / UHF (300-512 MHz)
- De-Licensed frequency Band- ISM - 2.4GHz/ 5.8 GHz/ 865-867 MHz (recently introduced)

Basic difference between licensed and de-licensed bands.

Parameters	**Licensed Frequency band/ VHF 136-174MHz band/ UHF 300-400MHz band**	**De-licensed Frequency band-ISM band 2.4GHz/5.8GHz band**
Data Rate	Low Data rate upto 64Kbps	High Data rate upto 1.3Gbps
Distance coverage	Long Range	Short range
Line of sight Requirement	Do not require	Clear Line of Sight Required
WPC License Frequency for using the frequency band	Required to be obtained from WPC India	No License is required to be obtained.

- The various frequency bands along with different modulation techniques and wireless technology standards.

Table-2

VHF	**UHF**	**UHF**	**UHF**
Licensed 136-174MHz	Licensed 380-512MHz	License Free 865-867MHz	License Free 2.4/5.8GHz
Single Carrier Modulation	Single Carrier Modulation	Single Carrier Modulation/ Spread Spectrum	Spread Spectrum
		Frequency-Hopping, GSM(TDMA)	Frequency-Hopping, OFDM, Direct Sequence, Zig-bee, Bluetooth

*Gua Ore Mines, RMD, SAIL

- Comparison of various modulation techniques and wireless technology standards.

Table-3

	Narrowband	GSM	Frequency Hopping	Direct Sequence	OFDM	VSAT
Communication Speed	Less than 100K bps	9.6K bps Few 100K bps for 3G	Up-to 1M bps	11M bps 54M bps	54M bps Up-to 300Mbps	As per Subscription
Standard Interfaces	Serial Ethernet Protocol Specific	Serial Ethernet	Serial Ethernet Protocol Specific	Serial Ethernet Protocol Specific	Serial Ethernet	Ethernet
Typical Coverage	Up-to 10Kms (can be up-to 100Kms)	As per Service Availability	3Kms (can be up-to 10's of Kms)	2Kms (can be up-to 10's of Kms)	2Kms (can be up-to 10's of Kms)	-
Typical Power Outputs	Up-to 50Watt	Low Power few milli-watts	Up-to 1Watt	Up-to 1Watt	Up-to 1Watt	-

- Selection of technology standards for particular applications.

Table-4:

	Narrowband	GSM	Frequency Hopping	Direct Sequence	OFDM	VSAT
Remote Pump House Monitoring & Control	YES	NO (Only Non-Critical)	Typically NO	Typically NO	Typically NO	YES
Fire Alarm System	Typically NO	Typically NO	Can be Utilized	Can be Utilized	Can be Utilized	Typically NO
Moving Machine	PLC Communication For Data & Signals	Typically NO	PLC Communication For Data & Signals	PLC Communication For Data & Signals	PLC Communication For Data & Signals	Typically NO
Fixed PLC – SCADA Communication	YES	YES (Monitoring)	YES (Monitoring & Control)	YES (Monitoring & Control)	YES (Monitoring & Control)	YES (Typically Monitoring)
Voice (Exchange Communication)	NO	NO	NO	YES	YES	YES
Video Communication	NO	NO	NO	YES	YES	Typically NO

IEEE STANDARD FOR SPEED OF RADIO MODEM IN 2.4GHZ/5.8GHZ LICENSE FREE BAND

IEEE 802.11 is a set of media access control (MAC) and physical layer (PHY) specifications for implementing wireless Local Area Network (LAN).

IEEE Standards	Description
802.11a	Frequency 5.8GHz with OFDM modulation and Data rate of upto 54Mbps
802.11b	Frequency 2.4GHz with DSSS modulation and Data rate of upto 11Mbps
802.11g	Frequency 2.4GHz with OFDM modulation and Data rate of upto 54Mbps
802.11n	Frequency 2.4GHz/5.8GHz with MIMO-OFDM technology and Data rate of upto 600Mbps
802.11ac	Frequency 2.4GHz/5.8GHz with BPSK to 256-QAM modulation and Data rate of upto 1.3Gbps

SCOPE OF WIRELESS TECHNOLOGY IMPLEMENTATION IN MINING INDUSTRY

Wireless Field Network (WFN)

This is a self organizing wireless field network based on WirelessHART communication standards capable of of delivering measurement data and diagnostics without the need for investing in a plantwide infrastructure. WirelessHART devices use small amount of bandwidth for enabling high priority communication. The self organizing mesh network ensures maximum integrity by allowing the field devices to communicate with each other. Since every device communicates with every other device, even with failure of an individual link or point the system does not fail and works by automatically finding out an optimum alternative communication pathway. The WIrelessHART field devices collect the field process data and the wireless plant infrastructure provides the means to transmit and integrate the measured data with the process control algorithm.

Wireless Plant Network (WPN)

WPN use mesh WiFi technology based on the IEEE 802.11 standards, to build cost effective wireless outdoor network for plant operations. The WPN provides a secure, high-bandwidth, reliable and scalable way to access fixed and mobile applications, such as process data monitoring, asset tracking, video surveillance, voice communication etc. The basic components of a Wireless Plant Network comprises of a mesh of access points, a LAN Controller and Network Management Software. Considering the need for security of confidential data, highly secure WPN Technology have been developed for industrial applications which restricts wireless eavesdropping and other external hacking. All data transmissions are totally encrypted with features for user authentication. Such security standards and protocols include IEEE 802.11i, WPA2 and AES. An intelligent routing protocol ensures the reliability of WPN by creating and maintaining the wireless mesh, managing self healing of network, reduces interference and minimizes network outages.

Common wireless applications in Mines

i. Voice communication over Wireless LAN (VoWLAN) , DMR and Simulcast Repeaters.
ii. Wireless Theft/Fire alarming solution for remote un-manned stations.
iii. Wireless video surveillance.
iv. IP based Public address system.
v. Wireless Pump/Motor monitoring and controlling
vi. Machine controlling and monitoring by wireless exchange of I/O's
vii. Anti-collision of mobile equipments like stackers reclaimers operating in same yard and EOT Cranes operating in same bay.
viii. Production Update/MIS over wireless.
ix. Solution on Anti-Theft at stores / important areas in plant and synchronization of security personnel.
x. Vehicle monitoring/surveillance/tracking.

ADVANTAGES OF WIRELESS COMMUNICATION SOLUTION

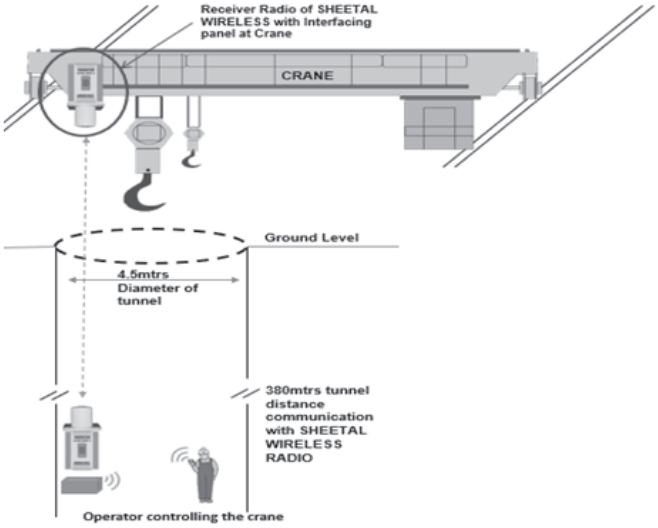
Almost nil down time due to less use of cabling.
Easy to troubleshoot.
Easy and fast installation, project implementation time is minimum, hence cost effective.
Fast ROI.
High security features with 128bit AES encryption. Less chance of data theft.
Cable theft at plants and mines is a big problem. Using wireless communication these cables are bypassed.
Best used for mobile application likes Stacker-reclaimer machines.

DISADVANTAGES OF WIRELESS COMMUNICATION SOLUTION

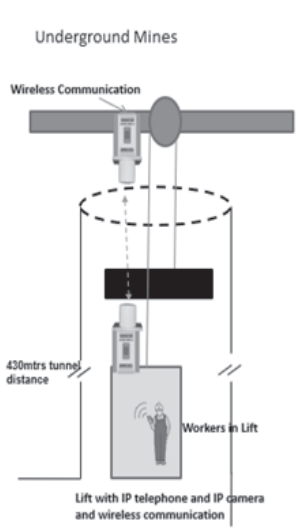
Due to lack of good solution designing of wireless solution the system failure may be there.
Interference may be a problem in License Free frequency band. So proper survey and designing is required.
Sometimes initial cost is high compared to cable communication.

SOME CRITICAL WIRELESS SOLUTIONS

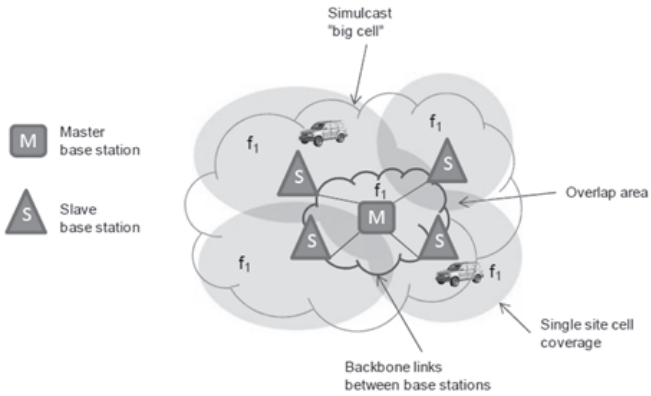
Wireless communication in vertical tunnel

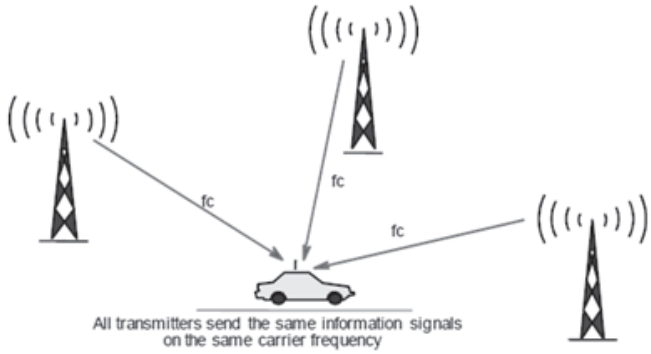


Wireless communication solution for CCTV and IP telephone solution in Underground Mines:



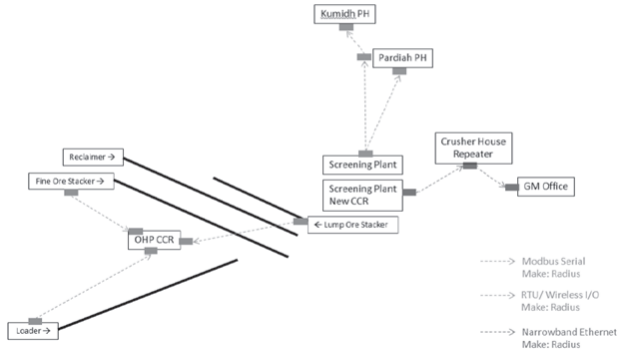
Wireless communication for Voice communication with Simulcast features





Wireless Control & Monitoring of mobile equipment and remote pump houses in Meghahatuburu Iron Ore Mines, RMD, SAIL

General Network Diagram:



A CASE STUDY OF IMPLEMENTATION OF WIRELESS COMMUNICATION NETWORK FOR DATA, VOICE & VIDEO SIGNALS AT GUA ORE MINES, RMD, SAIL:

Background: Gua processing plant which was commissioned way back in 1958 has a de-centralised control system layout & localized display system for various

plant equipments. Individual equipments are controlled and their status monitored locally near each drives. Since all the equipments are electrically interlocked with their respective up-stream equipment, there is frequent delay in resuming operation due to verbal communication exercise required to be done between operators of successive equipments. Also due to lack of centralized control system, displays of running/stopping status of all equipments are not available at a centralized location and compromises safety for operating manpower and machines. Absence of a central display limits immediate communication of current status of equipments and monitoring involves several manual information gathering efforts over telephone or PA system.

Along with difficulty of having centralized data from machines, reliability of voice communication over Walky-Talky and EPABX is poor due to frequent problem in media/ cable laid over a hostile terrain.

Planning & alternative selection: The solution was implementation of a central mimic display to enable effective and quick communication of status and ensure prompt corrective action by concerned operation, maintenance and safety personnel. The central display system shall help in reducing valuable time lost due to verbal communication exercise. However conventional approach would involve lot of cabling work and shutdown of operation. Moreover a conventional network over physical conductors shall always remain susceptible to hazardous operation and subsequent frequent damages in hostile mining environment. The ideal alternative was to establish a Wireless Plant Network (WPN) throughout the expanse of the plant premises by optimally locating radio equipments and accessories at nodal points. These individual radios shall pick up status signals from each equipment locally and communicate the same to a centrally located node which shall generate a real time display on a HMI unit by developing suitable pictorial graphics representing status of various equipments. The same display shall be replicated at three different locations of PPC, Secondary Screen House, Crusher House.
Considering the present layout of Gua Plant & Remotely located substations the following areas have been ear-marked as nodal points.

1. Crushing House (CH)
2. Primary Screen House (PSH)
3. Secondary Screen House (SSH)
4. HN-16 Sub-station
5. PPC (General Office)

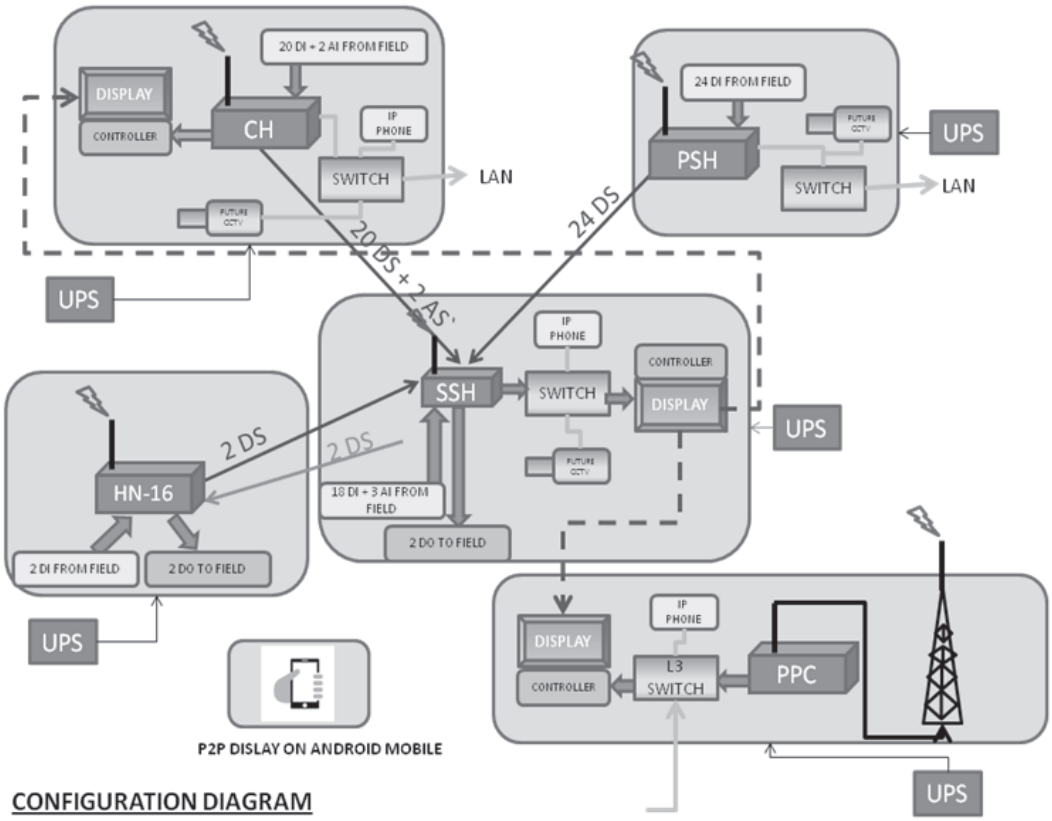
In this job CCTV live steaming and the Voice communication over IP Phone was also considered to provide additional information and surveillance and safety issues.

Technical details: The wireless communication system to be built was to act as a backbone for the network to provide Data, Voice and Video communication with the 300Mbps Radio modem. These Radio modems selected were IEEE802.11n compliant with MIMO-OFDM technology. The radio modem had modulation of upto 64-QAM and QOS for excellent service quality for voice, video and Data communication.

Digital I/O's from all the remote locations are taken locally in the RTU and the same information is passed and stored at the SCADA cum MIS for processing the Data to archive the history and the other parameters for analysing the trends of faults and alarms.

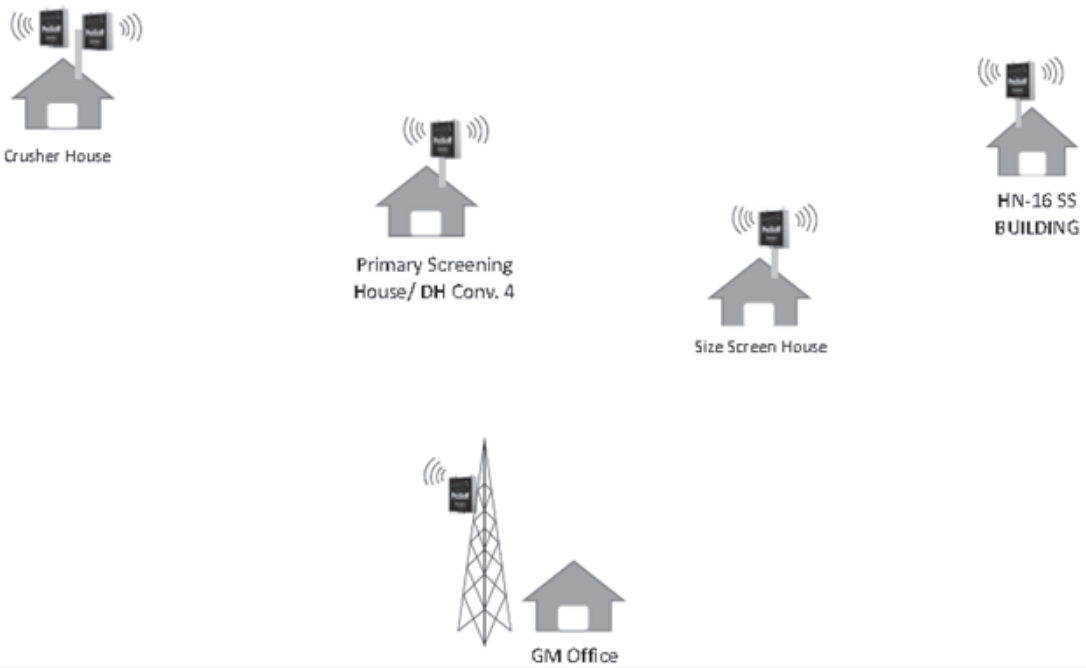
To take on the advantage of the wireless communication technology the project has been taken to IOT by providing the SCADA screen on the Mobile Phone. The authorized person with ID and Password can link and take the SCADA information from anywhere in India with his smartphone which would be connected on secured VPN connection through the use of GPRS services.

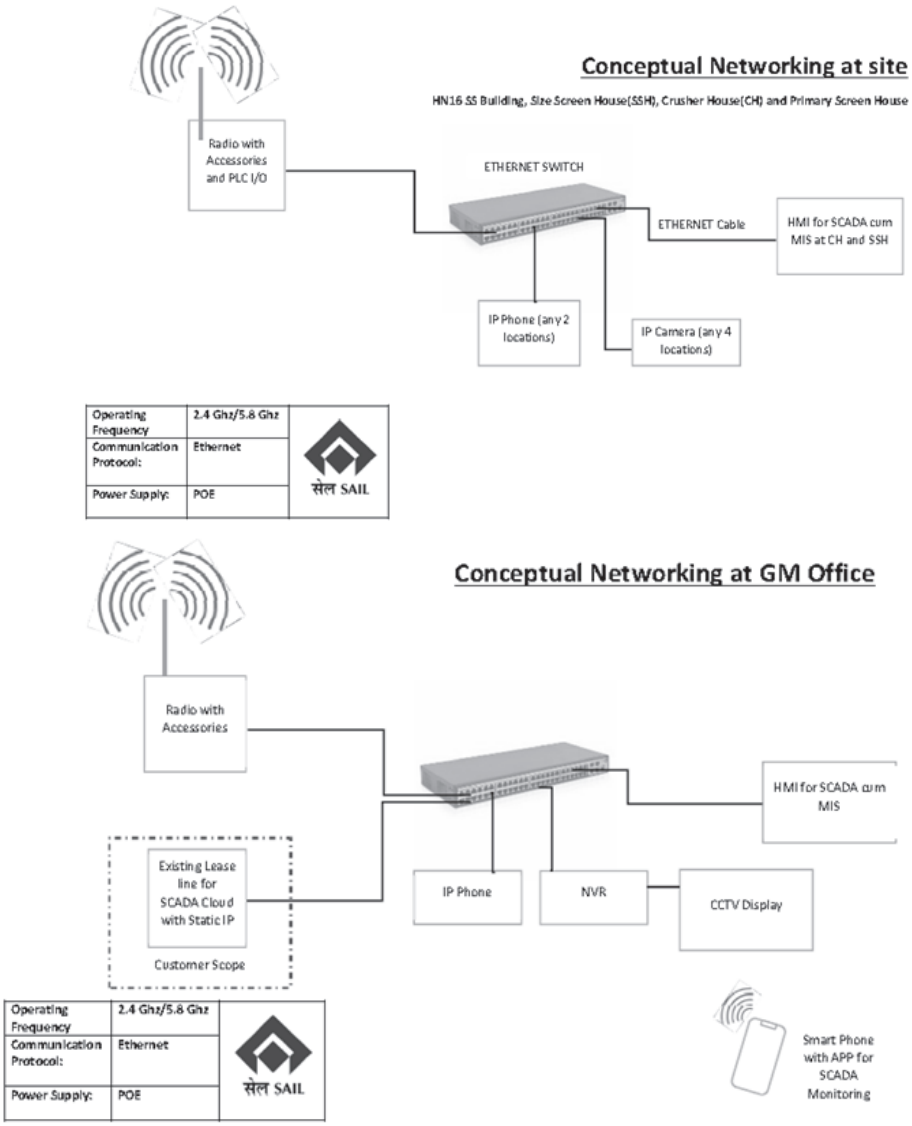
Benefits envisaged: The above project, involving latest wireless technology, after its completion shall help immensely in real time remote monitoring and storage of events over a long distance and shall act as a tool for ensuring high productivity along with safety of men and machine. The reliable and independent wireless network formed shall serve as a platform for any future communication need for data, audio and video.



CONFIGURATION DIAGRAM

Conceptual Wireless Network Architecture





CONCLUSION

Wireless technology is becoming more and more popular owing to its fast evolution into being a low cost and ease-of-use product. In many cases wireless has become cheaper than the wired alternative. This technology allows a faster and more convenient access to remotely located assets. With a variety of applications of interfacing of analog sensors and digital IO, wireless technology is being widely acceptable in variety of industries. From a simple domestic application of temperature control to the more complex mesh sensor network, wireless devices are gradually becoming an industry standard in communication. With the extremely advantageous features of mobility, simplicity, flexibility, reliability and cost saving, leveraging smart wireless devices and networks provide a better and safe option for many critical applications. With regular advancement in the technology, Wireless communication is surely going to stay and play a major and significant role in making industries efficient and safe and improve quality of life.

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Propelling 'Make in India': Heavy Engineering Corporation Ltd.

Anjana Nidhi*

Heavy Engineering Corporation Ltd. (HEC), Ranchi was incorporated on December 31, 1958 under the Companies Act, 1956. It was set up under the administrative control of Ministry of Heavy Industries and Public Enterprises, with the primary objective of achieving self-sufficiency and self-reliance in the field of design and manufacture of equipment and machinery for core sector, especially steel industry. The manufacturing facilities at HEC were created in collaboration with erstwhile USSR and Czechoslovakia wherefrom the initial product design and process technology were sourced. With manufacturing set-up for each stage of manufacturing operation, starting from preparation of liquid metal, pouring them to ingot, getting a finished steel forging, fabrication of large components and heavy machining operation facilities, HEC is placed as a unique manufacturing complex, second to none in India.

ACTUATOR OF SELF-RELIANCE

Promashexport of erstwhile USSR and Skoda of erstwhile Czechoslovakia provided equipment design for Steel plant, Mining equipment, Mineral Processing, Machine Tools and manufacturing process technology. These design and technology formed fundamental technical basis for HEC. Subsequently, HEC collaborated with various other global firms from USA, UK, Germany and Japan for equipment and process technology which enabled HEC to add various areas of expertise and emerge as the only indigenous source.

HEC also established the manufacturing of some critical strategic products for the first time in the country having substantial value for the nation in terms of technical capability.

IN STEEL MANUFACTURING

During the sixties when the upcoming steel plants were functioning to propel infrastructure development in India, HEC played a vital role, manufacturing and supplying import-substitute steel plant equipment to the green field steel plant projects. It continues to provide support & supplies to almost all the steel plants in India and is also contributing to their expansion and modernization. HEC developed its own design for Coke Quenching car which is a patented product. HEC developed the improved design of Coke Pusher which is installed in the Durgapur Steel Plant. Similarly, the design of a number of products in steel melting has been improvised.

FOR UNEARTHING

HEC acquired the design and process technology for excavating and crushing equipment from various sources and pioneered in manufacturing of heavy duty mining equipment. It assimilated the design and subsequently indigenized it, demonstrating a unique technology base in mining. HEC had entered into technical collaboration with UK based Ransom & Rapier for Dragline and later the equipment was indigenized phase-wise and necessary design modifications were carried out to make the product fully indigenous.

IN METAL CUTTING

Several Machine Tools in the heavier range, that find competitors mostly from overseas, is another area of prestige for HEC. Heavy Machine Tools ranging from Radial drilling machines, Heavy Duty Centre Lathe, Horizontal boring and milling machines, vertical boring & turning machines, Planing machines, Roll Grinding machines, and Special purpose Railway machine tools are being supplied to various ordnance factories, Railways, steel sector and engineering sector. HEC demonstrated its niche skills, when after the India's nuclear test in 1998 (Pokhran-II) the western world denied the supply of critical products and HEC was entrusted to develop CNC VTBs of 3 and 6 axis for space research application. The machines were successfully developed and manufactured as per international standards and supplied to HAL.

IN METALLURGY

HEC achieved a number of metallurgical milestones in the country. HEC developed its knowledge base by working in close association with BARC, DAE, Prometi (Russia), NPCIL etc., coupled with its in-house research and development work. Steel required for nuclear grade is characterised by ultra clean steel with hydrogen inclusion as less than 1.3 PPM. HEC could achieve even less than

*Manager, Corporate Marketing, Heavy Engineering Corporation Ltd. Ranchi

0.1 PPM with stringent ultrasonic quality. With its manufacturing capabilities in special steel development, heavy machining and fabrication, HEC has partnered at different junctures with Defense Metallurgical Research Laboratory (DMRL), Department of Atomic Energy, various Ordnance Factories, Indian Space Research Organization (ISRO), to meet their special requirements.

SETTING-UP TO FORWARD THE 'MAKE IN INDIA'

HEC is aiming high to set new standards of success for itself backed by the 'Make in India' campaign which lays strong emphasis on making the country a platform to conduct business. HEC is taking new initiatives to tap the opportunities coming forth. With its diverse skills for manufacturing, the company is diversifying and has embarked on a rapid growth path. HEC has recently entered into technology collaborations with foreign companies in the area of nuclear and strategic sector.

FOR SETTING UP NUCLEAR POWER PLANTS

HEC has entered into separate agreements with technology providers CNIITMASH and OKBM, of Russia. The collaboration shall empower HEC to manufacture critical equipment such as Tube Sheet, Calandria, Steam Generators etc. A way out has been chalked out in the agreements, where after conducting the technical audit of HEC on feasibility of manufacturing, the gaps will be bridged and technical information will be extended along with sufficient training. HEC is geared up to take this crucial responsibility of indigenisation in this sector.

FOR SHAFTINGS IN WARSHIPS

Partnering with the domestic Ship builders, HEC is putting efforts to indigenize the propulsion system of the warships, which at present, is an import segment. HEC is in continuous discussions to conclude the agreement with a Russian collaborator. The present facilities at HEC will only require some augmentation to embark onto manufacturing of propeller shafts and components.

IN STRATEGIC NUCLEAR SECTOR

HEC developed the manufacturing process for special steel for manufacture of Reactor Pressure Vessels (RPV) and associated components. This development put India amongst the select few countries capable with this technological expertise. HEC has further executed a subsequent project and is poised to take-up further projects.

AT THE KERNEL FOR 'MAKE IN INDIA'

HEC's uniqueness is in its ability to manufacture heavy components, specialized engineering products and its ability to complete all the manufacturing operations like casting, forging, fabrication, machining, assembly and testing at one location supported by design, engineering and project management functions making it an integrated manufacturing complex. These facilitate HEC to undertake manufacturing from the component stage to finished assembled product in one location which is not common with other heavy engineering companies in India.

HEC has acquired unprecedented knowhow and skill over the years for manufacturing products of strategic importance and has the potential to further contribute to this sector. HEC established the manufacturing of some critical strategic products for the first time in the country, having substantial value for the nation in terms of technical capability.

The company houses some of the key manufacturing facilities which are not commonly available across the industry, and availability of all of them at one location is unique to HEC only. Further, HEC has prepared a modernization plan for refurbishment of some of the old machinery and installation of new machinery for the targeted business segment. The modernization shall further result in lower cycle time, lower power/fuel cost and high output-input ratios.

HEC also functions towards development of skills of high order. It runs a training institute since more than four decades. Recently, HEC has entered into an agreement with CNIITMASH, Russia for creation of Common Engineering facility Centre which will provide specialized technical training. HEC has also taken an initiative to start industry-institute interface and signed MoU for design enhancement of existing product as well as new product development with IIT Kharagpur, IIT-ISM Dhanbad. Similar MoU has also been signed with NIFFT, Ranchi to bring improvement in the existing manufacturing process.

With immense technical capabilities, HEC has the potential to play a significant role for indigenous development, contribute effectively and efficiently to actualize the 'Make in India', strive for technological excellence and maintain its pace with developed nations.

Safety Management of Mining Machinery

Santosh Kumar Chouhan*

INTRODUCTION

Open-pit mining is carried out through conveying soil and rock peeled off from the upside of deposit to dump and then mining from the open pit. As a high risk industry open-pit mining safety is affected by many factors such as dump and slope stability, blasting operation safety, road conveyance safety and so on. During the last several years fatal accidents happened ever and again, which not only caused huge economic loss but also caused bad effect on society. Taking practical safety situation into consideration, improving mining safety through implementing intrinsic safety method for open-pit mining is coincident with the guideline on safety in production, which is "safety first, prevention first and comprehensive treatment" , and the request of society, enterprises and workers.

The most common mode of transport of coal/ ore and materials in opencast mines whether is big or small is trucks or tippers and its use is on increase. So are unfortunately the accidents are also on rise due to various reasons.

The analysis of accidents revealed that majority of them occurred due to:

- Head on collision and head to tail collision
- Failure of brakes.
- Over speeding or rash driving by operators
- While reversing
- Fire
- While truck is operated when body is raised
- Short circuit

A model code of practice was circulated vide circular no 11 of 1973 and was needed to be enforced by management after getting concurrence from concerned Director of Mines safety.

Further numbers of technical circulars were also issued on the subject.

In order to reduce accidents, the standard conditions are modified with respect to safety features to be available in trucks/ tippers. The standard conditions modified are in addition to circulars issued earlier. These are applicable to all types / model/ capacity of truck/ tippers either used by managementor out sourced through contractors.

The details of the safety features that are to be incorporated in Tippers/Trucks is as mentioned below : -

REVERSE CAMERA

This system provides very clear vision to the driver while reversing. In this system cameras are mounted on the back side of the vehicle and a monitor is planted in the cabin of the driver. This system helps the driver to reverse the vehicle without looking back continuously. This system helps in preventing accidents and loss of lives which generally takes place while reversing big vehicles as it is very difficult for the driver to judge.

The camera monitor are shock proof 100 G and vibration proof 10 G and are IP68 or IP69 and cameras have enough LED's to see in partial darkness.

PROXIMITY SENSOR

The Proximity Sensor are object detection equipment's with an in-cab warning device. It helps the driver in identifying large blind spots and any object moving or stationary (people and things). The detection range is up to 10 MTS. The Proximity Sensor is designed for various applications and in areas with various temperatures (-/+) humidity, dust, mud, fog, ice. The product is shock proof, vibration proof and works in long hours. It notifies and activates the driver to react. The proximity sensor is a standalone system and is very effective. It has intuitive in-cab display and it works on multiple types of machines and easily integrated with other technologies- like camera monitor, safety alarms, GPS/RFID. However this system fails frequently due to which we are thinking of installing a front vision camera which will give display in the same rear vision camera as well as it will give alert to the operator through an alarm . In this regard we are in touch with OEM and hope to get a solution at earliest.

**Mine Operations | Adani Enterprises Limited*

SEAT BELT REMINDER

Seat belt reminder with buzzer allow healthy and safety officers / inspectors to see if a seatbelt is being worn and incase it is not worn there would be an audible Buzzer sounding loud enough to alert the operator. This innovative system is ideal for both off-highway construction equipment where there is no cab on the vehicle and the driver/operator can fall off and for on-highway vehicles. It is a vehicle safety device designed to secure the occupant of a vehicle against harmful movement that may result during a collision or a sudden stop.

AUTO DIPPER SYSTEM

The prime function of our Auto dipping System is that it automatically shifts the headlight beam of Road Vehicles from high to low according to restored. Our customised device can be installed in all the vehicles as in Two-wheelers, Three-wheelers, Cars/Jeeps, Trucks, Dumpers, Tippers, Buses, etc. he road and traffic conditions. Also, as per the road and traffic requirements, the high beam is then automatically.

BATTERY CUT – OFF SWITCH

Disconnecting the battery when leaving your vehicle for an extended period helps keep from draining. When it's time to power up, simply engage the switch, reconnecting the battery, and away you go. The opposite holds true for the larcenous it types. By disconnecting the battery, you provide one more major obstacle for them to overcome before they take to their way.

FATIGUE MONITORING SYSTEM

The driver fatigue monitoring system is the most advanced, smart and intelligent System which captures the infrared images of people's eyes and alerts the driver in time without blocking the vision. The installation of this system is very easy as it can be installed at the dashboard. It pays close attention to the eyes of those operating heavy duty vehicles to check for signs of tiredness that could lead to accidents down the line. It works around the clock, both in the dark or the sun.

It works with sunglasses or prescription glasses. In addition to fatigue driving, if the driver does not focus on driving the system will respond.

AUDIO VISUAL ALARMS

It has observed that maximum number of fatal accidents have occurred in open cast mines while reversing of Heavy Earth Moving Machinery (HEMM) especially in dumpers/ tippers. Sizes of the dumpers are so big that it is impossible for the dumper operator to see the back side of the vehicle. Therefore, in order to avoid accident, during reversing, Audio and Visual Alarm is required. To reduce such accidents DGMS made it compulsory to install Audio Visual Alarm (AVA) in every HEMM. & Surface Transportation Machineries used in Mines.

TECHNICAL SPECIFICATIONS	
AUDIO	Two synchronised speakers, having sound of 110 dB output (measured at a distance of 1.2-meter distance). To make the fail-safe two speakers are arranged in such a way that if any fault occurs in one speaker other will work without any interface. (DGMS requirement Two speaker with 110 dB output)
VISUAL	Bright focus type Red LED (25 nos. of 5 mm size) blinks continuously while reversing emitting uniform light of 650 Lux. Brightness recorded form distance of 300 mm. (DGMS requirement not less than 300 Lux)
PROTECTION	Tested as per IP 67 & as per DGMS Circular No. 01 of 2010. The electronic circuits and speakers are totally sealed by epoxy resin, so that nothing can enter in it. Audio Visual Alarm is 100% Water Proof. It even works after totally immersed in water. It does not have free space to accumulate ingress dust/water into its enclose. (DGMS requirement not less than IP 65)

AUTOMATIC FIRE DETECTION AND SUPPRESSION SYSTEM

AFDSS is designed in such a manner, so that its coverage area can be increased as per need. Smallest system contains one cylinder of 10 Kg of Dry Chemical Powder and 1 Kg of CO2 as an expellant cartage, along with six numbers of nozzles. The same system can be enlarged by either providing more number of cylinders of same capacity or by using high capacity cylinders of 25 Kg, 50 Kg, 75 Kg or more. Similarly numbers of nozzles can be increased to 8, 12, 16 or more to cover larger area. This system can work both automatically as well as manually. System is designed to utilize fire extinguisher agent Dry Chemical Powder and Carbon dioxide

HOW THE SYSTEM WORKS
Automatic Operation, OptionA

Before installation of the system the fire prone areas are evaluated& marked. Then the LHS cable and nozzles are installed with the help of suitable hoses in such a way that all nozzles are directed to the fire prone areas. Nozzles spray the fire extinguisher agent on fire to suppress the same. At the time of fire, the temperature rises to 180ºC. The LHS cable detects the fire and gives signal to the control panel. The control panel starts alarm to alert driver, and the personnel in the surrounding area. It also gives visual signal on control panel. After few second it energies (opens) the electromechanical actuator located in between expellant cartridge & main cylinder. From expellant gas cartridge pressurized gas, Carbon dioxide / Nitrogen, to enter into main cylinder which is filled with fire extinguisher agent. Expellant gas fluidizes fire extinguishing agent and it flows through distribution system to fixed nozzles and on fire area and fire gets suppressed.

Manually, OptionB

In the event of fire, Vehicle Driver can also activate system manually. (1) By operating directly electromechanical actuator through separate switch provided in control panel

or (2) By knob / high pressure ball valve installed in between expellant cartridge and main cylinder. After this it will work same as the Automatic Operation, Option A

CABIN GUARD EXTENSION

Canopy should fully cover the operator's cabin so that while loading if by chance any material fell from the tipper should not hit the front portion of the glass and thereby ensuring the safety of the driver .

ANTI-COLLISION DEVICE

In case of collision whether head to head or head to tail the maximum damage is caused to the operator's cabin . To ensure that in such a case the damage is not caused to the cabin tail end protection is used.

NON DESTRUCTIVE TEST (NDT)

Nondestructive testing (NDT) is a wide group of analysis techniques used in industry to evaluate the properties of a material, component or system without causing damage. It also indicates whether the machine is stable and can be put to operation .Because NDT does not permanently alter the article being inspected; it is a highly valuable technique that can save both money and time in product evaluation, troubleshooting, and research. The six most frequently used NDT methods are eddy-current, magnetic-particle, liquid penetrant, radiographic, ultrasonic, and visual testing.

Any machinery operating in mines which is more than 2 years old should undergo NDT for smooth and hassle free operation.

The competent person should be NDT Expert (Steel / Concrete) , ASNT- Level II.

In case of tippers NDT is done for welding joints of various shafts (Rear hinge shaft of dump truck , Lifting cylinder top pin eye & base pin eye , bed & bolts on LHS & RHS of lifting cylinder.

In case of excavators welding joints of various parts (Boom, bucket,stick,undercarriage, revolving frame).

EXHAUST / RETARD BRAKE

An exhaust brake is a device that essentially creates a major restriction in the exhaust system, and creates substantial exhaust back pressure to retard engine speed and offer some supplemental braking ,to slow a heavily loaded vehicle on a downgrade without ever applying the vehicle's service brakes.

PROPELLER SHAFT GUARD

There are several cases in which due to a mechanical failure (such as shearing of bolts etc. the rear end of propeller shaft), the shaft would become free to dangle and consequently spin violently over a wide area and thus smash the brake system components (servo chambers, master cylinders as well as pneumatic and hydraulic lines,) which are in the vicinity and this damage would in turn result almost immediately in brake failure.

To prevent possibility of failure in the above situation, a sturdy safety guard for the propeller shaft is provided in tippers. These are simple in design and can be adopted to any type of dumpers easily.

LIMITING SPEED DEVICE

To ensure speed limits as per DGMS norms the device may be electronic or mechanical type speed governors is installed in each and every tippers so as to ensure the maximum speed of the tipper is as per DGMS norms.

PROVISION OF TWO BRAKES

Tippers are being increasingly used for transport of coal/ mineral waste material in opencast mines. These tippers are provided with service brakes which operate by air over hydraulic pressure and parking brakes released by air pressure.

Hence the provision of two brakes is made in case if parking brakes are found defunct service brakes can be applied or vise-versa.

BLIND SPOT MIRROR

For better visibility of the front portion blind spot by the operator the tippers these days are mostly incorporated with blind spot mirrors to ensure proper visibility of the blind spot area .

RETRO REFLECTIVE REFLECTORS ON ALL SIDES

For better visibility of the tippers during night the radium / retro reflectors are installed on all the sides of the vehicles.

FIRE RESISTANT HOSES AT HOT ZONE

To decrease the chances of fire in mining machines the hoses used in the tippers are fire resistant.

ELECTRIC WIRES AND SLEEVES ARE TO BE OF FIRE-RESISTANT QUALITY

To decrease the chances of fire in mining machines the wires / sleeves used in the tippers are fire resistant.

Oil Analysis: Tool to Monitor/Improve Health of Mining Equipment

Prabhakar Sinha*

WHY DO OIL ANALYSIS

The goals of an effective oil-analysis program How to Set up an Oil Analysis Program for mining locations How to take samples How to analyze the sample information Case study on benefits of Oil analysis & how to set up drain intervals based on oil analysis information.

WHY DO OIL ANALYSIS : MONITOR & EVALUATE

Oil analysis—a condition-monitoring tool that reflects both predictive and proactive maintenance capabilities—is a crucial component of a world-class lube program.

- Lubricant Condition
- Equipment Condition

WHY DO OIL ANALYSIS : GOALS OF USED OIL ANALYSIS

The goals of an effective oil-analysis program are to… Why do Oil Analysis : Goals of Used Oil Analysis Improve asset reliability. Identify and eliminate repetitive problems. Reduce unscheduled maintenance. Obtain maximum use of lubricants in service. Reduce maintenance and lubrication costs. Achieve fault-free component-life extension and Achieve condition-based maintenance Utilize proactive maintenance flanked by predictive maintenance techniques.

Set up an Oil Analysis Program : Different HEMM Equipment's

Set up an Oil Analysis Program : What it can tell you

	Root Cause Detection	Incipient Fault Detection	Problem Diagnosis	Failure Prognosis	Post Mortem
What Oil Analysis is Telling You	When something is occurring that can lead to failure – root cause conditions	When an early stage fault exists that is otherwise going unnoticed – for example, abnormal wear	What is the nature of observed problem? • Where is it coming from? • What is the failure mode? • Root cause?	• How severe or threatening is the condition? • How much time is left? • Corrective actions needed?	What caused the machine to fail? Could it have been avoided?
What You Monitor	Particles, moisture viscosity, temperature additives, oxidation, AN/BN, soot, glycol, FTIR	Wear debris density, temperature, particle count, moisture, elemental analysis, viscosity, analytical ferrography	Wear debris, elemental analysis, moisture, particle count, temperature, viscosity, analytical ferrography, vibration analysis	Elemental analysis, analytical ferrography, vibration analysis, temperature	Analytical ferrography, ferrous density, elemental analysis
Maintenance Mode	Proactive	Predictive	Predictive	Run-to-Failure	Run-to-Failure
Relative Savings*	10	6	3	2	1

*10 = High, 1 = Low

*Technical Services, Jamshedpur Indian Oil Corporation Ltd

SET UP AN OIL ANALYSIS PROGRAM : FOR MINING LOCATIONS

• Determine your objectives
• Monitor equipment conditions
– Reduce in-service failures and field repairs
– Eliminate unnecessary maintenance
• Coordinate service intervals with other components
• Modify oil change intervals
• Evaluate lubricants/equipment
– Improve cost control
– New Products

SET UP AN OIL ANALYSIS PROGRAM : FOR MINING LOCATIONS

• Select vehicle components
• Engine
• Drivetrain
– Transmissions
– Axles
• Cooling systems
• Auxiliary equipment
– Power Steering
– Hydraulic system, etc

• Select Proper Tests
• Spectrochrmical analysis
– Elements
– Wear metals (Fe, Cr, Al, Cu, Pb)
– Additive elements (Zn, Ca, Mo, B, Mg, P)
• Physical analysis
– Physical characteristics of the lubricant
– Environmental contaminants (dirt, water, etc)
– Fuel dillution
– Soot
– Glycol
– TBN/TAN
– Viscosity

Key Oil Analysis Parameters : Corresponding analytical techniques

Category	Key Analysis	Analytical Techniques
Machine Wear	Fine wear metals	Rotating Disc Electrode (RDE) Spectroscopy*, Inductive Coupling Plasma (ICP) Spectroscopy
	Large wear metal elements	Rotode Filtration Spectroscopy (RFS)*
	Partice count and distribution	Particle count, LaserNet Fine (LNF)*
	Wear particle shape analysis	LNF*, Ferrography, Wear Debris Analysis (WDA)
Contamination	Sand and Dirt	Particle count, LaserNet Fines (LNF)*
	Fuel Dilution	Fuel Sniffer*, Gas Chromatography (GC)
	Water/Moisture	Infared (IR)*, Karl Fischer Titration (KF)
	Glycol/Coolant	IR*
	Soot	Soot meter, IR*
	Alien Fluid	IR*
Degradation	Oxidation, Nitration, Sulfation	IR*
	Viscosity	Viscosity*
	Acid number (AN), or Base Number (BN)	Titration, IR*

Different Oil Analysis Parameters: by machine applications

Category	Diesel Engines	Gear Systems	Hydraulic Systems
Elemental	Wear contaminants, additives Viscosity - contamination from soot or fuel	Gear boxes generate all sorts of wear, but the levels can sometimes get confusing	Will often validate or clarify particle count: added value for additive and contamination
Particle Count			Quantitative, somewhat holistic
Ferrography		Tracks the large iron-laden particles for Analytical Ferrography trigger	
Fourier Transform Infrared Spectroscopy (FTIR)	Oxidation, nitration combustion by products, glycol contamination	Oxidation, base stock integrity	Oxidation, base stock integrity
Viscosity	Contamination from soot or fuel	Always useful and worthwhile	Always useful and worthwhile
TAN		Contamination or degradation	Contamination or degradation
TBN	Reserve alkalinity, detergency		
Water	Mostly to identify an invalid sample	To validate the sample	Any deductable amount is probably abnormal or critical need particle count validity check
Fuel Dilution	Excessive idling or mechanical issue, such as a nozzle dribbling or leaking injector seal		
Fuel Soot	Combustion cycle indicator, Air fuel ratio		

HEMM

Set up an Oil Analysis Program : For Mining Locations

- Determine sampling frequency
- Sample only at drain
  - Use normal drain intervals (engines)
  - Monitor oil and equipment condition
- Between drain periods
  - Use if modifying drain intervals (engines)
  - Long drain interval
  - Transmissions
  - Axles
  - Hydraulics

How to take samples: Oil sampling equipment's

HOW TO TAKE SAMPLES: SAMPLING PROCEDURE

- Fill out sample label before taking sample
- Take a "hot" sample after at least 15 minutes of operation
- Clean sampling area
- Insert probe or sampling tube
- Use clean container and take lab sample
- Apply label to sample container
- Send to Analysis Lab in a timely manner

Sampling Point: per equipment type

IndianOil

Equipment	Sampling Point
Engine Crankcases	• Through dipstick holder • Sample valve on crankcase sump wall • Return line before filter
Hydraulic Systems	• Sampling Valve on return line before filter • Reservoir- about mid point, away from reservoir walls
Compressors	• Crankcase: about mid point away from crankcase walls • Return line after oil separator
Gearboxes	• Sump: mid point. Avoid sump floor sludge and sidewall deposits
Turbine Systems	• Reservoir- mid point-keep away from sidewalls and baffle plates • Main bearing return line • Secondary points- After bypass filtration system

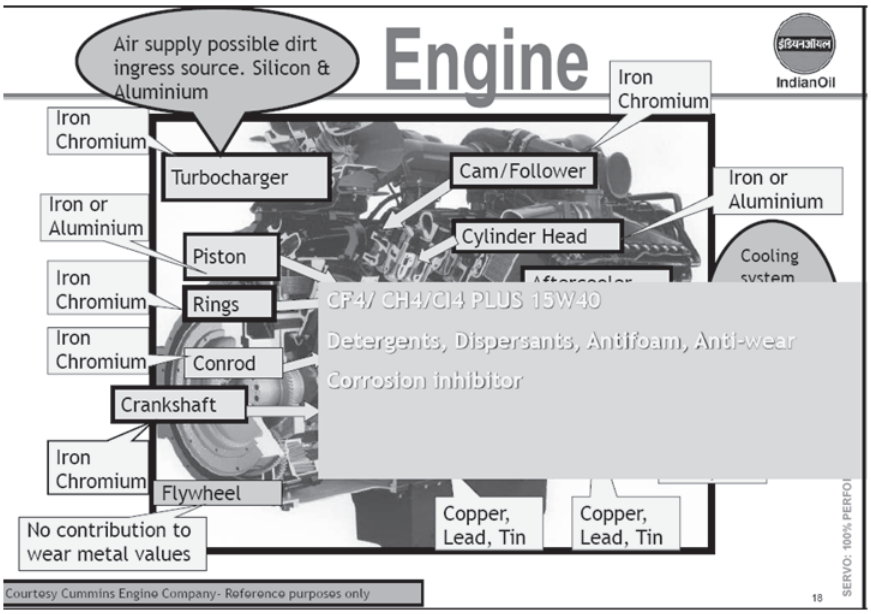
USED OIL: RESULTS

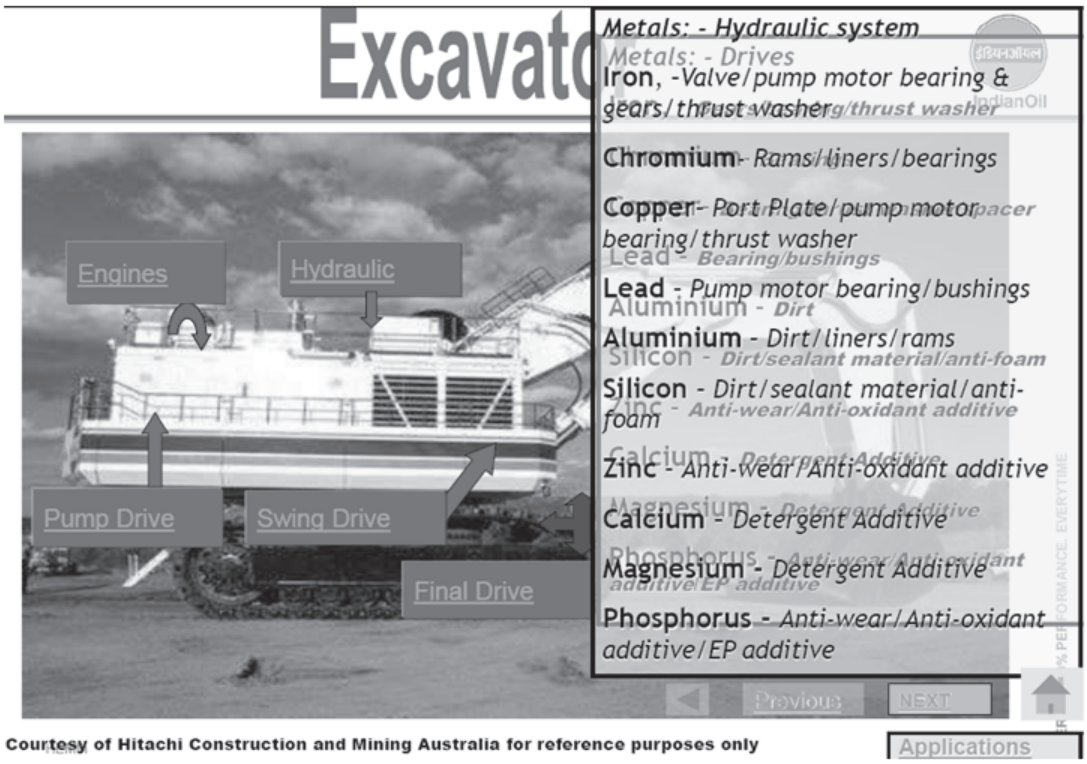
- Wear metals (Fe, Cr, Al, Cu, Pb)
- Additives (Zn, Ca, Mo, B, Mg, P)
- Contamination (Coolant, Fuel, Soot, Dirt, Water)
- Acidity (TAN, TBN)
- Coolant (Na, K)
- Viscosity
- High wear metals
- Component damage

– Match the analysis with the metals in the component (refer slides next to it)

– Bearings, pistons, rings, gears, etc.

- Air filtration problem
- Seal leakage





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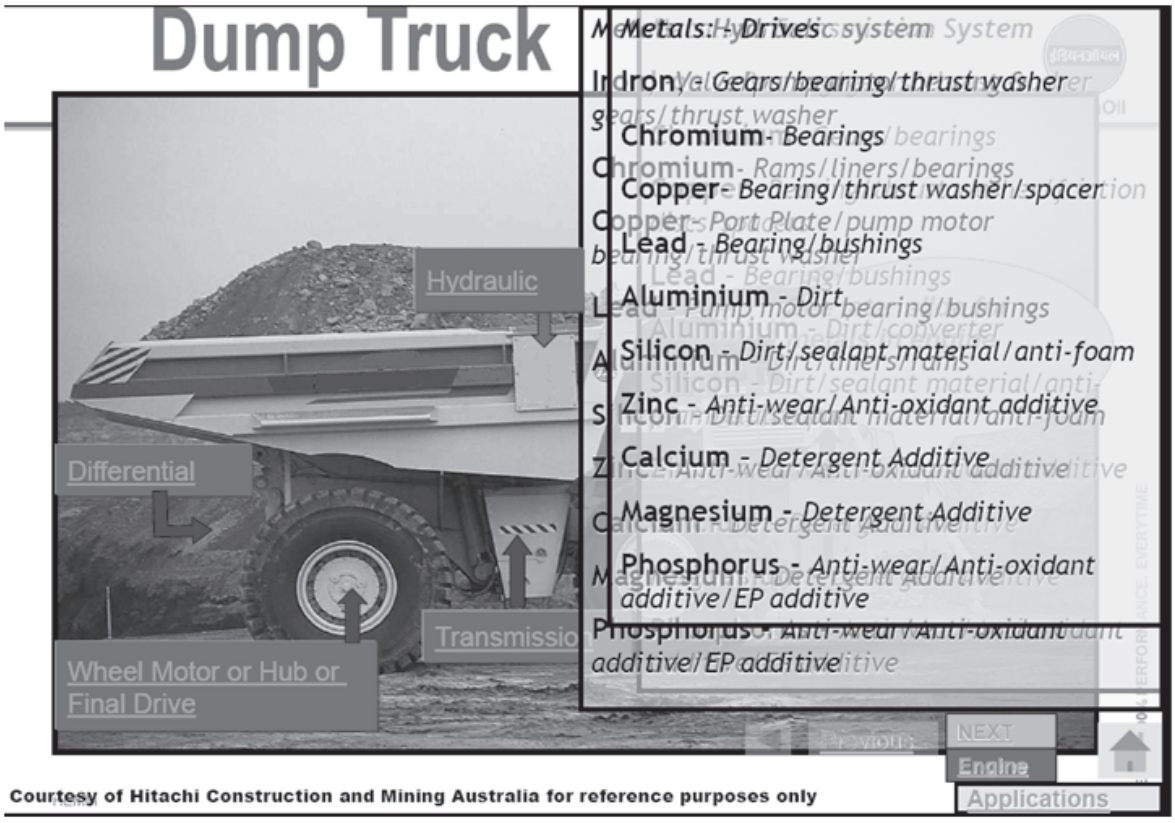

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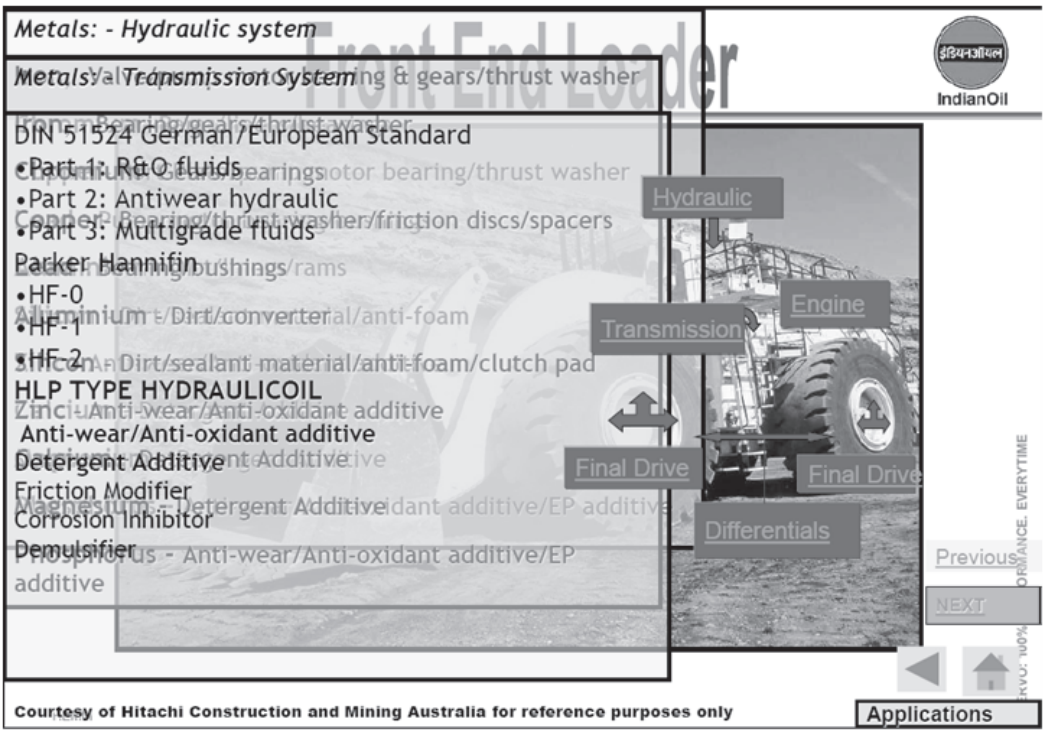

Typical Source of Elements: Analyzed by Spectroscopy in Oil

Metal	Engine, Transmission, Gears	Hydraulic Fluid	Coolants
Aluminum Al	Pistons or Crankcases or Reiprocating Engines, Housings, Bearing Surfaces, Pumps, Thrust Washors	Pumps, Thrust Washers, Radiator Tanks	Coolant Elbows, Piping, Thermostat, Spacer Plates
Barium Ba	Synthetic Oil Additive Synthertic Fluid	Additive	Not Applicable
Calcium Ca	Detergent Dispersant Additive, Water Containment, Airborne Contamination	Detergent Dispersant additive, Water Contaminant, Airborne Contamination	Hard Water
Chromium Cr	Pistons, Cylinder Liners, Exhaust Valves, Coolant Leak from Cr Corrosion Inhibitor	Shaft, Stainless Steel Alloys	Corrosion Inhibitor
Copper Cu	Either brass of bronze allot detected in conjunction with zince for brass allloys and tin for brass alloys. Bearings, Bushing, Thrust Plates, Oil Coolers, Oil Additive	Bushings, Thrust Plates, Oil Coolers	Radiator, Oil Cooler, Heater Core
Iron Fe	Most common or wear metals. Cylinder Liners, Walve guides, Rocker arms, Bearing, Crankshaft, Camshaft, Wrist Pins, Housing	Cylinders, Gears, Rods	Liners, Water Pump, Cylinder Block, Cylinder Head

Typical Source of Elements: Analyzed by Spectroscopy in Oil

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Metal	Engine, Transmission, Gears	Hydraulic Fluid	Coolants
Lead Pb	Bearing Metal, Bushings, Seals, Solder, Gease, Leaded Gasoline	Bushings	Solder, Oil Cooler, Heater Core
Magnesium Mg	Housing on Aircraft and Marine Systems, Oil Additive	Additive, Housing	Cast Alloys
Molybdenum	Piston Rings, Additive, Coolant Contamination	Additive, Coolant Contamination	Anti-cavitation Inhibitor
Nickel Ni	Alloy from Bearing Metal, Valve Trains, Turbine Blades	Not Applicable	Not Applicable
Phosphorous P	Anti-wear Additive	Anti-wear Additive	pH Buffer
Potassium K	Coolant Leak, Airbirne Contaminant	Coolant Leak, Airbirne Contaminant	pH Buffer
Silicon Si	Airborne Dusts, Seals, Coolant Leak, Additive	Airborne Dusts, Seals, Coolant Leak, Additive	Anit-foarming and Anti-corrosion Inhibitor
Silver Ag	Bearing Cages (silver plating), Wrist Pin bushing on EMD Engines, Piping with Silver Solder Joints from Oil Coolers	Silver Solder Joints from Lub Coolers	Not Applicable
Sodium Na	Coolant Leak, Salt Water and Grease in Marine Equipment, Additive	Coolant Leak, Salt Water and Grease in Marine Equipment, Additive	Inhibitor
Tin Sn	Bearing Metal, Piston Rings, Seals, Solder	Bearing Metal	Not Applicable
Titanium Ti	Gas Turbine Bearing Hub Wear, Turbine Blades, Compressor Discs	Not Applicable	Not Applicable
Zinc Zn	Anti-wear Additive	Anti-wear Additive	Wear Metal from Brass Components

HEMM

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USED OIL: RESULTS

- Out of grade lubricant
- Low viscosity (lack of film thickness)

– Indicator of fuel dilution
– Poor shear stability of lubricant

- High viscosity (lack of oil flow)

– Oxidation
– Combustion issue (high soot)

- High Soot
- Poor lubricity due to oil thickening
- Ring sticking
- Combustion issue
- Fuel quality issue
- Engine timing issue
- Drain interval too long
- High TAN (high acidity)
- Corrosion of metallic components
- Accelerated component wear
- Drain interval too long

- Water / Glycol Contamination
- Bearing damage due to loss of lubricity
- Bearing corrosion
- Filter blocking
- Poor centrifuge operation
- Bacteriological growth (bug)
- Ferrous corrosion (rust)
- Hydrolysis of the lubricant
- NOTE: sodium and potassium will be present in sample before testing positive for glycol
- Fuel Contamination
- Bearing damage due to loss of lubricity
- Review used oil sample analysis results
- Compare results to OEM/ Oil suppliers limits
- Compare results to other units
- Similar duty cycle
- Same engine brand/model/power
- Plot most critical data
- Iron, viscosity, soot, TBN/TAN

Benefits of Used Oil Analysis: Case study on Viscosity depletion in Engine Oil at Mine A :

• Customer observed over heating in Engine of HITACHI EX-600-5
• Oil sample was taken and sent to lab for evaluation.
• Viscosity of Servo Premium CF4 @ 100 deg C was way below 9 cst; Flash Point was
reduced considerably, upon further analysis fuel dilution was confirmed by FTIR.
• It was therefore recommended to check all seals & fuel injector for leakages.
• Engine component wear/damage was averted through used oil analysis in this case which
may have led to catastrophic failure of engine costing in millions.
Amount of Dilution Viscosity Effect
5% SAE 30?20
7% SAE 30?10
• Change oil when fuel dilution exceeds 2%
• Reduces lubrication and dilutes additives
• Tests for fuel dilution: Viscosity, FTIR, Flash Point, Gas Chromatography, Steam
Distillation.

BENEFITS OF USED OIL ANALYSIS: CASE STUDY ON CONTAMINATION OF FUEL WITH ENGINE OIL AT CUSTOMER

• M/s Tata Cummins observed that the diesel from the return line i.e. diesel from the firing
zone to the tank had turned blackish. Such anomaly in the diesel was referred to us to
find the root cause of such changes in the colour.

• Root Cause analysis:
• Samples of diesel were taken from the engine sump along with the fresh diesel sample to
do a comparative study of the both samples at R&D. ICP elemental analysis was carried
out to understand the colour change behaviour of the diesel.
• It was gathered from the report that there has been hike in the level of Zn and Ca. CI4 Plus
engine oil does contain additive packages containing Zn and Ca.

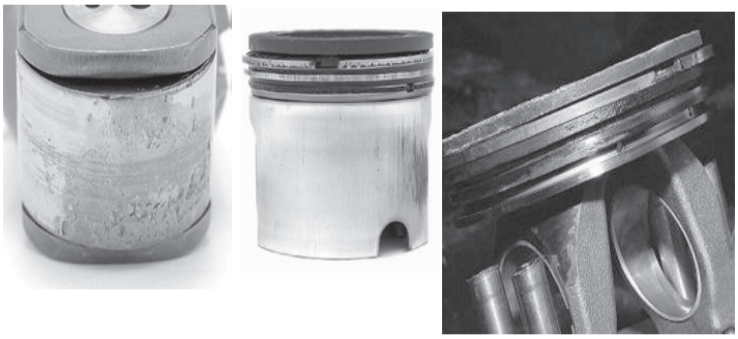
Parameters	Test Method	Diesel Sample	Specification
Metal Content ,ppm	ICP MS		
Zinc		0.3	<0.1
Aluminum		<0.1	<0.1
Iron		<0.1	<0.1
Silica		<0.1	<0.1
Calcium		0.9	<0.1
Phosphorus		0.3	0.3
Chlorine	WDXRF	10	10

CONCLUSION

• It was therefore concluded that the change in colour in the diesel may be because of
contamination with engine oil. It was recommended to check all the seals to avert such
leakages of engine oil in to the diesel.

Benefits of Used Oil Analysis: Avert damage in equipment's components

• Damaged engine components which could have been averted with proper used oil / fuel contamination analysis



• Cost saving:
• Almost close to 50% cost saving (lubricant cost) to the tune of 70 Lacs based on Used Oil analysis

Consumption in Litres		Rate per Litre (example)	Amount in Rs.	Cost Saving in Rs.
Existing ODI (300 Hrs)	150000	₹95	₹1,42,50,000	₹67,50,000
With extended ODI (600 Hrs) based on used oil analysis	75000	₹100	₹75,00,000	

• Improved equipment availability.
• Reduced manpower requirement.
• Diagnose many equipment problems before they lead to catastrophic failure
• Perform maintenance or repairs when convenient with savings in downtime and costs
• Determine maximum time lubricant can be used without risking damage to equipment

• Oil Analysis is only a tool!
• Results may vary due to
– Equipment duty cycle
– Equipment age
– Oil and fuel quality
– Analytical test
– Sample contamination
• When in doubt resample!

Enhancing Safety Features in IDM 45 Drill

A J George* Sanjay Kumar Pankaj* Vishnu Tiwari* Arun Sahu*

ABSTRACT

Drilling is the major activity in any mining industry. It is used for drilling of holes in faces for charging of explosives for blasting, which finally produce RoM. For drilling in faces drill machines are used.
The movement & Operation of drill machine is quite different from the hauling equipment and roughly it works in almost an uneven terrain. And so, safety of man & machine is very important.
Although lot of safety features are inbuilt in drill machine to provide the safety environment during operation & movement of machine. Still some more requirements arose based on the field experience / near miss type incident or from some incidents happened, which have the potential to harm man as well as machine.
Khonbond Iron Mines of OMQ Division of TATA STEEL LIMITED, has taken several initiatives to further enhance safety to man and machine associated with drilling operation and are explained one by one.

INTRODUCTION

At Khondbond Iron &Manganese mines, we are operating two nos of ATLAS COPCO make IDM 45 drill machine. These drill machines were purchased in year 2015.OEM has supplied machine with following inbuilt safety features.

1. Auto Fire Detection & Suppression System
2. Auto Lubricating system
3. Angle and Depth meter
4. Real time vital data monitoring and downloading system
5. Rear vision Camera
6. ROPS & FOPS
7. Air Conditioner with Heater
8. Propel Interlock with Drilling
9. Fire resistant hose, electric wires & sleeves
10. Turbo charger guard & exhaust tube quoted with heat insulation
11. Battery cut off switch
12. Retro reflective on all side
13. Barricading at higher platforms
14. Reverse Audio-visual alarm
15. Ground level engine cut off switch

The safety of man & machine associated with drilling operation are concern for Khondbond Iron &Manganese Mines. Many incidences were reported by the drilling crew of Khondbond Iron mines having low, medium and high severity potential to harm man and machine and accordingly initiatives were taken by implementation of technological solution to mitigate the further re-occurrence of such incidents.

The purpose of this paper is to explain the conditions, incidents, provide & implementation stages of initiatives to enhance the safe condition in drill machine working in mines.

FABRICATION OF PLATEFORM AROUND THE OPERATOR CABIN

Introduction

In newly procured machine it was observed that operator is having access to cabin from one side (i.e from platform side). In some places if the face condition doesn't allow entry from platform side then it is very difficult for operator to get in and get outfrom cabin or in other words operator has to compromise with his safety to get in & out from cabin. The problem is more severe in case of any emergency.

Analysis

In IDM 45 drill operator cabin having two doors. One door is on the drilling platform side, while the another one is on the opposite side of drilling platform. The other side of drilling

Tata Steel Limited

platform door opens in air and the ladder provided is in vertical position and so there is always a chance of tripping hazard.

Solution

Platform with railing along the other side door fabricated in the drill machine. For easy in climbing up and climbing down one ladder was fixed in the platform. Before & After implementation of initiates are depicted in fig1.

Later on, this initiative was appreciated by OEM and it comes OEM fitted in new machine.

Before	After
Operator cabin door opens in air leads to falling hazards	*A platform has been erected to eliminating the potential falling hazards*
Operator cabin door opens in air	**Fabricated Platform with ladder and handrail**

fig1

Advantages

1. Enhanced safety of work environment
2. Elimination of chances for slip / trip / fall of person
3. Enhanced safety to operator/helper at the time of cleaning of cabin glass

PROPEL INTERLOCKING IN IDM 45 DRILL

Introduction

This initiative is linked with one incident in which operator moved the machine, while 10" of hammer was in hole as a result, hammer & drill rod got bend in S shape. Fortunately, nothing has happened to the operator but the incident was of very high severity potential.

Analysis

The existing IDM45 drill is having a 3-position mode selector switch (Drilling, Neutral & Propelling). In normal condition operator keeps this mode selector switch in neutral position. He uses drilling & propelling position as per requirement. Since in drilling & propelling position separate piloting line gets activated and so there is no chance that operator can

propel machine while drilling or drill while propelling. But once operator stop machine intermittently and shift the mode selector switch to another mode then other operation of machine can be performed. This scene was created in this incident. Operator was doing the drilling operation. He thought that hammer is above the ground (No automation in machine is available to judge the rod position) and so un-jacked the machine and propel. In this way hammer & and drill rod got damaged.

Solution

To avoid such situation, Automation for estimation of rod position as well as jack position has been introduced in the machine. By implementation of this automation, propel system gets feedback from rod position sensor and all the jack position sensors. If the position of rod and jack are at pre-defined place then only propel system gets activated. Fig2 shows the installation of limit switch in jacks and Fig3 shows the installation of limit switch in top end position of tower. Normally these limit switches are in NO position and it get becomes in NC position if all jacks are fully retracted a position of tower.

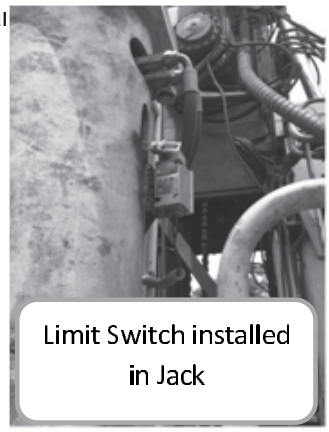


Fig2

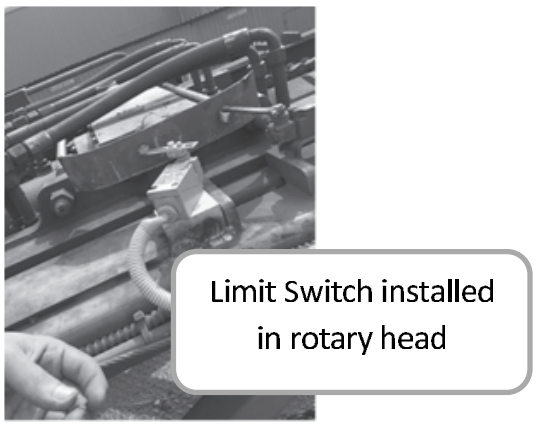
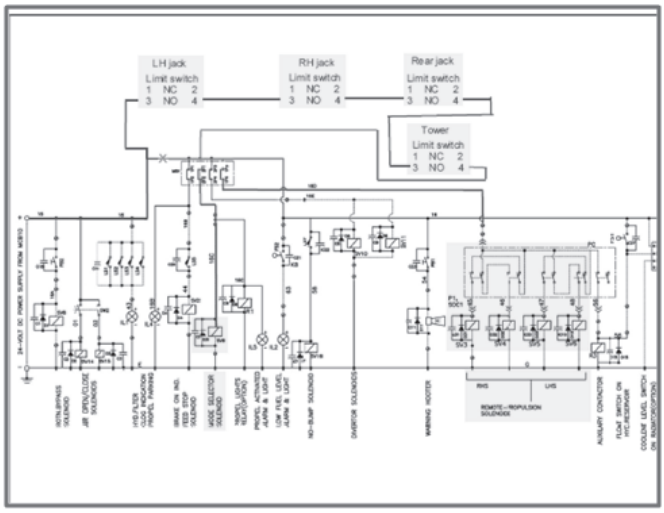


Fig3

Working Principals

Fig2 shows the installation of limit switch in jacks and Fig3 shows the installation of limit switch in top end position of tower. Normally these limit switches are in NO position and it get becomes in NC position if all jacks are fully retracted and rotary head is in top end position of tower. When the mode selector switch is kept on propelling mode the pilot line will get activated only if all the three limit switches installed in jack cylinder and one limit switch installed in tower are in NC condition. This can be understood by the electrical circuit also.

Modification of Electrical Circuit



Advantages

1. Elimination of man-machine interface
2. Full proof System to eliminate any incident
3. Enhanced safety of work environment

AUDIO VISUAL ALARM FOR GATE OPEN REMINDER

Introduction

IDM 45 drills is having two doors in cabin, one opening in the drilling platform side and another is on the opposite side of the platform. This initiative is related with the incident in which, operator was positioning the tower to horizontal position from vertical position. In this way tower touched the platform side gate and the gate got damaged (Fig4a, 4b & 4c)

Fig4a

Fig 4b

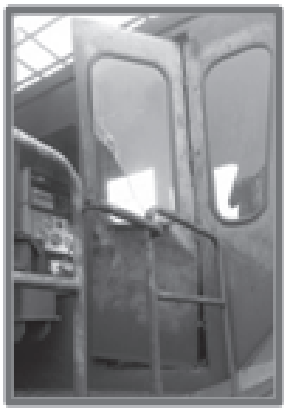


Fig4c

Analysis

The reason of the incident interfacing of safety on human. Once there is a human mistake incident happened. The severity of the incident was quite high as it may injured to operator also.

To eliminate this type of situation the platform side gate was fitted with audio visual alarm, which alerts the operator in case the gate is open.

Solution

An Audio-visual alarm was fitted in machine to caution the operator in case the platform side gate is in open condition (Fig 5)

Fig 5

Advantages

1. Reminder to operator any case of mistake
2. Minimise the chances of incident
3. Enhanced safety of work environment

INSTALLATION OF AUTO GREASE REFILLING IN CENTRALIZED LUBRICATION SYSTEM INSTALLED IN IDM 45 DRILL

Introduction

IDM 45 Drills at Khondbond Iron & Manganese mines are having factory fitted automatic lubrication system (centralized lubrication system) of single line progressive type for greasing all the critical points. The reservoir of 180kg grease holding capacity is used for storing grease. This reservoir is fitted with pump, which supplies grease to different sections. As per OEM standard, every time this reservoir needs to be replaced by new barrel.

Analysis

As there is no system provided in machine for refilling of grease in barrel and so every time barrel needs to be replaced with the new barrel. For every replacement, 3 to 4 persons with crane, crane operator &Rigger are needed. The person has to stand on the platform for loosening the mounting clamps, pump connections & tiding sling and work under the elevated load condition. (Fig 6).

Fig 6

Similar process is adopted for mounting of new reservoir. This complete cycle of reservoir replacement takes 3 hours and person working there are exposed in unsafe conditions (working under elevated load etc) due to the requirement of man machine interface for replacing the grease reservoir. This unsafe condition leads to potential hazard like Slip, trip & fall of person, injury due to other six directional hazards.

Fig 7

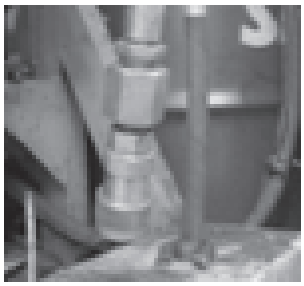


Fig 8

Fig 9

At the time of refilling of grease in reservoir, mobile service van having system of pneumatically operated grease dispensing system is required. At the discharge end of grease dispensing hose female part of quick coupler is fixed in place of grease gun & finally this quick coupler is connected with male quick coupler mounted in reservoir. (Fig 10)

Fig.10

Solution

To avoid this unsafe condition, it was the requirement to reduce or eliminate the man machine interface. For this modification done in existing centralized lube system to make it auto grease refilling system. For this modification ¾" adaptor (01 no.), ¾'' Quick Coupler (01 no.) has been arranged. ¾" adaptor fitted in empty grease barrel in which male part of quick coupler fitted (fig7 & fig8). This empty barrel is mounted in IDM 45 with existing pump(Fig 9)

Advantages of Automatic grease refilling System

1. Elimination of man-machine interface
2. Reduction in engagement of manpower
3. Reduction in downtime of machine
4. Less exposure of person to work environment
5. Safe way for refiling of grease
6. Enhanced safety of work environment

REFERENCES

1. Manual of IDM 45 drill machine supplied by M/s Atlas Copco
2. Discussion with service engineers of M/s Atlas Copco
3. References from SEMS, QUICKS & MOC site of TATA STEEL LIMITED

Designing of Commercial Explosives Formulations: GPeng Model

Gayatri Patel* Dr Manoj K Patel**

INTRODUCTION

"Chemicals" and "mixture of chemicals" that are high energetic materials need special attention. This category subsumes – pyrotechnics and explosives (initiating devices included). These categories of materials have their unique thermodynamic properties.

Thermodynamic properties of high energetic materials can be measured both experimentally as well as through theoretical means. Both the methods have got their own advantages and dis-advantages.

Experimental methods are based on very sophisticated equipments and now a days these are available on PLC Control basis. Results can be obtained within a time frame of 30 minutes per sample. But these experimental methods need high end laboratory, expensive equipments and skilled instrumentation engineer to conduct the experiments. Moreover, the experimental method needs high energy materials to be handled in a chemical laboratory time and again. Additionally, state statutes and safety-security-issues come in to picture in terms of licenses to handle high energetic materials in the laboratory. Hence attempts have been made in the past for effective, theoretical calculations of the detonation parameters and the chemical equilibrium composition of reaction products.

Alternate way thus is to go for – Theoretical Methods. Survey of literature showed that a number of theoretical methods have been available for carrying out thermodynamic calculations of the detonation parameters of chemicals, high energy mixture of chemicals, and explosives. Some of these are, a BKW Fortran [1], ARPEGE [2], Ruby [3], TIGER [4], CHEETAH [5], EXPLO5 [6], MWEQ [7], BARUT-X [8]. Although in many research centers in the world thermo-chemical codes were worked out, access to them is difficult and, moreover, any changes in the codes aren't possible because they are made available in the compiled form. Therefore, we have worked out and have come up with our own numerical code named **GPeng** from which one can derive as many as 18 different parameters for a "chemical" or "mixture of chemicals".

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EXPERIMENTAL METHOD vis-a-vis "GPeng MODEL":

Parr 6100 Bomb Calorimeter for Experimental Purpose:

It is worth mentioning here that, we carried out a large number of experiments with the use of calorimeter to determine **the õH** of a number of chemicals and emulsion formulations. The calorimeter used for the purpose was Parr 6100 fully automatic calorimeter which is best suited for "moderate enthalpy plus high pressure generating" chemicals or mixture of chemicals such as AN, ANFO, Emulsion explosives, slurry explosives etc.

The 6100 Calorimeter a modern calorimeter with the convenient automatic features with precision requirements met with a static system without isoperibol control. This can be set up and made ready to operate in a few minutes, or it can be set aside when not in use. All sensors and controls in the 6100 Calorimeter are built into a single, compact cabinet to provide a self-contained operating unit consisting of:

- An 1108P oxygen bomb with an oval bucket which fits into the jacket.
- A built-in automatic system for charging the bomb with oxygen.
- A high precision electronic thermometer.
- A bright, color, touch screen display for data entry and operation control.
- USB port for printer and balance communication

- Ethernet port for computer and network (LAN) connections.
- Removable SD memory card slots for simple program updates and test report archiving.

THE GPeng Model for Theoretical Calaculation:

This is a Theoretical Model. Our **GPeng** is a new model for calculation of thermodynamic properties of chemicals, mixture of chemicals, high energetic materials and pyrotechnics. **GPeng** is based on such facts as: (a) physical and chemical properties of an energetic material, (b) its atomic composition, (c) enthalpy of formation, (d) entropy of chemicals, (e) molecular reaction dynamics, (f) the mathematical model of an ideal detonation, (g) the principle of extreme of characteristic functions delineated by Gibbs, and (h) thermodynamic equations of state for the real gasses (reaction products. In its present form **GPeng** is able to determine 18 different thermodynamic parameters and these are:

No	Output Parameter from "GPeng"	UoM
01	OF (Oxygen Balance Factor)	No.
02	SF (Strength Factor)	No.
03	del H (Enthalpy)	Kcal/kg
04	So (Entropy)	Cal
05	Gibbs Free Energy	Kcal/kg
06	Volume Expansion Considering Water is Gas	Percent
07	Volume Expansion Considering Water is Liquid	Percent
08	Mole of Oxygen Generated from Decomposition of OB	Mole/kg of Product
09	Mole of Oxygen Required for Complete Combustion of FB	Mole/kg of Product
10	Mole of Gases Generated from OB	Mole/kg of Product
11	Mole of Gases Generated from FB	Mole/kg of Product
12	Mole of Gases Generated from Composition	Mole/kg of Product
13	Absolute Bulk Strength or ABS	Kcal/cubic meter
14	Absolute Weight Strength (i.e. del H)	Kcal/kg
15	Relative Bulk Strength wrt ANFO or RBS_ANFO	Percent
16	Relative Weight Strength wrt ANFO or RWS_ANFO	Percent
17	Relative Bulk Strength wrt NG or RBS_NG	Percent
18	Relative Weight Strength wrt NG or RWS_NG	Percent

To verify the **GPeng** Model, its results are compared with that obtained from the experimental methods by using a Parr 6100 Calorimeter.

We are further going to develop this model– (1) to calculate the parameters of combustion, explosion and detonation of condensed energetic materials, (2) to determine the curve of expansion of detonation products, (3) to arrive at a correlation between the parameters obtained through **GPeng** with Rock Characteristics (**GPengRock)**.

Parr 6100 output vs "GPeng Model" Comparison:

Sl. No.	Subject of Comparison	Experimental Method	Theoretical Method	Remarks
01	No of Parameters that can be determined	07 (Primary = 01 and Deduced = 06)	18 (Primary = 12 and Deduced = 06)	Please judge yourself
02	Result precision	**Excellent**	with 95% Confidence level	Parr 6100 is better
03	Safety Hazards	Hazard Exists	No Hazard	GPeng is better
04	Statutory Issues	Hazard Exists	No Statutory Issues	GPeng is better
05	Statutory Permission Required from Explosives Department	Yes Permission Required	No Not Required	GPeng is better
06	Cost	**High**	Less (25% of Experimental Method)	GPeng is better

Parr 6100 output vs "GPeng Model" output:

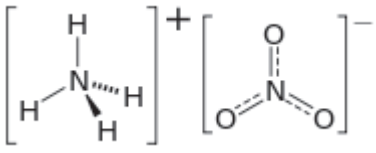
The taste of pudding is in eating it. We are therefore declaring the results obtained through the said two different models with respect the **the õH** values:

Formulation - 01		
Sl No.	σH **Calorimetry**	σH **Gpeng**
01	630	602
02	641	602
Formulation - 02		
Sl No.	σH **Calorimetry**	σH **Gpeng**
03	633	611
04	618	611
Formulation - 03		
Sl No.	σH **Calorimetry**	σH **Gpeng**
05	620	594
06	627	594
07	632	594
08	622	594
09	614	594
10	623	594
11	601	594
12	632	594
13	630	594
14	628	594
15	631	594
Formulation - 04		
Sl No.	σH **Calorimetry**	σH **Gpeng**
16	745	706
17	698	706
18	689	706

APPLICATION OF GPeng in Some of the CHEMICALS

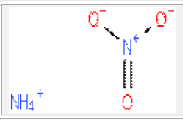
Ammonium Nitrate (AN)

Ammonium Nitrate is having chemical formula NH4NO3 and its structure is:



On explosion, it undergoes the reaction of:

(NH4)NO3 (c) □N2 (g) + 1/2 O2 (g) + 2 H2O (g)

Species Name	Preferred Formula	Image	$\Delta_f H°(0K)$	$\Delta_f H°(298.15K)$	Units	Relative Molecular Mass
Ammonium nitrate	(NH4)NO3		-350.28	-365.25	kcal/kg	80.04344 ± 0.00095

This reaction path has been considered in the **GPeng** and the values obtained are

Results for AN		
Output Parameter	**UoM**	**RESULT**
SF	No.	0
del H (i.e. Enthalpy)	Kcal/kg	-353
So (i.e. Entropy)	Cal	1555
Gibbs Free Energy	Kcal/kg	-399
Volume Expansion Considering Water is Gas	Percent	350
Volume Expansion Considering Water is Liquid	Percent	150
Mole of Oxygen Generated from Decomposition of OB	Mole/kg of Product	15.63
Mole of Oxygen Required for Complete Combustion of FB	Mole/kg of Product	0
Mole of Gases Generated from OB	Mole/kg of Product	162.45
Mole of Gases Generated from FB	Mole/kg of Product	0
Mole of Gases Generated from Composition	Mole/kg of Product	162.45
Absolute Bulk Strength or ABS	Kcal/cubic meter	-395
Absolute Weight Strength (i.e. del H)	Kcal/kg	-353
Relative Bulk Strength wrt ANFO or RBS_ANFO	Percent	51
Relative Weight Strength wrt ANFO or RWS_ANFO	Percent	34
Relative Bulk Strength wrt NG or RBS_NG	Percent	19
Relative Weight Strength wrt NG or RWS_NG	Percent	24

Ammonium Nitrate Fuel Oil (ANFO):

ANFO in its best form is - 94.5% of AN and 5.5% of Diesel Oil. When this mixture undergoes explosion, it releases lot of energy, and its output thermodynamics parameters also have been calculated by using **GPeng**. Findings are as follows:

RESULTS for ANFO		
Output Parameter	**UoM**	**RESULT**
SF	No.	18.81
del H (i.e. Enthalpy)	Kcal/kg	-917
So (i.e. Entropy)	Cal	1517
Gibbs Free Energy	Kcal/kg	-963
Volume Expansion Considering Water is Gas	Percent	374.75
Volume Expansion Considering Water is Liquid	Percent	97.75
Mole of Oxygen Generated from Decomposition of OB	Mole/kg of Product	14.77
Mole of Oxygen Required for Complete Combustion of FB	Mole/kg of Product	39.53
Mole of Gases Generated from OB	Mole/kg of Product	153.52
Mole of Gases Generated from FB	Mole/kg of Product	67.64
Mole of Gases Generated from Composition	Mole/kg of Product	221.15
Absolute Bulk Strength or ABS	Kcal/cubic meter	-1027
Absolute Weight Strength (i.e. del H)	Kcal/kg	-917
Relative Bulk Strength wrt ANFO or RBS_ANFO	Percent	132
Relative Weight Strength wrt ANFO or RWS_ANFO	Percent	89
Relative Bulk Strength wrt NG or RBS_NG	Percent	49
Relative Weight Strength wrt NG or RWS_NG	Percent	62

RESULTS for the above SME Formulation		
Output Parameter	**UoM**	**RESULT**
SF	No.	16.76
del H (i.e. Enthalpy)	Kcal/kg	-840
So (i.e. Entropy)	Cal	1518
Gibbs Free Energy	Kcal/kg	-885
Volume Expansion Considering Water is Gas	Percent	347.36
Volume Expansion Considering Water is Liquid	Percent	70.34
Mole of Oxygen Generated from Decomposition of OB	Mole/kg of Product	15.16
Mole of Oxygen Required for Complete Combustion of FB	Mole/kg of Product	52.78
Mole of Gases Generated from OB	Mole/kg of Product	131.27
Mole of Gases Generated from FB	Mole/kg of Product	91.13
Mole of Gases Generated from Composition	Mole/kg of Product	222.40
Absolute Bulk Strength or ABS	Kcal/cubic meter	-940
Absolute Weight Strength (i.e. del H)	Kcal/kg	-840
Relative Bulk Strength wrt ANFO or RBS_ANFO	Percent	121
Relative Weight Strength wrt ANFO or RWS_ANFO	Percent	82
Relative Bulk Strength wrt NG or RBS_NG	Percent	45
Relative Weight Strength wrt NG or RWS_NG	Percent	56

THE WAY FORWARD before CONCLUDING

We believe that – *a good theory is better than an experiment*. In the present paper we have found out that - *values obtained with the Bomb Calorimeter are very much close to those obtained through* ***GPeng*** **Theoretical Model** *(95% confidence limit)*.

We both authors have very high admiration for the Parr 6100 Bomb Calorimeter. It is an amazing equipment but as mentioned earlier, it has got its own limitations in deriving certain other parameters that we need to find to design suitable commercial explosives. On the other hand, **GPeng** itself gives rise to these values with good accuracies.

So, explosive and blasting engineers may certainly rely on the **GPeng** Model, during designing of explosives formulations. We are further going to take forward this model – (1) to calculate the parameters of combustion, explosion and detonation of energetic materials, (2) to determine the curve of expansion of detonation products, and (3) to arrive at a correlation between the parameters obtained through **GPeng** with Rock Characteristics (**GPengRock)**.

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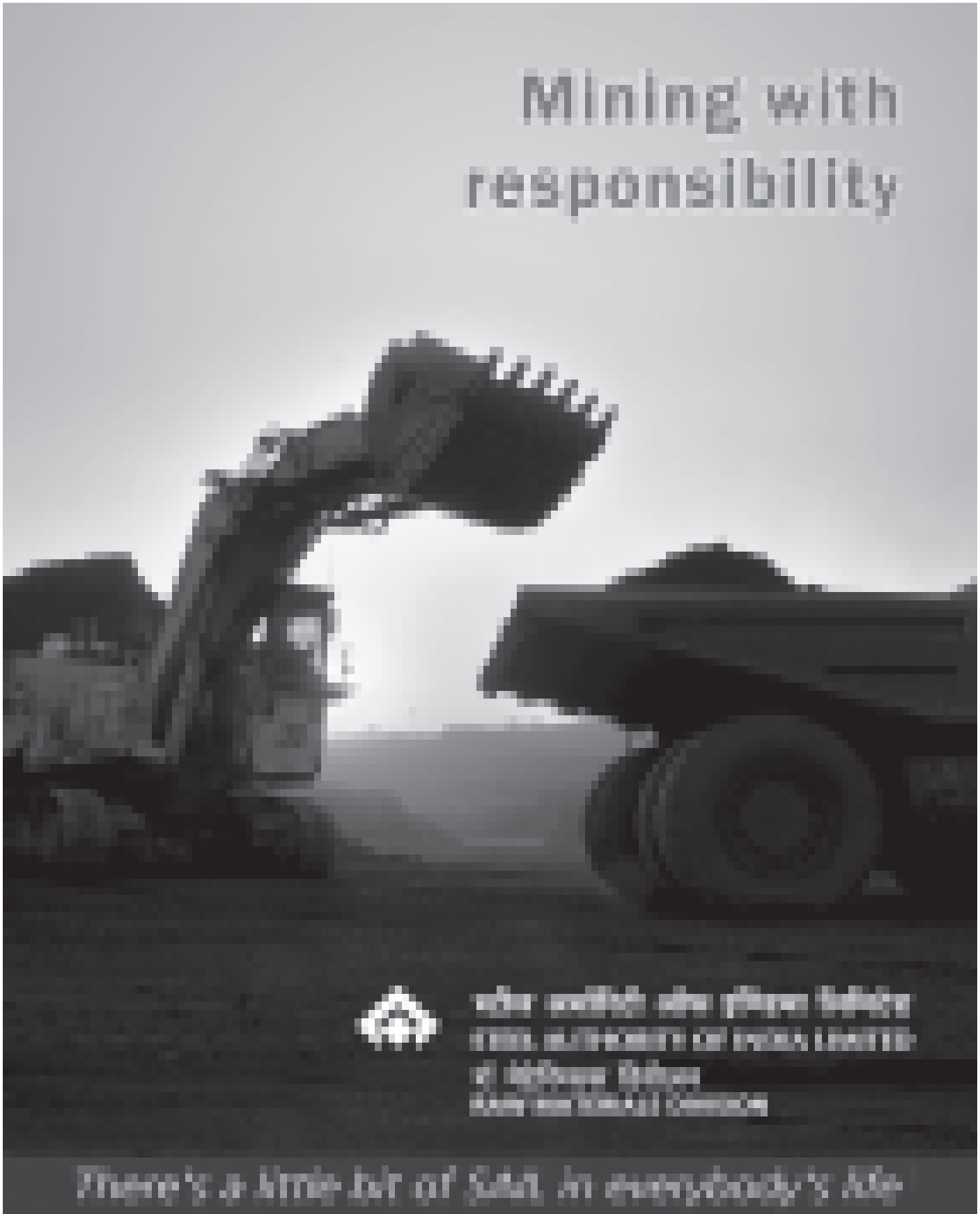
Mining with
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Indian Mining Industry News

MINING NEWS

TATA SPONGE MAY INVEST RS 3,000 CRORE TO SET UP STEEL MANUFACTURING FACILITY

Tata Sponge Iron may invest around Rs 3,000 crore to set up a steel manufacturing facility. “The project is under active consideration,” said the person, speaking on the condition of anonymity. The Tata Steel subsidiary had announced last year that it would set up a 1.5 million tonne steel plant at Joda in ironore rich Odisha. The state also houses its current facility. “Considering the future growth potential of the steel industry, the company has applied to the ministry of environment, forests and climate change for permission to set up a 1.38 million metric tonne steel plant in phases at Joda,” the company had said in its annual note to shareholders for the year.T he company is looking to set up a blast furnace and expects the integrated steel plant to be ready in the next four years. Even though it will be sourcing iron ore from parent Tata Steel, Tata Sponge is on the lookout for acquiring iron ore and coal mines as and when these are auctioned by the government, the note added.

“As a progressive company, Tata Sponge has been evaluating various avenues of growth aligned to the group objectives,” the company said in an emailed response to ET’s questions, declining to offer further comments. Tata Sponge Iron reported a net profit of Rs 141 crore on revenue of Rs 816 crore in fiscal 2017. For the first quarter of the current fiscal year, it reported 49% year-on-year growth in profit at Rs 46 crore. The company is planning to also add 30,000-35,000 MT to its current sponge iron capacity of 3,90,000 tonnes. The management has indicated in the past that it would be executing the steel project in two phases. "The company might be in an overall comfortable position to execute the first phase of 0.6-0.8 MT and might finance it through internal accruals, debt and some external equity funding," said Abhisar Jain, lead analyst for metals and mines at Centrum Broking. Tata Sponge Iron has Rs 700 crore of cash on its books.

NIPPON STEEL SEES INDIA AS MOST PROMISING MARKET

Japan's top steelmaker Nippon Steel & Sumitomo Metal Corp sees India as the most promising market and wants to become "an insider" to capitalise on growth of the world's third-biggest steel market, a senior executive said. "India will be the fastest-growing steel market in the world going forward," Nippon Steel Executive Vice President Katsuhiro Miyamoto told."But since it's not an easy market to export to due to trade and distribution issues, it's important for us to become an insider. That's why we are bidding for Essar Steel," he said. Nippon Steel has teamed up with Luxembourg-based ArcelorMittal, the world's largest steelmaker, to bid around $6 billion for bankrupt Essar Steel, India's 4th-biggest steelmaker. But the bidding process has been delayed due to legal battles over eligibility for the bidders. Asked if he thinks the chances are in their favour in the bidding race, Miyamoto said: "We have always believed so."

"We have submitted all the documents requested to the National Company Law Appellate Tribunal (NCLAT) and we expect their decision by the end of this month," he said. World Steel Association (WSA) forecast steel demand in India will climb 5.5 percent in 2018 and 6 percent in 2019, becoming the fastest-growing market among the world's top ten steel consumption countries. Even so, Japan's steel exports to India nearly halved in 2016 after India imposed duties of up to 20 percent on some hot-rolled flat steel products in September 2015. India also set a floor price in February 2016 for steel product imports to deter countries such as China, Japan and South Korea from undercutting local mills. Since then, Japan's annual steel exports to India have been hovering at around 1.3 million tonnes, just 3 percent of the country's total exports of the metal. Nippon Steel has a joint venture with India's Tata Steel to produce cold-rolled sheets for automobiles, but it has little presence in steel used in other areas in the South Asian nation. "If we can buy Essar, it will give us access to India's general steel users including builders," Miyamoto said. Nippon Steel said in March it will spend 600 billion yen ($5.4 billion) for business investment, including for mergers and acquisitions (M&A), over the next three years. That would be up from 210 billion yen spent over the previous three years to step up global expansion.

R SRIKANTHAN APPOINTED CPCL DIRECTOR (TECHNICAL)

R Srikanthan has assumed charge as Director (Technical) at Chennai Petroleum Corporation Limited (CPCL) with effect from August 13. He was earlier Chief General Manager at CPCL’s Cauvery Basin Refinery. Srikanthan, who joined CPCL in 1984, has more than three decades of experience in project development, operations, production planning and process engineering.

Mining Events Diary

4-5 September 2018, "Mining Investment Central America" Venue: Panama City, Panama. For further detailed contact: Spire Events Pte Ltd. 2018 Mining Investment Central America, Daniel Radziszewski, Speaking, registration & general queries, 24 Peck Seah Street#02-09 Nehsons Building, Singapore, Singapore, Phone: +65 6717 6018, Fax: +65 6717 6015, Email: daniel.radz@spire-events.com, Web: https://www.spire-events.com

6-8 September 2018 "MEI2018" Mining & Exploration International. Venue: Las Vegas, USA. For further detailed contact: Mining Exploration International Madalena Maestri, EdD, Conference Director, Phone: 608.588.5481 Email: madalena@miningexplorationintl.com, Web: https://www.miningexplorationinternational.com

10-11 September 2018 "10th Asia Pacific Congress On Oil and Gas". Venue: China. For further detailed contact: Conferenceseries LLC, Pheobe Wook, One Commerce Center- 1201Orange St. #600, Wilmington, USA, Phone: 7025085200 ext 6094, Email: oilandgas@enggconferences.com

12-13 September 2018 "International Conference on Oil and Gas". Venue: Holiday Inn Singapore. For further detailed contact: Pulsus Conference, Suresh P, Project Manager, Singapore, Singapore, Phone: 4084292646, Email: oilgas@pulsusconference.com, Web: https://oil-gas.pulsusconference.com

19-21 September 2018 "Strategic Mine Planning with New Digital Technologies, Risk Management and Mineral Value Chains" Venue: Montreal, Canada. For further detailed contact: McGill University, Deborah Frankland, 3450 University Street, Montreal, Canada, Phone: 514-398-5461, Email: admcrc.mining@mcgill.ca Web: http://cosmo.mcgill.ca/professional-development/short-course-series

2-3 October 2018 Asian Retread Conference 2018. Venue: Sima Darby Convention Centre, Kuala Lumpur, Malaysia. For detailed contact : Dato' Mohamed Ishak bin Abdul Hamid, e-mail: ishak.arc2016@gmail.com, M: +60 19 350 3036

10-12 October, 2018, IIT (ISM) Dhanbad is organising an International Seminar on **"Mineral Processing Technology MPT-2018"** (details at : www.mpt2018.org) For further dertails contact: Prof. R. Venugopal, Chairman, Organising Committee, Dept. of Fuel and Mineral Engineering, Indian Institute of Technology (Indian School of Mines), Dhanbad, Ph. No. : 0326-2235225, Mob. No. : +91 94311 26330, Email: vrayasm@yahoo.com

11-13 October 2018 "4th Oil & Gas 2018 - Tanzania" Venue: Dar-es-Salaam, Tanzania, Mlimani Conference Centre, Sam Nujoma Rd. For further detailed contact: Expo Group, 1910, 19th Floor, Monarch Office TowerOne Sheikh Zayed Road, Dubai, United Arab Emirates, Phone: +971-4-3721421, Fax: +971-4-3721422, Email: expo@expogr.com, Web: http://www.expogr.com

18-20 October 2018, "China Mining Conference and Exhibition 2018" Venue: Tianjin, China. For further detailed contact: Unismart Events Limited, Beijing, China Phone: +86 10 64465066, Fax: +86 10 64466368, Email: info@chinamining-expo.org, Web: http://en.chinamining-expo.org

22-23 October 2018 "Mining Investment Oman". Venue: Muscat, Oman, Sheraton Muscat. For further detailed contact: Spire Events Pte Ltd. Mining Investment Oman, Daniel Radziszewski, Speaking, registration & general queries, 24 Peck Seah Street#02-09 Nehsons Building, Singapore, Singapore, Phone: +65 6717 6018, Fax: +65 6717 6015, Email: daniel.radz@spire-events.com, Web: https://www.spire-events.com/

25-26 October 2018, "MiningTech Australia". For further detailed contact: Spire Events MiningTech Australia, Mahesh Babu, 24 Peck Seah Street #02-09Nehsons Building, Singapore, Singapore, Phone: +65 6717 6016, Fax: +65 6717 6015, Email: Mahesh.babu@spire-events.com, Web: https://www.spire-events.com/conferences

31st October, 1-3 November 2018, 14th International Mining & Machinery Exhibition, Eco Park, Rararhat, Kolkata, India. For further detailed contact: Confederation of Indian Industry, 98 / 1, Velachery Main Road , Guindy, Chennai-600032, Tamil Nadu India, Phone : +91-44-42444564 / 42444520, Moblie : +91-97898 08994, Fax :+91-44-42444510, Email : imme@cii.in

07-08 November 2018 "Mining Investment China". Venue: Beijing, China, The Westin Beijing Financial Street Hotel. For further detailed contact: Spire Events Pte Ltd. 2018 Mining Investment China, Daniel Radziszewski, Speaking, registration & general queries, 24 Peck Seah Street#02-09 Nehsons Building, Singapore, Phone: +65 6717 6018, Fax: +65 6717 6015, Email: daniel.radz@spire-events.com, Web: https://www.spire-events.com/

08-09 November 2018 "MiningTech Africa". Venue: Johannesburg, South Africa. For further detailed contact: Spire Events MiningTech Africa, Mahesh Babu, 24 Peck Seah Street #02-09Nehsons Building, Singapore,Phone: +65 6717 8500 Fax: +65 6717 6015 Email: mahesh.babu@spire-events.com Web: https://www.spire-events.com/conferences

18-25 May 2019, "ALTA 2019" Nickel-Cobalt-Copper, Uranium-REE-Li and Gold-PM Conference & Exhibition. Venue: Perth, Australia. For further detailed contact: ALTA Metallurgical Services - ALTA, Allison Taylor, Conference & Exhibition Manager, PO Box 1211, Blackburn North, Australia, Phone: +61 411692442, Email: allisontaylor@altamet.com.au, Web: https://www.altamet.com.au/conferences/alta-2019