

# **TERMINAL EVALUATION REPORT**



## **UNDP/GEF-GOI: CBM PROJECT**

(Project No. IND98/G34 & MT/S&T/CE-27)

# **COALBED METHANE RECOVERY AND COMMERCIAL UTILIZATION**

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## LIST OF ABBREVIATIONS

BCCL	Bharat Coking Coal Ltd
CBM	Coalbed Methane
BCM	Billion M <sup>3</sup>
CDM	Clean Development Mechanism
CIL	Coal India Ltd
CH <sub>4</sub>	Methane
CMM	Coal Mines Methane
CIMFR	Central Mining Research Institute
CO <sub>2</sub>	Carbon dioxide
CMPDI	Central Mine Planning and Design Institute Ltd
DEA	Department of Economics Affairs
DGMS	Directorate-General of Mines Safety
GEECL	Great Eastern Energy Corporation Ltd.
GEF	Global Environment Facility
GHG	Greenhouse Gas
GOI	Government of India
GSPC	Gujrat State Power Corporation
INR	Indian Rupees
ISMU Ltd.	Indian School of Mines University Limited
MoC	Ministry of Coal
MW	Megawatt (1 million watt)
ONGC	Oil and Natural Gas Corporation Ltd
PIR-APR	Project Implementation Report – Annual Progress Report
S & T	Science & Technology
TCF	Trillion Cubic Feet
UBD	Under Balanced Drilling
UN	United Nations
UNIDO	United Nations Industrial Development Organization
UNDP	United National Development Programme
USD	United States Dollar

## **EXECUTIVE SUMMARY**

India is endowed with huge resources (267 billion tones) of coal and that of CBM, which is associated with coal, anywhere between 3.4TCM (CMPDI estimates). Its capturing in advance of mining is not only environmentally friendly can also substantially improve the safety, efficiency and economics of mining besides giving us a additional source of energy.

In view of these aforesaid advantages Ministry of Coal (MOC) in collaboration with UNDP/GEF has approved implementation of a comprehensive “Demonstrations Project for CBM Recovery and Commercial Utilization”. The project involve:

- Drilling ahead of mining to pre-draw the gas in coal seams by vertical drilling from surface to underground mine in Moonidih.
- Recovery of gas from surface by vertical drilling in the gob areas.
- Recover gas in seam by long hole underground drilling at Sudamdih.
- Methane gas so drained was to be utilized for Power Generation at Moonidih and fuelling the mine vehicles at Sudamdih.

The project was perceived in 1996 and Project report prepared by International Consultants in February, 1988. GEF council cleared the proposal in April, 1998. Project document after being approved by MOC, DEA & UNDP in October’ 1998, was cleared by CCEA in September’1998 for INR 76.85 cores (USD 18.082 million) with MOC approval in September’1999 for project duration of 5 years. UNIDO, Vienna was appointed in September’2000 as project equipment procurement agency and other support services on payment of 3% commission on the actual cost of international equipment procured. Chief Technical Advisor (CTA) Dr. Hillmar Voh Schoenfedt and six international experts were appointed by UNIDO in September’2000 for various services.

The visit of CTA and other international experts during November and December, 2000 (1 week) for drawing up of specifications of CBM equipments and their budgetary cost estimates indicated gross under provisioning in the equipment budget of the original UNDP-GEF project documents. As a consequence decision was taken to shelf procurement of some non essential equipments considered then such as second light weight drill, second underground drill, mud logging system and two phase testing unit.

The budget had to be revised by MOC in August, 06 for INR 92.427 cores and completion schedule revised to December, 2007. Due to delay in procurement of international equipment the completion schedule was again revised to December, 2008 in the existing form.

The scope of the project has undergone some revisions on account of a few major compulsions viz:

- (i) Non procurement of some equipments to reduce the budgetary gap and
- (ii) Due to physical and technical constraints at site in locating borehole.
- (iii) These have resulted in reduction of GOB wells from 10 to 02 & vertical CBM well from 17 to 07 i.e. 02 at Sudamdih and 05 at Moonidih.

On the request of UNDP and as per latest decision by MOC the Project has to complete remaining objectives as S&T project by December'2009 in absence of UNDP/GEF participation after December' 2008

The project has suffered long delays primarily due to under provisioning in the budget, long delays in procurement of project equipments from International market and procedural delay in obtaining sanctions at various stages. The under provisioning had to be met by downsizing the requirement of the project equipments as well as work programmes. This involved fresh approvals and sanctions. For instance in absence of fund for procurement of essential Hydro-fracturing and Cementation units, the GOI had to sanction additional fund besides seeking the help of ONGC which contributed USD 2.699 million. Preparation of a follow up extended preparatory phase based on field assessment of specification of equipments, international marketing scenario and a realistic assessment of time schedule for implementation for a new project like this in Indian conditions would have averted many problems and considerably improved the efficiency of implementations While acknowledging that UNIDO's rules did slow down the procurement process and primarily affected the implementation of the project it has to be borne in mind that tender rules of both International & National governments do generally require strict compliance wherein transparency and fair deal gets precedence over even schedule of procurement .

Admittedly there were low response to Tenders also from International equipments providers who were enjoying sellers market. On top of this there were no penal provisions in the tender document. As a consequence bidders backed out even after making supply commitments. A provision of bank guarantee/earnest money and black listing could have certainly deterred the bidders. It has to be noted that procurement of underground long hole CMM recovery equipment which was scheduled for January'2001 could eventually materialize during 2006 and the Steering tool in June'2008 but commissioning of the equipment in Sudamdih by the Supplier is still not complete.

It is certainly not the intention to criticize and find faults with the Project Report of UNDP/GEF consultants. On the contrary consultants analysis of the project details indicate that provision of equipments was rightly made in the PR The only thing that possibly missed was providing a mechanism for cost escalation in the event of delay in procurement for a highly specialized niche equipments in India .

P.R. had rightly made provisions for 02 vertical & 02 horizontal drills for the project. These were reduced to 01 in each case due to fund crunch. It is felt that availability of the same numbers of drills provided in the P.R. would have definitely helped in faster execution of the drilling programme and the CBM Project.

Despite delay in implementation of the project, it is heartening to note that the project has been extremely successful in achieving the laudable objective of capturing CBM from the underground mine at Moonidih giving us additional clean fuel resource to contribute energy basket of this country and the world at large beside giving benefits in terms of improving the safety and efficiency of mining operations concurrent with

environmental benefits. The project has brought to the country state-of-art technology for planning and execution of such projects in Indian scenario. It may be mentioned that four workers who were interviewed by the consultants and who were getting power from CBM well at Moonidih expressed their extreme happiness for getting uninterrupted power supply of desired voltage. These have helped their family in household work as well as in study of their children. The workers had also become very conscious of environmental benefits and wanted more such projects to come up in collieries.

As mentioned earlier, as per decision taken by MOC, the project is now to complete the remaining objectives as S&T project by December'2009. This will involve drilling a total of 07 CBM wells out of which 02 wells have been completed and 01 is in progress at Moonidih. Two wells are supplying gas for power generation. Till May, 2009 these wells have generated 5,89,755 KWh of power to colonies of Moonidih. The only PC pump available is presently dewatering and cleaning the well in the 1<sup>st</sup> completed well where as gas recovery from this well has also been established. The SRP pump will be commissioned soon for regular recovery of gas for power generation. The third well drilling is still in progress and the present depth is 801m as on 31<sup>st</sup> May'2009.

Due to non-commissioning of the Steering tool of the underground directional drilling, drilling has not commenced at Sudamdih. Upon drilling after commissioning of underground drilling unit the recovered gas (CMM)/CBM) will be utilized for demonstration of running of gas based engine truck at Sudamdih.

The man power presently deployed for CBM project work is follows:

Project	CMPDI			BCCL		
	Executive	Non-executive	Total	Executive	Non-executive	Total
Moonidih	04	26	30	02	46	48
Sudamdih	-	-	-	03	31	34
Total			30	05	77	82

Grand Total – 112 Nos.

As per RCE (June'2004) a budget provision of INR 92.43 crores (USD 20.52 million) was made. Out of this INR 80.46 cores (USD 18.11 Crores) have been spent up to December'2008. While the GEF/UNDP share has been almost entirely spent (balance only INR 0.35 Crores) out of their INR 46.89 Crores (millionUSD10.408) up to December'2008 the rest of balance money is out of GOI contributions (Cash + Kind) which is attributed to delay in project implementation/delay in procurement of international equipment etc.

The RCE December'2008 and that for continuing this project in the existing from up to December'2009 works out likely INR 132.67 Crores, which will leave a fund gap of INR 40.24 Crores. To bridge this gap CIL has sanctioned Rs. 15 Crores to start with for disbursement on account of geophysical logging and perforation services and other activities. The RCE details up to December'2008 and up to December'2009 are furnished in Annexure - V.

In terms of providing fund in the approved Project Report for Training of the Project Personnel, it is felt that the right policy would have been to expose a few selected personnel to long and detailed training to make these selected personnel sufficiently competent to train other in operational work for efficient implementation of the project. However, the project has given on the job training to executives and non-executives of CMPDI/BCCL to implement such projects elsewhere also. It has also substantially upgraded the course of study for CBM studies in the Indian School of Mines University. The capabilities of CIMFR has also been substantially improved to carry out laboratory studies and testing on much greater scale than that existed before CBM project under review was taken up.

In order to enable India to push ahead with more CBM projects, a clearing house has been established at CMPDI (HQ) to put up a data base to give an impetus to CBM recovery/utilization technology. In due course, CIL should go for a separate subsidiary to manage and develop the future CBM projects within CIL command area.

# TABLE OF CONTENTS

	Page#
<b>LIST OF ABBREVIATIONS</b> .....	2
<b>EXECUTIVE SUMMARY</b> .....	3
<b>TABLE OF CONTENTS</b> .....	7
<b>INTRODUCTION</b> .....	8
<b>1.1 BACKGROUND</b> .....	8
1.1.1 PREAMBLE .....	8
1.1.2 INDIAN SCENARIO .....	9
<b>1.2 PROJECT DESCRIPTION AND OBJECTIVES</b> .....	10
1.2.1 PROJECT GOALS/OBJECTIVES .....	10
1.2.2 DEVELOPMENT OBJECTIVES .....	11
<b>1.3 REVIEW METHOD</b> .....	11
<b>1.4 PROJECT SET-UP AND PARTNERS</b> .....	13
<b>1.5 SCOPE OF PRESENT EVALUATION REPORT</b> .....	15
<b>2. PROJECT AND ITS DEVELOPMENT CONTEXT</b> .....	16
<b>2.1 PROJECT DEVELOPMENT/FIRST STAGE (1999-2004)</b> .....	16
2.1.1 PROJECT INITIATION PHASE .....	16
2.1.2 PROJECT DESIGN PHASE .....	16
2.1.3 BUDGET CONSTRAINT PHASE .....	17
2.1.4 EQUIPMENT PROCUREMENT PHASE .....	17
<b>2.2 MID TERM REVIEW</b> .....	18
2.2.1 OBSERVATIONS AND RECOMMENDATIONS .....	18
2.2.2 IMPACT OF DELAYS ON THE PROJECT .....	19
<b>2.3 PROJECT DEVELOPMENT/SECOND STAGE (2005-2008)</b> .....	20
<b>3. COMMENTS-OBJECTIVES VIS-A-VIS ACHIEVEMENTS</b> .....	22
<b>3.1 OBJECTIVE-I STRENGTHENING CAPABILITIES</b> .....	22
3.1.1 EXPECTED OUTPUTS .....	22
3.1.2 ACHIEVEMENTS .....	23
3.1.3 COMMENTS .....	24
<b>3.2 OBJECTIVE-II EXECUTION CBM GAS RECOVERY</b> .....	25
3.2.1 EXPECTED OUTPUTS .....	25
3.2.2 ACHIEVEMENTS .....	27
3.2.3 COMMENTS .....	27
<b>3.3 OBJECTIVE-III USE OF GAS FOR POWER/REFUELLING</b> .....	28
3.3.1 EXPECTED OUTPUTS .....	28
3.3.2 ACHIEVEMENTS .....	29
3.3.3 COMMENTS .....	29
<b>3.4 OBJECTIVES-IV PLAN FOR REPLICATION</b> .....	29
3.4.1 EXPECTED OUTPUTS .....	29
3.4.2 ACHIEVEMENTS .....	30
3.4.3 COMMENTS .....	31
<b>3.5 COMMENTS- SPECIFIC ISSUES</b> .....	31
3.5.1 PROJECT FORMULATION .....	31
3.5.2 PROJECT IMPLEMENTATION .....	32
3.5.3 OTHER ISSUES (PARA 4/7 OF TOR) .....	33
3.5.4 SOCIAL IMPACT ASSESSMENT .....	37
<b>4. OBSERVATION &amp; RECOMMENDATIONS</b> .....	41
<b>5. LESSONS LEARNT</b> .....	43
<b>6. ANNEXURE LIST</b> .....	45
<b>I- TERMS OF REFERENCE (TOR)</b> .....	46
<b>II- TOUR ITENERARY OF EVALUATION MISSION</b> .....	51
<b>III- LIST OF DOCUMENTS REVISED</b> .....	54
<b>IV- UPDATED STATUS OF EQUIPMENT PROCUREMENT</b> .....	55
<b>V- FINANCIAL PLANNING CO_FINANCING</b> .....	58
<b>VI- DETAILS OF CBM STUDY COURSES AT ISM</b> .....	60
<b>VII- CIMFR FACILITIES FOR CBM STUDIES</b> .....	62
<b>VIII- COMPUTATION SHEET FOR COST/KILO WATT HOURS</b> .....	64

## **1.0 INTRODUCTION**

### **1.1 BACKGROUND**

#### **1.1.1 PREAMBLE**

Considerable efforts are now being made globally to control the emission of greenhouse gases (GHG) and thereby reduce the presence of accelerated climate change. Methane (CH<sub>4</sub>) is a powerful GHG, as its adverse impacts are felt more intensely due to its shorter residence and higher potency in the atmosphere than carbon-dioxide (CO<sub>2</sub>). CH<sub>4</sub> has 21 times higher impact a GHG than that of CO<sub>2</sub>.

Emission of CH<sub>4</sub> is related to various human activities like rice-cultivation, live stock management, burning of bio-mass and fuels, coal mining and land fills. Human activities account for about 60% of total methane emissions. Although the growth in emission is loosely correlated with increase in population, presently the global concentration of methane is increasing by about 1% per annum.

Coal mining is estimated to account for about 10% of all human related methane emissions. The knowledge of methane occurring with coal beds is as old as coal mining itself but had been treated more as a hazard rather resource till last few decades. Methane is associated with coal as a by-product of the coal formation process i.e. coalification. It is generated by two distinct processes i.e. (i) Biogenic and (ii) Thermogenic. It is stored in coal (i) upon (adsorbed) coal surface or within (absorbed) the molecular structure of the coal or (ii) within the micropores and cleats in coal and surrounding strata.

The Coalbed Methane (CBM) is trapped in coal beds and is released during and after mining. The methane associated with the coal beds has caused numerous disasters in underground coal mines all over the world. In order to reduce the hazard from methane explosions, the conventional method was to ventilate the mine working with sufficient fresh air to reduce the methane content in the mine to well below the explosive range of 5 to 13% mixture with air. But in some situation the methane trapped was so large that it was not physically or mechanically to dilute the same economically. This led to first step of trapping the methane from coal beds prior or during mining operation through drilling of boreholes in coal. Soon it was found that large quantity of CBM recovered could be used as additional source of energy while reducing both the escape of methane gas to the atmosphere and mining hazard.

Captured CBM forms a remarkably clean fuel when burnt, the combustion process of methane produces no particulates and only half of CO<sub>2</sub> associated with coal combustion. Besides depending on gas quality, methane recovered from underground mines may be sold to utilities to generate electricity, used on site as fuel for drying coal, used to run vehicles or sold to nearby industrial, domestic or commercial facilities. USA was the first country to show that if suitably harnessed CBM could be significant potential source of energy. Currently CBM accounts for about 10% of all gas production in USA – clearly indicating that CBM can be an additional source of energy while reducing both, the escape of CH<sub>4</sub> to the atmosphere and the mining hazard.



### 1.1.2 INDIAN SCENARIO

Being a populous country with high population density, the rapid development of the energy sector has been one of the priority areas of GoI as it realises that energy availability is key to economic development.

India with its geographical size and population is however poorly endowed with energy resources. With low reserves of liquid hydrocarbons and paucity of uranium-coal reserves are comparatively more abundant with latest estimate putting them at 267 Billion tonnes. Coal has thus remained India's predominant source of commercial energy accounting for about 60% of the primary energy used in the country. In absolute terms the coal production has steadily increased from 72.3m tonnes of oil equivalent (toe) in 84-85 to 200 toe, in 2008-09. Coal production touched 448 M tones in 2008-09 and is scheduled to go up +2 Billion tones by 2030-31 as per Integrated Energy Plan prepared by Planning Commission.

Under the circumstance coal production is to grow rapidly with concomitant negative environmental impacts brought about by the continued high emissions of CH<sub>4</sub> and CO<sub>2</sub>. In this context it is important to exploit and utilize the available resources of CBM which will supplement natural gas resources and partially reduce dependence on coal. The substitution of coal by methane gas for specific end uses can also serve as an instrument of GHG mitigation. As per recent estimate made by CMPDI, reserves of CBM which is associated with coal is around 3.4 Trillion M<sup>3</sup>. With modern CBM recovery technologies using specialized methods of drilling (Vertical and Horizontal), large amount of CH<sub>4</sub> can be produced.

Prior to nationalization of coal mines (1971-73) in India Amlabad Expansion Project. Report (located in Jharia Coalfield) was prepared by Soframines, France with envisaged target of 1700t/day of prime metallurgical coal from Seam XIII & XIV. The project was based on existing make of 50 m<sup>3</sup>/te of coal corresponding to the experience of working the upper seams which were also gassy. On opening of lower seams the emission of CH<sub>4</sub> went up to 200-300 m<sup>3</sup>/tones and was even recorded as high as 600m<sup>3</sup>/te necessitating slashing down the production down to 100 te/day.

Coalbed Methane which has CH<sub>4</sub>, as its major constituent, is most dangerous natural hazard confronted in course of underground coal mining in India. It has been responsible for a number of major gas explosions such as Amlabad (1955), Jitpur (1973), Sudamdih (1975 & 1976), Bhatdih (2007) in Jharia coalfield, Chinakuri (1958) in Raniganj coalfield and Dhori (1965) in East Bokaro coalfield.

However dwindling emphasis on underground mining since nationalization and consequent reduction in quantum of coal produced from these mines, the focus on mitigation of methane ebbed. And it was again in mid 90's that subject of methane from coalfields was brought to the fore. Some national and multinational private sector enterprises did approach the GoI and showed keen interest to introduce CBM technologies and accordingly some areas were allocated by MoC to Reliance, Modi Mckenzie, Amoco, Essar Oil, ONGC etc but with little progress on the ground. It was discussed that resource came under Ministry of Petroleum & Natural Gas (MOPNG).

However coal bearing areas where CBM prospects exist are under MoC/CIL. In 1997-2000 ONGC did some prospecting boreholes flaring in Parbatpur located in Jharia Coalfield. Boreholes were capped after flaring of the gas for sometime and search started for the technology for its exploitation and customer for its utilization.

## 1.2 PROJECT DESCRIPTION AND ITS OBJECTIVE

Keeping in view the advantage described above of capturing CBM, Coal India Ltd (CIL) subsidiary, Central Mine Planning & Design Institute (CMPDI) was entrusted by MoC, the task of formulating a comprehensive “Demonstration Project” for CBM recovery and Commercial Utilization. The Project document was prepared by International consultant in 1997-98 and was approved by UNDP in April’1998. The project came into effect in September’1999 with a target duration of five years. It had following approved budget:

Collaborators	Approved PR (Oct’98)	
	INR Crores	Equivalent mUSD
A. UNDP/GEF	39.09	9.198
B. UNDP	5.14	1.210
C. GOI		
i) Cash	17.29	4.067
ii) Kind	7.00	1.647
iii) Part of the revenue cost met out of the income generated from the project on account of utilization of exploited CBM in the initial time period	8.33	1.960
Grand Total	76.85	18.082

### 1.2.1 PROJECT GOALS AND OBJECTIVES

The key issues addressed are as follows:

- Reduce the potential adverse social, environmental and economic consequences of global climate change,
- Improve the health and safety of the workmen engaged in underground mining.
- Improve the environment by using otherwise wasted clean energy source (CBM)
- Promote the development of indigenous enterprise engaged in CBM.

In nutshell, the project goals were to (i) harness methane – to minimize safety risks in mines, to utilize the potential energy source and to mitigate damage to the atmosphere (ii) to bring to the country state of art methodology for resource assessment and recovery techniques of CBM and adopt the same to Indian condition and (iii) to demonstrate the utilization of the exploited CH<sub>4</sub> for power generation and fuel for transport and industrial domestic sector and (iv) to engender development of an action plan for replication and to set up a CBM Clearing house.

## **1.2.2 DEVELOPMENT OBJECTIVES**

The project is to degasify coal seams for subsequent safer extraction of coal and to demonstrate economic viability of harnessing CBM in India. The project would undertake techno-economic evaluation of in-situ gas from existing mines in areas where mining is contemplated in future as well as areas goaved out and to demonstrate harnessing of methane which other-wise would have escaped into atmosphere.

### Objective-I

Strengthen and increase capacity of CMPDI, BCCL, ISMU, CIMFR, Ministry of Coal, and the Ministry of Environment to develop and support mine associated CBM recovery and utilization projects, through training, and to build experience in design, identification, and implementation of programme to recover and use coal bed methane (CBM) in a safe, cost effective, and environmentally acceptable manner.

### Objective-II

Prepare and execute demonstration Projects at the Moonidih and Sudamdih coal mines located in the Jharia coalfield for the recovery and use of mine associated CBM in the Jharia Coalfield, design and execute CBM resource recovery programmed, using three different drilling technologies at the two proposed demonstration sites.

### Objective-III

Use recovered gas, after successful execution of the above objectives, for vehicle refuelling and electric power generation.

### Objective-IV

Develop and adopt action plan for replication of successful aspects of demonstration projects. Use CBM Clearinghouse to disseminate information, educate, promote, and to facilitate interaction with potential foreign investors.

## **1.3 REVIEW METHOD**

As mentioned earlier the project was started in September'1999 with a project life of 5 years but it faced serious time constraint due to delay in equipment procurement (UNIDO) and budget problems due to underestimation of the cost of equipment and services in the project report. The activities then had to be scaled down and actual gas recovery process could start only in mid 2005 with start of drilling, more than 6 months after the project was supposed to have been completed in September, 2004.

As per the procedural Rules of GEF a mid-term evaluation, under the responsibility of implementing agency in this case UNDP was required and the same was carried out in Oct-Nov 2004 due to sizable time over-run of the project without any significant activities on the ground.. The same was carried with specific objective of reviewing the entire project. A fresh cost estimates with reduced scope of work was prepared in 2004

for INR Rs. 92.427 Crores with completion schedule of December' 2007. The updated format containing details of co-funding in GEF format is given in Annexure V.

Though considerable progress was made till then, the basic objective of the project of recovery and utilization of gas was still not achieved and hence the project was extended in its earlier form to December'2008 without any change in budget.

Now that these objectives have been almost achieved and the project being officially closed on December 08, the GEF rules call for immediate formulation of a terminal evaluation report.

The external evaluation team was constituted and awarded the task of preparing the Terminal Evaluation report in May'2009 with instruction to cover the issues to be addressed as mentioned in the Terms of Reference (Annexure-I) and follow broadly the under mentioned structure of this report :

1. Executive summary
2. Introduction
3. The project and its development context
4. Finding and Conclusion
  - o Project Formulation
  - o Implementation
  - o Remarks
5. Recommendations
6. Lesson Learnt
7. Annexures

During the mission travel to Delhi, Bokaro, Ranchi, Dhanbad extensive interviews and discussion were held with all relevant project partners and associates and where appropriate request for relevant document and missing information was made. The mission took place with initial briefing by UNDP followed by discussion with country representative of UNIDO and National Project Director and former Project Advisor (CBM) at New Delhi on 11<sup>th</sup> May'2009. The mission then undertook field visits to Bokaro, Dhanbad and Ranchi (12<sup>th</sup> May - 16<sup>th</sup> May'2009) and visited Ranchi again between 26<sup>th</sup> – 29<sup>th</sup> May'2009 to meet CMD and Director (Tech) of CMPDI who were missed in earlier visits due to their being abroad (26<sup>th</sup> - 29<sup>th</sup> May'2009).A third visit to Ranchi (7<sup>th</sup>-10<sup>th</sup> June'2009) was made to enable the team to finalize the draft report in consultation with CBM officials. The team was of the view that 15 days time allocated to prepare the report was not adequate and as such it had no option but to accept delay in the submission of the draft report which led to submission of final report beyond the deadline of 30<sup>th</sup> June 2009 due to circumstances beyond control of the team.

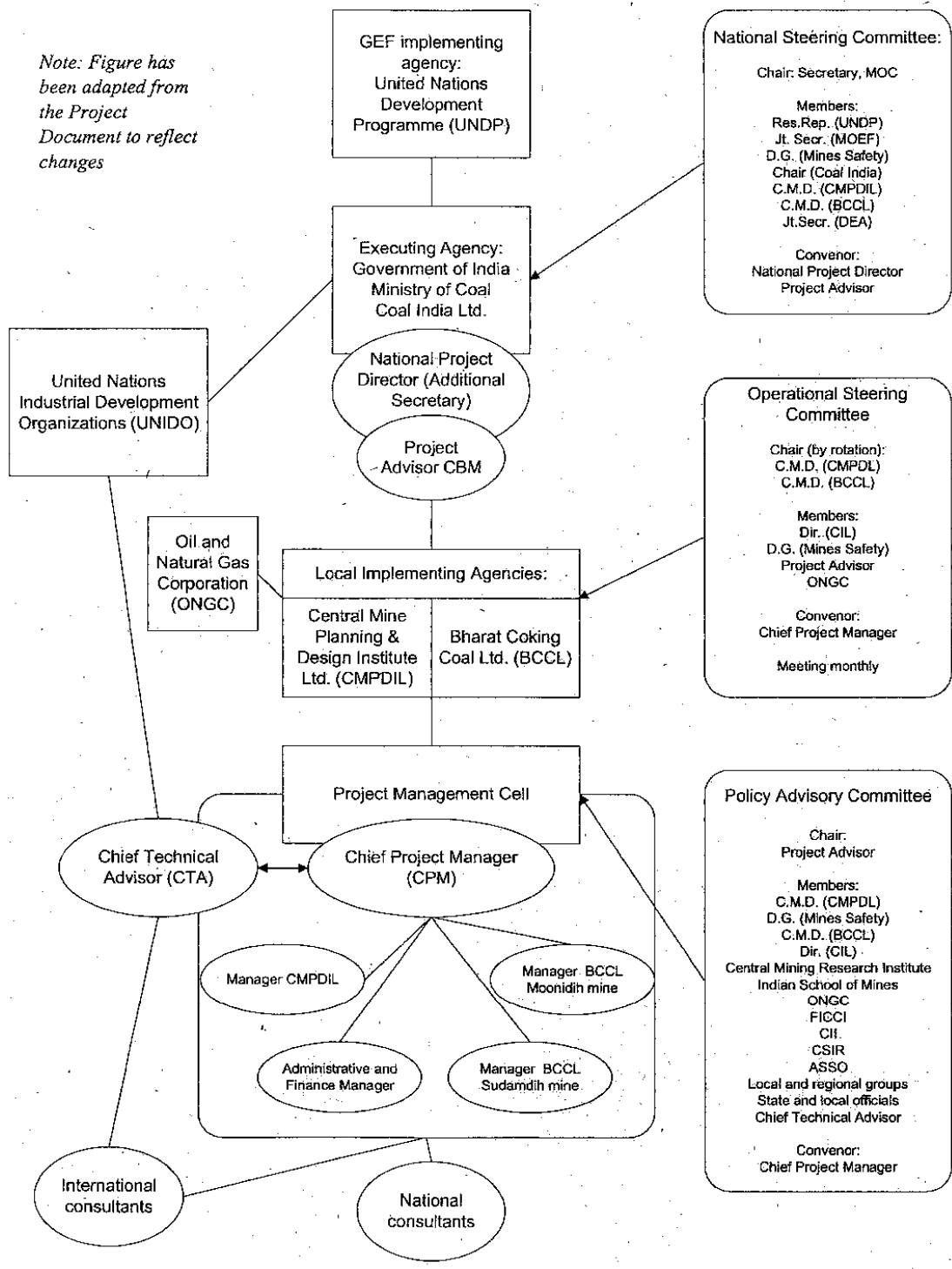
## 1.4 PROJECT SET-UP AND PROJECT PARTNERS

Project management and implementation involved a number of executing and implementing agencies as described in Fig.1 and whose roles are summarized as follows:

The GEF and UNDP as Implementing Agency are the collaborators of the project with the GoI. UNDP provides overall guidance and management from its New Delhi country office as per normal GEF & UNDP requirements.

- CMPDI, a subsidiary of CIL, is the main implementing agency from the very inception at all stages of execution of the project.
- BCCL, another subsidiary of CIL, is the co-implementing agency. It has participated in project formulation process as well as played a major role in implementing field trials at two specific project sites – Moonidih and Sudamdih located in its control area in Dhanbad district of Jharkhand State.
- After the project initiation, an agreement was reached in February'2000 for involving UNIDO in providing technical supervision and equipment procurement services (from UNDP/GEF budget). Chief Technical Advisor and other International Experts were involved in preparing various tender documents, drawings, technical specifications of equipment and of bids and in evaluation of bids. Subsequently UNIDO has provided services in procurement of some project equipments such as CBM fuel gas control unit, Steering tool & accessories, etc.
- The project partners relied on variety of universities and technology institute of repute such as Indian School of Mines University and Central Institute of Mining & Fuel Research both based in Dhanbad to perform part of the study, research and engineering work.
- Also ONGC, a public sector company has been involved at a later stage by providing budget and support for equipment procurement & support when drilling and gas recovery operations were started.

In addition there were various committees as a part of implementation arrangement (Fig. 1) for monitoring and guiding the project. These include National Steering Committee under MoC with Special Secretary ( the then Additional Secretary), MoC as National Project Director for monitoring the project work. Project Director was assisted by a Project Advisor (CBM) to carry out coordination with various Govt. Ministries and agencies, provide guidance to the project team to coordinate with UNDP and UNIDO, to review reports and to look after the administrative arrangement required under GoI, UNDP and UNIDO procedures. Two other committees called (i) Operational Executive Steering Committee convened by Chief Project Manager consisting of CMDs of CMPDI & BCCL, Director (Tech), CIL, representatives of DGMS & ONGC for reviewing the work progress on a regular basis (ii) Policy Advisory Committee was a forum for broader policy issues and also to assess inputs from other organizations besides the institutions involved in the project, also existed.



**Figure 1 : Project Implementation Arrangement upto December, 2008**

## **1.5 SCOPE OF PRESENT TERMINAL EVALUATION REPORT**

As outlined (See Annexure I) in the terms of reference (TOR), the evaluation team noted that a detailed mid term evaluation report of the project was prepared in November'2004 giving project back ground and reasons for inordinate delays in getting the equipment at sites. Hence, it will not like to go into the details of the delays and their causes but will refer to them briefly particularly on activities which had bearing on the program implementation of the project. Similarly there has been Completion Report prepared by the CBM Project which has sufficient information about the project.

As directed, the team has followed the evaluation approach which comprises methods such as documentation reviews, interviews and field visits. It has tried to talk to all the partners of the project; the funding sponsorers; the operators; the beneficiaries; and the regulators to have their feedback about the project. Direct interviews were taken of four workers of Moonidih project who are benefited by way of having a regular power supply to their quarters and expressed their happiness for being served better than the other workers of the Moonidih project who are not having the benefit of power from CBM project. The team has tried to give ratings to the various activities of the project as required by TOR.

## **2.0 THE PROJECT & ITS DEVELOPMENT CONTEXT**

The project development has passed through two distinct stages-the first stage lasting 64 months from the start of the project in Sep, 99 to Dec,04 which saw delays in four phases: project initiation, project design, budget constraints and equipment procurement process. The second stage lasting next 48 months from January 05 to December 08 where focus of activities was at the project site but still suffering delays due to messy equipment procurement delays and delayed operational support from the equipment suppliers. The mid-term evaluation in November 04 can be considered as water-shed between the two stages.

### **2.1 PROJECT DEVELOPMENT-FIRST STAGE(1999-2004)**

The first stage of the project lasting 64 months can be seen as consisting of four distinct phases: the project initiation phase, the project design phase, the budget constraint phase and finally the equipment procurement phase.

#### **2.1.1 PROJECT INITIATION PHASE**

The project was perceived in 1996 and Project report prepared by International Consultants in Feb.'1998. GEF council cleared the proposal in April, 1998. Project document after being approved by MOC, DEA & UNDP in October, 98, was cleared by CCEA in Sept.'1998 for INR 76.85 cores (USD 18.082 million) with MOC approval in Sept.'1999 for a project duration of 5 years. UNIDO, Vienna was appointed in September 2000 as project equipment procurement agency and other support services on payment of 3% commission on the actual cost of international equipment procured. Chief Technical Advisor (CTA) Dr. Hillmar Voh Schoenfedt and six international experts were appointed by UNIDO in September, 2000 for various services.

The visit of CTA and other international experts during Nov. & Dec., 2000 (1 week) for drawing up of specifications of CBM equipments and their budgetary cost estimates indicated gross under provisioning in the equipment budget of the original UNDP-GEF project documents. As a consequence decision was taken to shelf procurement of some non essential equipments considered then: such as second light weight drill, second underground drill, mud logging system and two phase testing unit.

Almost first 18 months of the project were thus lost in putting up required technical teams, initiating the equipment specification exercise and selecting suitable sites etc.

#### **2.1.2 PROJECT DESIGN PHASE**

Six International Experts for Surface drilling & completion, Laboratory sorption & permeability equipment, Experts for Underground drilling & completion, Gas Plant, Underground gas collection, Reservoir Modelling & Economic Modelling visited the Project sites in November/December, 2000 for familiarization with local conditions and



discussions with local project officials for preparation of equipment specifications in their respective areas.

### **2.1.3 BUDGET CONSTRAINT PHASE**

The evaluation revealed that total cost of equipment totaled USD 12,373,490 as against budget provided by GEF of USD 8,578,000 i.e. there was gap of USD 3,795,490 in provision. In reality the gap was USD 5.20 million but since it was decided not to procure certain equipment (vertical drill, underground drill, mud logging system & two phase testing tool) valued at USD 1.50 million, the gap got reduced to USD 3.785 million

ONGC was approached to jointly fund on 50:50 cost sharing basis the high cost of equipment i.e. Hydro fracturing and Cementation unit. After initiating the MOU between ONGC & CMPDI in Sept. 2002, the remittance of fund amount of USD 2.69 million was completed in April, 2003. A gap of USD 1.097 still remained which was provided by GOI by re-appropriation of funds duly approved by DEA in May, 2003 entailing a delay of around 10 months in the project schedule.

### **2.1.4 EQUIPMENT PROCUREMENT PHASE**

In Jan'2000, UNIDO took action for issuing Expression of Interest (EOI) and subsequent tendering process. Based on recommendation of experts and due approval of the Project authorities, four Equipment packages were made: Package-I: Underground drilling and completion equipment, Package-II: Underground Gas Collection Equipment, Package-III: Surface drilling and completion equipment and Package-IV: Laboratory equipment.

The global bidding of four packages did not elicit satisfactory response as each of these packages contained equipment from multiple suppliers located in different parts of the world.

The four initial equipment packages were then split into 26 packages to be procured by UNIDO, 04 packages by CIMFR, Dhanbad and 05 by the project directly. All 35 packages were tendered (2<sup>nd</sup> round) in Nov, 2001. Partial response received for 12 packages and balance 14 packages were re-tendered in March-May, 2002 (3<sup>rd</sup> round). Evaluation of 25 packages of UNIDO and other 9 packages for which offers were received was done in July'2002 on receipt of clarifications. One package, for which no offer was received was re-tendered and evaluation done in Nov. 2002.

A total of 16 packages were re-tendered for various technical reasons in December'2003 (4<sup>th</sup> round).

Five packages were again tendered in March'2004 (5<sup>th</sup> round). Only three package received bids. Two packages along with one package left earlier were re-tendered by UNIDO after receipt of USD 1.03 million from GoI (Cash) S&T FE component in July'2004 (5<sup>th</sup> round) almost 5 years after the official start of the project.

Suffice it to say that process of tendering and re-tendering continued into second stage till December' 2007, the revised target completion date of the project without 100% achievement of the targeted equipment.

For example, Moonidih Mine CBM Fuel Gas Control unit was delivered at Moonidih in June'2008 and only thereafter demonstration of power generation could be achieved on 27<sup>th</sup> June'2008.

Similarly Steering tool and accessories for directional drilling at Sudamdih mine ordered by UNIDO in July'2007 was supplied only in June'2008. Commissioning with the help of supplier was done in Sept.'2008 but malfunctioning was noticed in pulsar of the Steering tool. Thereafter equipment was sent back to manufacturer for repairing and testing. Testing of Steering tool (Package-04B) designed for directional drilling in pre-defined drill paths in underground coal seams was repaired at M/s Russell Sub-Surface Systems Ltd's (RSS) Works at Abadeen/UK and was sent back to the site on 28<sup>th</sup> April'2009. Due to non commissioning of Steering tool the horizontal in seam directional drilling at Sudamdih could not be commenced, till date.

## **2.2 MID-TERM REVIEW AND ITS IMPACT**

A mid term evaluation of CBM project was undertaken, through UNDP in October' 2004 by independent consultants and final report submitted in November'2004.

### **2.21 OBSERVATION AND RECOMMENDATIONS**

The main observations of this report were as follows:

- The original approved project document (PR) was conceptual in nature and details were lacking.
- The budget for procurement of equipment was very much under provided.
- The procurement procedure of UNIDO were found to be quite rigid and at times inadequate, particularly the absence of the clause of depositing any earnest money/ bank guarantee by the bidder. Due to this along with some other factors, re-tendering for all the equipment packages were done 5 – 6 times which led to huge delay in procurement of the equipment.

This evaluation team made following recommendations:

- Long delay in project initiation and equipment procurement (5 years) should not over shadow the project implementation.
- The revised budget with raised target appears to be adequate but looking to the forthcoming programme and the contingencies for a complex project like this one, more funds may be needed in order to achieve its planned out puts.
- A detailed work plan and budget for the remaining part of the work ought to prepared.
- The project should be extended by three years (2005-2007).
- The project's objectives remained valid

In short, the idea to give the chronology of the events in the first stage in the project is to show that unusual, unplanned delays have occurred in international equipment procurement indicating that there were serious procedural and technical short falls in whole procurement process that affected the project. In fact it would not be wrong to comment that the project really took off the ground after the mid-term evaluation done in 2004.

The five to six rounds of tendering for international equipments already outlined above led to serious over- run both on time and cost of the project. While cost over run was somehow brought under control by deleting some of the equipment and services and by roping in ONGC for additional funds, the time over-run could not be checked. A study of the facts presented in the Completion Reports indicated that vertical drilling at Moonidih could only start in mid 2005, while the horizontal drilling package did become operational in Sudamdih in 2008but got suspended later due to the failure of the Steering tool.

It is observed from above that the project has suffered long delays primarily due to under provisioning in the budget, long delays in procurement of project equipments from International market and procedural delay in obtaining sanctions at various stages. The under provisioning had to be met by downsizing the requirement of the project equipments as well as work programmes. This involved fresh approvals and sanctions. It is noted that UNIDO's rules did slow down the procurement process and primarily affected the implementation of the project. It has been also felt that a escalation clause for price rise in the event of delayed procurement would have sufficiently helped the procurement which unfortunately was not foreseen. But it has to be borne in mind that tender rules of both International & National governments do generally require strict compliance wherein transparency and fair deal gets precedence over even schedule of procurement. As such putting the blame on UNIDO will be fair. The delays occurred due to various procedural shortcomings as mentioned above.

## **2.2.2. IMPACT OF DELAY IN IMPLEMENTATION:**

### **2.2.2.1 CHANGES IN SCOPE OF THE PROJECT**

Major changes in the scope of the project are on account of following compulsions

- i. Non procurement of items to reduce the gap in funding and
- ii. Due to physical and technical constraints at site which resulted in reduction of the number of wells .These are:
  - a. Reduction in GOB wells from 10 to 02 numbers as no GOB well could drilled in stowed area of Sudamdih mine.
  - b. Vertical CBM well reduced from 17 to 07 i.e. 2 at Sudamdih and 05 at Moonidih.
  - c. Major changes in procurement of equipment were:
    - Only one vertical drilling rig in place of two rigs

- Non procurement of 2 units of mud logging system
  - Only one horizontal drilling rig in place of two
  - Non procurement of geophysical logger unit and hiring of services in its place.
- iii. Part funding of Hydro-fracturing unit and Cementation unit of the project (cost USD 5.24 million) which was shared between ONGC & GEF/GoI funding with a rider that ONGC would take over of the equipment after 5 years when the project will be completed. In lieu of this all hydraulic fracturing and cementation jobs of the project will be done free of cost by ONGC.

Hiring of Geophysical logging services contracted at the cost of Rs. 13.2 Crores beyond the approved budget. CIL has come forward with 15 Crores grant for this expenditure.

#### **2.2.2.2 CHANGES IN BUDGET**

Based upon the changes in the scope of the project and the additional fund requirements the initial budget of INR 76.85 Crores was revised to INR 92.47 Crores.

#### **2.2.2.3 TRAINING**

The programme initially started with visits of two high level fact finding mission. The training modules provided were all delayed due to delays in equipment procurement as most of training slots were linked to the technical support by equipment suppliers. Training details are as follows(For more details see para 3.1.1. also):

- Two high level fact finding team comprising 05 senior officials visited USA, Germany and Austria in 2000 to acquaint themselves in latest development on CBM technology.
- 06 project personnel comprising Drilling Engineers, Mechanical Engineers and Electrical Engineers have been trained for two weeks in March' 2004 at Rig manufacturer works in USA to familiarize with drilling equipment.
- 07 project personnel comprising of Mining, Mechanical and Electrical Engineers have been given two weeks training in 2005 on Gas utilization at various Center in USA.
- 02 project personnel have been trained for one week during September'2005 on application of Down hole motor at supplier's works in USA.

### **2.3. PROJECT DEVELOPMENT-SECOND STAGE (2005-2008)**

In this stage one can decipher two distinct areas of actions viz; one side was the follow up of the spill-over of the equipment procurement by UNIDO and on the other side was the activities at the field sites of Moonidih and Sudamdih. Delay in equipment procurement continued to plague the progress of the work at the sites. Due to these delays the revised completion date originally fixed at Dec, 2007 had to be further

extended to Dec, 2008 without any change in the scope of work or budget (Annexure IV).

During this period the equipment started arriving at the sites from various suppliers and with that the opportunity of training of personnel abroad like two weeks training of 07 personnel on gas utilization in USA, one week training on underground drilling for 02 engineers in USA. Most of the manpower was given hands-on training on various equipments under guidance and supervision of experts. The training programme both in terms of fund provision and time-frame was quite inadequate and as such the time taken by the team to reach the desired level of skill and confidence got severely affected contributing to the delay in implementation of the project. In order to train CBM project drilling personnel on the procured CBM vertical rig a retired Dy GM of ONGC was also engaged for one year on the job training of drilling.

Due to delayed delivery of certain items, the work on the site could not take off as per the planned schedule. Operation of the first vertical borehole drilling rig started in Moonidih in September'2005 only and after its completion the second vertical well drilling commenced in September'2006.

In spite of procurement delays as well as delay in finalization of Geophysical logging & perforation services contract and supply of CBM fuel gas control unit the Project team achieved the demonstration of electricity generation on 27<sup>th</sup> June'2008 through optimization of team work and sharing of experiences gained during operation. The third well is currently under drilling and reported at 801m depth as on 31<sup>st</sup> May'2009 and is expected to be in production by November'2009.

A study of the activities during this period shows that the shadow of the messy project equipment procurement process continued to plague the field operation. Even now the horizontal drilling programme at Sudamdih is held up for want of proper functioning of the Steering tool and supervision of suitable Experts. The Underground drilling unit, Gas Recovery Unit and CBM Compression and Fuelling units are lying idle due to non-commissioning of the Steering tool and commencement of underground directional drilling in association with suitable Experts.

In summarizing, one can say that the objectives achieved by vertical drilling technology at Moonidih mine have been the saving grace enabling the project to be declared successful. Alternative technology of recovery of gas from horizontal drilling and subsequent use of the compressed gas as fuel for mine vehicles still remains to be achieved. The project management is hopeful that this will be achieved with resumption of horizontal underground drilling with rectified steering tool arrangement by December'2009.

Technically, the project as conceived formally ended in December'2008. But the local partners felt that having achieved so much, it will be not in the interest of the country to abandon the project. Hence a decision was taken by GoI to continue the project as S&T Project to achieve in the first instance all the physical objectives originally laid down in the project and even go beyond if found desirable later.

### 3.0 COMMENTS – OBJECTIVES VIS-À-VIS ACHIEVEMENTS

Having gone through the overall framework of the project, it is now proposed to go through the project in terms of achieved outputs, activities and finally accomplishment for each of the four project objectives laid down in the Project document.

#### 3.1 Objective 1 : Strengthen and increase capacity of CMPDI, BCCL, CIMFR, MOC, CIL & others

##### 3.1.1 *Expected outputs (as defined in the 1998 UNDP Project document) :*

1.1	<i>Members of CMPDI and BCCL trained in reservoir modeling and prediction of gas production parameters</i>
1.2	<i>Team members trained in latest vertical well drilling technology (including equipment specification to be purchased).</i>
1.3	<i>Team members trained in latest underground directional drilling (including equipment specification).</i>
1.4	<i>Team trained in use of CBM for power generation (including equipment specification).</i>
1.5	<i>Team trained in use of CBM gas in vehicle internal combustion engines (including equipment specification).</i>
1.6	<i>Team members trained to develop safety protocols on the technologies mentioned in 1.2-1.5.</i>
1.7	<i>Team members CMPDI and ISM trained in the financial-economic assessment of CBM.</i>
1.8	<i>CBM Information System (library, Internet Gateway) installed at CMPDI</i>
1.9	<i>CMPDI, CIL, MOC Intranet installed at CMPDI</i>
1.10	<i>CBM Clearinghouse established</i>

With reference to the aforesaid objectives the achievements are as follows:

- Two high level fact finding team comprising 05 senior officials visited USA, Germany and Austria in 2000 to acquaint themselves in latest development on CBM technology.
- 06 project personnel have been trained for one week in reservoir engineering at ISMU, Dhanbad (India) during May'2001 (Out put 1.1).
- 07 Project personnel have been trained in Drilling Technology at IDT/ONGC, Dehradun & Ahmedabad (India) for two weeks during November' 2003 (Out put 1.2).
- 02 Chemists were sent to ONGC drilling site in December'2003 to get acquainted on Mud chemistry (Out put 1.2).

- 06 project personnel comprising Drilling Engineers, Mechanical Engineers and Electrical Engineers have been trained for two weeks in March' 2004 at Rig manufacturer works in USA to familiarize with drilling equipment (Out put 1.2).
- 07 project personnel comprising of Mining, Mechanical and Electrical Engineers have been given two weeks training in 2005 on Gas utilization at various centers in USA (Out put 1.4 – 1.5).
- 02 project personnel have been trained for one week during September'2005 on application of Down hole motor at supplier's works in USA (Out put 1.3).
- As mentioned earlier, the training schedules (Out put 1.1 - 1.7) got seriously affected by the long time over runs of the project from Sept.'1999 to Jan.'2005 (64 months) due to delay in project initiation (18 months); delay due to project design (10 months), delay in securing sufficient funds for procurement (10 months) and final delay in equipment procurement process itself (26 months). This was primarily due to the fact that most training slots to be undertaken were with assistance of the equipment providers. The budget provided in the PR was not sufficient to allow the required personnel to be trained abroad for longtime exposure to acquire desirable skill and confidence.
- Discussion with project officials brought out clearly that overall quantum of training, both in funds as well as in time frame was quite inadequate for the desired goals. The efforts on in-house training and "on the job" training also suffered due to late arrival of equipment. Even handling the vertical drilling operation at Moonidih, the project had to hire services of ONGC experts
- By in-house efforts both in cash and kind CBM information library (Out put 1.8), CBM intranet (Out put 1.9) and Clearing house (Out put 1.10) at CMPDI, Ranchi have been established.
- Though some "on job" training could be provided for underground horizontal drilling (Out put 1.3) but due to improper functioning of the Steering tool there is still lot to be learnt which will be possible when the underground drilling is resumed. Only activity of vertical gob well drilling (Out put 1.6) was dropped while redrawing the revised programme due to mining constraints.

### **3.1.2 ACHIEVEMENTS**

- Capacity of the CIL subsidiaries CMPDI and BCCL was strengthened and the capability developed in recovery of CBM/CMM from working mine by procuring all modern equipment for drilling of vertical wells and its cementing after geophysical logging (hired services) of drilled well followed by perforation (hired services) to administer hydro-fracturing of potential coal seams by the project units in vertical CBM wells. All the procured international equipment was operated by departmental man power after pre-operation training and initial hands-on training.

- Two vertical wells have reached CMM recovery stage. Approximately 5000 Cubic M of nearly pure methane (98%) is being produced from two wells at Moonidih mine of BCCL at Dhanbad (Jharkhand).
- Long hole drill unit for drilling long hole (1 Km.) in coal seam through guided directional drilling was under commissioning to undertake underground directional drilling at Sudamdih mine of BCCL by the departmental man power after pre-operation training and initial hands-on training. However the same had to be suspended due to malfunctioning of the Steering tool.
- Establishment of CBM information system, intranet/internet and clearance house has been carried out with a view to disseminate information and facilitate interaction with potential investors.
- Graduate and post graduate courses started in ISMU on CBM technology with a view to train future manpower.
- Capability of CIMFR enhanced to carry out testing of core samples and assessing potential of new fields.
- Similarly DGMS also have exposure to the new technology in all its operation to enable to ensure proper safety regulations.

### 3.1.3 COMMENTS

- It is noted that a new technology to tap CBM services has been successfully introduced in the country and expertise built particularly in CIL, CIMFR and ISMU to enable Indian players to replicate the same in new areas.
- The analysis of project delays in implementation shows that it would have been better to have a project preparatory phase of a year or so before starting the implementation of the project. This would have allowed proper project initiation, more detailed work on cost and time framework, training needs and possibilities, description of the project sites and to have detailed specifications of equipment needed with listing of potential equipment suppliers.
- The training specifically could have been framed with clear objectives of
  - i) Exposures of higher management of organization involved in the new technology
  - ii) Training a “core group” of Indian technical personnel as “trainers” in each critical area for subsequent in-house training of the other project personnel.
- Omission of second set of drills for vertical as well as horizontal drilling from procurement list proved to be a soft option that costed the project dearly, efforts should have been made to provide additional budget. For this a suitable



mechanism should be evolved for future project to take care of reasonable cost escalation.

### **3.2 Objective-2: Prepare and execute CBM gas recovery demonstration projects in the Jharia Coalfield.**

#### **3.2.1 Expected outputs (as defined in the 1998 UNDP project document) :**

2.1	Fully equipped and trained unit for vertical well drilling
2.2	Plan for vertical well drilling into coal seams and advance of mining strata (Moonidih:9; Sudamdih:8 wells).
2.3	Fully equipped drilling camp
2.4	Vertical wells located and drilled.
2.5	Plan for vertical well drilling into sealed gob area (10 wells
2.6	Vertical gob wells drilled
2.7	Oxygen and CO monitoring system installed
2.8	Fully equipped and trained unit for underground directional drilling
2.9	Plan for directional drilling.
2.10	Fully equipped centre of operations
2.11	Directionally drilled boreholes

#### **3.2.1.1 Project Methodology :**

The project concept was to effectively capture methane in working coal mines. Two mining sites Moonidih and Sudamdih in the Jharia Coalfield were identified by UNDP consultants who had prepared the project document. For developing the coal bed methane, it has been proposed in the project document to:

- Pre-drain the gas in virgin coal seams by vertical well drilling (Out put 2.1-2.4).
- Recover gas from surface by vertical drilling in gob areas (Out puts 2.5-2.6).
- Recover gas in-seam by long-hole underground directional drilling (Outputs 2.8-2.11).

Essentially, two important changes have occurred regarding the procurement of equipment and the drilling plan; the project has been downsized and there have been huge delays (of five years) in the procurement of equipment.

#### **3.2.1.2 Downsizing of the demonstration component of the project**

The first major change in the scope of the project related to the physical and technical constraints at the two mining sites and subsequent reduction in the number of drilling sites as described below:

- Vertical wells were reduced from 17 to 7 (two at Sudamdih and 5 at Moonidih)

- Only one GOB well was to be drilled (at Moonidih), instead of the envisaged ten (many areas have been stowed).
- There was one site each for underground drilling at Moonidih and at Sudamdih.

**3.2.1.3 Executing the project with the originally defined number of borehole was not practically feasible, due to the following reasons:**

- Many areas were heavily built up and with ownership titles not belonging to the mine, which sets a limit on the sites that can be developed.
- Underestimation of the budget needed for drilling equipment, as discussed in the next paragraph. Since only one vertical and one horizontal drilling systems were purchased instead of the original two per system, this has reduced the number of holes that can be drilled within the project period by half, and this ‘period’ has been reduced anyway from 2001-2004 to 2005-2007.

The mid term evaluation team felt that the project downsizing in terms of number of wells drilled should not affect the overall objectives. The cost-benefit analysis might result to be less satisfactorily since fewer wells will be developed in view of the high investment cost in drilling equipment, but, such analysis would be preliminary anyway given the demonstration nature of the gas recovery operations.

**3.2.1.4 Budget for equipment**

A second major change concerns the budget for procurement of equipment. After the project inception, a field visit of the international expert team for drawing up the specifications of the equipment and for detailing the cost estimates clearly revealed that there was gross underestimation of the budget for equipment, estimated at around USD 13.87 million; in contrast, in the UNDP-GEF project document, the budget line available for UNIDO procurement of equipment was only USD 8.578 million. To reduce the cost, it was decided to use one vertical drill rig instead of two, one underground drill instead of two and leave out non-essential equipment (mud-logging system and two-phase testing tool, etc.), which yielded a cost reduction of USD 1.5 million. However, this still left a gap of USD 3.795 million, which was closed.

- In September 2002 an agreement was signed between ONGC and CMPDI & BCCCL to co-share the cost of certain equipment, (although the funds were only repatriated to UNIDO by April’2003), adding a ONGC contribution of USD 2.698 million.
- The remaining shortfall in funds of USD 1.097 million has been met by re-appropriation in the budgets, of which the Government of India provided USD 1.049 million, which was approved in May 2003.

It is important to mention that without the ONGC contribution in 2003 and without the budget re-appropriation in 2004, no sufficient budget would have been available for UNIDO to continue the bidding process of the equipment. UNIDO's regulations require sufficient funds to be in its bank account before it can tender and purchase equipments.

### **3.2.1.5 Equipment Procurement**

About procurement and acquisition of equipment the same has been dealt in para 2.1.4. The details of the updated status of the equipment procurement has been given in Annexure-IV.

### **3.2.2 ACHIEVEMENTS**

A fully trained unit for undertaking vertical well drilling has been created (Out put 2.1-2.4). This includes competence to locate and drill future boreholes.

GOB drilling has not been undertaken so far for reasons explained in 3.2.1.1 and delay in execution of the project (Out put 2.5 – 2.6).

The CBM project being located near the Moonidih Underground project, the facilities available for the mine project have been utilized for the Camp establishment. (Out put 2.3)

As mentioned in para 2.1.4 at the stipulated completion date of the project out of the 7 vertical holes in Moonidih site only two wells have been completed. Neither vertical well in Gob areas nor 2 horizontal drilling holes in Sudamdih could be completed. While four 250 KW gas generators have arrived at sight only two are operational from gas coming out of two wells.

The third well was spudded in January'2009 only and as on date this has been drilled up to a depth of 801m and is likely to start power generation by February' 2010.

Directional drilling at Sudamdih is held up due to non functioning of the steering unit. The gas compression unit for supply of compressed CBM to the mine vehicle is awaiting supply of CMM (CH<sub>4</sub>) from underground mine.

Finally, it can be said that Moonidih and Sudamdih coal mines of BCCL have acquired all the know how required for recovery of gas and are capable of executing further recovery programme with departmental manpower that has been trained to design and execute different drilling technologies.

### **3.2.3 COMMENTS**

- Despite the vagaries of equipment supply the implementing agencies and their associate are ready for replication of CBM gas recovery projects with associated gas usage systems.

- Due to basic inadequacies of the approved project report there has been inordinate delay in project implementation but this can be brought to within acceptable techno-economical favorable limits now that the pit falls of such a project are well recognized.
- The time is ripe for acquisition of more drills for accelerating the CBM recovery program at both Sudamdih and Moonidih and go ahead for replication of the project in newer areas under jurisdiction of Coal India. MOC should approach GOI for more funds to kick-start replications in other coalfields.
- In Sudamdih the seams are steeply dipping, area is heavily faulted and suffer from swings along the strike of the seam. The coal too is softer because of its being crushed due to local structure. Because of these problems steering the drill hole within the seam will definitely be tricky. These problems will have to be faced by CBM project at Sudamdih.

### 3.3 Objective 3: Use CBM gas recovered from above mentioned wells for vehicle refueling and power generation.

#### 3.3.1 Expected outputs (as defined in the 1998 UNDP project document) :

3.1	<i>Surface gas gathering system designed and connecting each of the vertically drilled wells to a pipeline that will deliver the gas to a central location at Moonidih and Sudamdih respectively</i>
3.2	<i>Surface gas gathering system designed and connecting each of the vertically drilled gob wells to a pipeline that will deliver the gas to a central location at Moonidih and Sudamdih.</i>
3.3	<i>Surface gas gathering system designed and connecting each of the underground borehole manifolds to a surface pipeline that will deliver the gas to a central location at Moonidih and Sudamdih</i>
3.4	<i>A small gas blending plant located at each of coal mines at which gas from the various wells is blended to meet end-use requirements.</i>
3.5	<i>An internal combustion (IC) stationary engine generator set with 1 MW installed capacity at Moonidih mine.</i>
3.6	<i>A fully equipped and functional compressed methane fuelling station located at Sudamdih, used to refuel coal dumper trucks, powered by engines that have been converted to operate on methane.</i>

In accordance with the change in the number of wells, Output 3.2 has been merged with 3.1. The methane recovered from the various wells and underground systems will be piped and blended at a central collection point at each of the two mines, to be used subsequently in a 1MW stationary engine generator set for power generation at Moonidih and for fuelling mine trucks at Sudamdih. The following activities have been completed:

- Design of the surface gathering and pipeline systems for the vertical wells and underground systems as well as procurement of materials (Out puts 3.1 - 3.3).
- Design of a low-cost gas blending station (Out put 3.4)
- Design of the gas re-fuelling station (compressor and dispenser; Out put 3.6) of course activities 3.1 and 3.2 are dependant in how quickly the new wells are dug in the two locations.

Considering that total programme of drilling the wells as envisaged is completed in terms of gas production, a first rough estimate gives gas production of around 21,000-24,500 M<sup>3</sup> per day at Moonidih and 3000 M<sup>3</sup> at Sudamdih. The expected gas usage of the 1 MW generator is 9000 - 10000 M<sup>3</sup> per day. Assuming a gas usage of 300 M<sup>3</sup> per truck the gas usage of the fleet of 10 mine trucks with conversion kits installed or gas based engine mine trucks, its daily gas usage will be 3000 M<sup>3</sup> per day. This implies that of the combined gas production of say around 25000 M<sup>3</sup>, only 13000 M<sup>3</sup> per day will be utilized. In line with the environmental objective of the project the surplus methane gas either has to be flared or alternative uses have to be found. BCCL should therefore contemplate installing more generation sets, a second compressor and dispenser to unit (for fuelling the trucks) or piping the gas to nearby communities.

Alternatively, due to lack of gas marketing expertise, BCCL may consider outsourcing the distribution and marketing to suitably qualified agency.

### **3.3.2 ACHIEVEMENTS**

- Considerable success has been achieved at Moonidih site with successful electricity generation since 27<sup>th</sup> June, 2008 which is supplied to mine worker colonies of Moonidih. Gas from two wells is being harnessed for electricity generation and arrangement for power evacuation to more steady load of Water filtration plant is under way.
- However at Sudamdih though horizontal drilling was started in June'2008 it could not be continued due to problems of the Steering tool. Now all the arrangement for gas compression for use by mine trucks are ready. The start of recovery of methane is awaited.
- It is to be noted that all the gas utilization equipment has been purchased locally from Indian market and is working satisfactorily.

### **3.3.3 COMMENTS**

- Slow pace of drilling of wells is seen as the main bottle-neck for the progress of the revised programme. The omission of the second units of vertical and horizontal drilling rigs and associate equipment from the original list has been a serious omission. It is high time that implementing agency considers acquisition of more drills to give necessary thrust to this extremely potential important energy resource process.
- This objective was the easiest of the project objective as there was considerable expertise available in India and the equipment required was also available as such further strengthening of the gas utilization facilities should not have been a problem.

## **3.4 Objective 4 : Action plan for replication and CBM clearinghouse**

### **3.4.1 *Expected outputs (as defined in the 1998 UNDP project documents) :***

4.1	<i>Report presenting methane production and cost-benefit analysis and recommendations for future activities.</i>
4.2	<i>Action plan adopted by MOC to promote CBM methane recovery</i>
4.3	<i>A CBM clearinghouse located at CMPDI</i>
4.4	<i>Additional courses on CBM added to ISMU curriculum</i>

The following activities have been completed:

- Analysis of production data and estimates of methane gas content in the coal seams of Moonidih and Sudamdih, as well as cost-benefit analysis and impact analysis, including greenhouse gas emission reduction estimates (Output 4.1).
- Development of an action plan for up-scaling of CBM activities in the project areas and replication to other areas, including involvement of private sector (Output 4.2).
- Dissemination of project results (publications, workshops; Output 4.3)
- Integration of CBM in mining engineering course materials (Output 4.4).

### 3.4.2 ACHIEVEMENTS

- All the four activities have been addressed for promotion of CBM activities. A E-library has been made operational at CMPDI and a clearance house has also been established (Output 4.3). To strengthen the later a collaboration agreement has been signed with United States Environmental Protection Agency (USEPA). One CBM website has also been created ([www.cmmclearinghouse.cmpdi.co.in](http://www.cmmclearinghouse.cmpdi.co.in)).
- CIL/MOC has appreciated the tremendous commercial potential over and above the mitigation of climate change in recovery and utilization of CMM from working mines. Secretary, MOC has already directed as a policy that CMPDI should prepare plans for identification of suitable blocks in CIL leasehold areas for recovery of CMM in commercial manner and replicate such projects which would be also entitled for carbon credits. With a coal production of 456 mt in 2008-09 CIL with 85% of coal production, should be the main focus (Output 4.2).
- Around 193 coal blocks for captive coal mining have been allotted by MOC where considerable numbers of those are amenable to underground mining and these have a very profitable potential for recovery of CMM in advance of coal mining. These coal block owners have become aware of this additional potential and are seriously considering recovery of CBM/CMM in advance of coal mining at the planning stage itself.
- As mentioned earlier additional courses on CBM (Output 4.4) have been added to ISMU curriculum as part of dissemination of knowledge on CBM.

- As far as cost benefit analysis is concerned the Completion Report prepared by the CBM cell, has arrived at the cost of the INR4.23/KWHR considering all the cost incurred till Dec, 2008 on the project. This has been loaded on the output of the two gas wells successfully completed till that date. This compares favourably with the current power unit cost being supplied to BCCL by the power utilities despite the fact that various one time costs incurred by the project are involved because of its being a “Demonstration” project. Details of the computation of cost per kWHr is given in Annexure IX.

### **3.4.3 COMMENTS**

- The above review clearly show that this demonstration project has been able to bring clear verdict for favourable commercial viability of the methane recovery in Indian mining environments. Before the project was taken up there were some doubts as to the sufficiency of methane from Indian coal seams to make the methane recovery as a stand alone profit center. These misgivings have been fully laid to rest.
- GoI/CIL has also finalized a policy to push forward CBM/CMM programme on a fast pace by building suitable nodal points at CMPDI in form of Clearing House, E-library and intranet connectivity, at CIMFR in form of a Laboratory testing center and at ISMU as the educational center imparting specialized courses on CBM technology.
- The techno-economic picture is quite attractive with CBM/CMM projects likely to offer internal rate of return of the order of 25-40% meaning thereby that entire investment will be recovered within 2.5-4 years. With more experience of handling the drills it is expected that cost of gas well should come down to within 5 Crores making it possible to earn an IRR on the higher end of the range given above.

### **3.5 COMMENTS ON SPECIFIC ISSUES**

The report has already given the progress of each of the four objectives, output and activity and listed the achievement in each case and given its comments/ systematically in each case. Taking the para 4 & 7 of the scope of Terms of Reference, the comments on specific issues raised are as follows:.

#### **3.5.1 PROEJCT FORMULATION ( Rating: Marginally Satisfactory)**

It has already seen brought that there was not much fault in the project set up as such. This ‘Demonstration Project’ was intended to build national capabilities in the field of CBM recovery and utilization.

The objective, output and activities were clearly formulated, achievable. However there was a lack of details of the inputs:

- The project report mainly lacked essentials like list of equipment, their technical specifications and a description of equipment supply market i.e. it was ‘conceptual’ in nature.
- The costing of the project was very unrealistic – perhaps contributed somewhat by the gap of 4-5 year between project provision and actual ordering of equipment. Specification of training needs was also vague and insufficient in scope.
- It will be necessary to keep in mind the geological complexity of the area for making the choice of drilling technology (vertical/horizontal). For instance application of Inseam horizontal drilling technology in Sudamdih or for that matter any other complex area where we have friable strata, steeply dipping beds, heavily faulted strata may face difficulty and drilling operations will have to be planned and executed meticulously.
- There was lack of detailed time schedule for the various activities – though overall life of the project was fixed for 5 years. The late kick starting of the project, the induction of UNIDO and the drawl of specification took extremely long time – possibly due to lack of fixing suitable milestone for monitoring over the progress of the project.
- A project preparatory phase should have been allocated before start up of the project.
- Similarly with respect to delay in equipment procurement this evaluation team confirms the observation made by the mid term evaluation team that selection of UNIDO’s as procurement agency was a correct one but what made actual procurement time taking was UNIDO’S tendering and contracting process and procedure were too rigid to handle purchase of this type equipment. Particularly its inability to re-validate the tender bids after the tender period expired (120 days), lack of suitable money deposit, and the precondition of allowing start of the tender and contracting process only after it had received money in its bank account did result in delays.
- From the way the tender process moved to five rounds, it is obvious that more experienced was called for to handle procurement of specialized equipments needed. The non response by equipment suppliers further complicated the matter due to the fact of its being overwhelming sellers market. The evaluation team feels that a such a situation would have occurred no matter who the procurement agencies was. Offcourse it would be better that in future the UN System should not normally be involved in procurement of such specialized equipment.

### **3.5.2 PROJECT IMPLEMENTATION ( Rating: Satisfactory)**

- The biggest hurdle that the project faced was in the procurement of the equipment. The overall delay of 64 months from the start of the project to the start of first activity of drilling has already been explained elsewhere. Once the equipment arrived at the site the implementation was quick and satisfactory.
- The plethora of organizations involved in the project GEF, UNDP, UNIDO, GOI, MOC, CIL, CMPDI, BCCL, DGMS, CIMFR, ISMU, ONGC etc on



the one side and the suppliers of equipment on the other side across continents needed a complex project set up which has to our great satisfaction survived all the vicissitudes. Overall the operational relationships between the institution involved and others has remained cordial barring few exceptions with some equipment suppliers who played 'snakes & daggers' with UNIDO. By and large technical capabilities associated with the project were well absorbed by the field staff in India and improved considerably with 'on-job' experience.

- Though periodically monitoring committee met at the project level and at the national level, due to basic lacunae in the project report, there was continued period of 'fire fighting' throughout the project period. Due to this, the project completion date had to be deferred from 2004 to 2007 and then to 2008 without achievement of even the tasks laid out by the revised curtailed scope of the report. Mid-term evaluation normally scheduled for 2002 was also deferred to 2004 due the poor progress of the project on the ground. The monitoring system proved **Satisfactory** as it did bring out the problems timely to the notice of project officials which allowed them to respond effectively to put the project back on the rail.
- As far as the stake holders participation (Rating: **Highly Satisfactory**) was concerned all of them did their best vis-à-vis numerous problems that arose in the implementation of the project. Despite constraint of GEF/UNDP it was commendable to see that GOI came up with additional funds and manpower to overcome the hurdles and thus sustain the project to bring to its laid out goals/objectives
- As far as the financial planning is concerned it has already been stated due to various reasons including perhaps the time the first cost estimate was made in 1997 to the time orders for equipment purchased were being executed in 2005, a long time lapse of 6 -7 years was there which could have contributed to the cost estimates being found way below the actuals. With International contribution being frozen, the only way for the project to go ahead was by increased financial commitments by GOI to the project. Co-financing which was about 43% by GOI went up to 49% on the first revision of the project cost to INR 92 Crores in 2004 -05 and has further been estimated to go up to INR 124 Crores by 2010 with GOI share rising to 63% of the total project cost. Of course the bulk of the increased cost is meant to meet the manpower cost but a significant part is toward acquisition of additional equipment. The above figures speak on their own on financial planning. It is to be emphasized the project get time overrun, the cost element is difficult to keep down.
- Despite the fact that the project was a "demonstration project " and hence entailed lot of expenses that would not normally form part of a commercial project (such as training, laboratory upgradation, etc), the cost of electricity generation at Rs 4.23/Kw-hr is quite competitive to the commercial energy rate existing in India. With a fully commercial project this generation cost is likely to come down substantially. It is obvious that

CBM can sustain itself on its own. A quick estimate indicate that a CBM project can yield a high IRR of 25 – 40% indicating high profitability of exploiting CBM as a fuel source.

- As far as execution and implementation modalities are concerned, this team has little to state. Of the stakeholders tried their best in trying circumstances that this project faced. They all knew that the project was good for everybody but none knew the pitfalls that they have to face. Despite all the ups and downs none can deny that it has laid a solid foundation to enable the Indian coal industry to seize the opportunity of building up a CBM industry in the country. The biggest accolade goes to the International partners for coming forward to financially support the project and then to the local project personnel including GOI to make it a success. With the few remaining jobs to be completed there is no doubt the project will be a path breaking success.

### **3.5.3 OTHER SPECIFIC ISSUES ( Para 7 of Terms of Reference)**

- Vis-à-vis the expected situation at the end of the project, the main objective of the recovery of CBM and its commercial utilization at Moondih was fully achieved but at Sudamdih it could not be achieved despite best efforts and is likely to be achieved in 2009. Other objectives of the capability of planning, implementing and utilization have been fully achieved. India today can replicate such project.
- Due to rigid rules governing GEF on the budget, the project as such has to be fore closed with many objectives still to be achieved. Fortunately seeing the importance of the project to the country CIL, ONGC and GoI has come up with additional funds to complete the project by 2009 (or 2010).
- The policy impact of the project has been very positive. All the players in the coal/gas sector of the country are positive in their approach to CBM/CMM development. Already CIL is actively looking at extending the spread of CBM recovery to more areas under its control and so also the new coal block owners.
- We have already dilated the commercial viability of the project. With project authorities claiming cost of electricity generation of electricity at Rs. 4.23 per KWhr in this “Demonstration project” vis-à-vis commercial electricity supply rate of Rs. 4.50 per KWhr to BCCL, there is enough scope to bring down the cost of electric generation such that such project can yielded an IRR of 25-40%. With projected cost of INR 5 Crores per well, the IRR may touch the upper limit making the CBM project commercially very attractive, even more than mining projects. This scenario should lead in short term to creation of a new subsidiary within Coal India Limited (CIL) exclusively looking after the CBM/CMM recovery and utilization.

- Use of CBM recovery and utilization equipment for the first time at the country needed a lot of work to updating the safety regulation and equipment approval procedure. Constant interaction with DGMS at all stages, even training their executives abroad in USA has led to development of many new procedure and safety regulations which will make it easier for replication of CMM project. Involvement of CIMFR and ISMU to this is also to be noted.
- Methane being a very potent GHG, its emission control to atmosphere and utilization as fuel has a major relevance to climate change. Both national and international players have expressed interest in harnessing CBM and already 26 coal/lignite blocks in Indian coalfields has been allocated. Project is already influencing closer cooperation between Indian Public sector companies with ONGC and CIL joining hands in development of CBM in two blocks one each in Jharia and Raniganj Coalfields.
  - Assuming the gas recovery system at Moonidih and Sudamdih (7 vertical wells, 1 GOB well and 3 underground long holes) will produce 32,000m<sup>3</sup> of CH<sub>4</sub> per day is sufficient to generate 3.5 MW electricity this comes to about 11.5 MCM or 7626 tonnes of gas per year. This is equivalent to 160,151 tonnes of CO<sub>2</sub>. The simple burning of methane (flaring) would reduce annual GHG emission to 155,525t of CO<sub>2</sub> equivalent assuming all CH<sub>4</sub> otherwise would have escaped to atmosphere. Further if this gas is used as a fuel, this would lead further to annual CO<sub>2</sub> reduction of 180,000 tonnes of CO<sub>2</sub>. Alternately Diesel would have to be used. Thus overall CO<sub>2</sub> reduction could touch 340,151 tonnes per year for the whole project as envisaged in by the revised project targets.
  - Currently Moonidih is generating 500 KW of power since June'2008, consuming on an average 2000m<sup>3</sup> per day i.e. saving 10000te of CO<sub>2</sub> from going to atmosphere plus using 4500 m<sup>3</sup> per day of CMM gas for power generation contributes to saving of 4292 tonnes of CO<sub>2</sub> per year. Thus in last one year operation about 14290te of CO<sub>2</sub> per year has been saved. On increasing the power generation to 1 MW, this will double to about 28500te of CO<sub>2</sub>. Considering USD 20 per tonnes, CO<sub>2</sub> saved, the project though currently not entitled for carbon credit under CDM (due its funding from grant by GEF/UNDP and GOI) but otherwise the project would have already earned USD280,580 and would reach USD 561,060 per year when upgraded to 1 MW power generation capacity.
  - As far as the exit policy is concerned, a decision was taken to continue the project as GOI S&T project for completion of the remaining objectives of CBM project. A management committee (Fig. 2) constituted of the following for supervision, direction and control of the project:
    - i. Adviser (Projects), Ministry of Coal

- ii. CMD, CMPDI
- iii. CMD, BCCL
- iv. Director (Technical), CIL
- v. Officer In charge of CBM Project at CMPDIL to be nominated by CMD, CMPDIL.

The Director (Tech/RD&T), CMPDI has subsequently been nominated by the Management Committee to act as Nodal Officer.

The Committee thus constituted has been assigned the following responsibilities:

- i) The Committee shall develop yearly programme and review the status of projected activities on at-least quarterly basis and keep the Ministry informed.
- ii) Technical and commercial evaluation of the implementation of project and identification of areas requiring further attention.
- iii) Identification of location and replication of the technology for CBM extraction through departmental, JV or outsourcing mode in other areas of Coal India.
- iv) Suggesting of measures to be taken by the coal companies / government to improve extraction of CBM/CMM as an alternative source of energy from working mine area;
- v) To avail of services of expert as and when required for smooth implementation/continuation of the project. The expenses for availing the services of experts would be borne by BCCL as per the extant rules of the company;
- vi) To ensure proper manning of the project at all levels including drilling, extraction and distribution/utilization of CBM even at expanded scale.

The overall project set-up is depicted as per Fig 2. below:

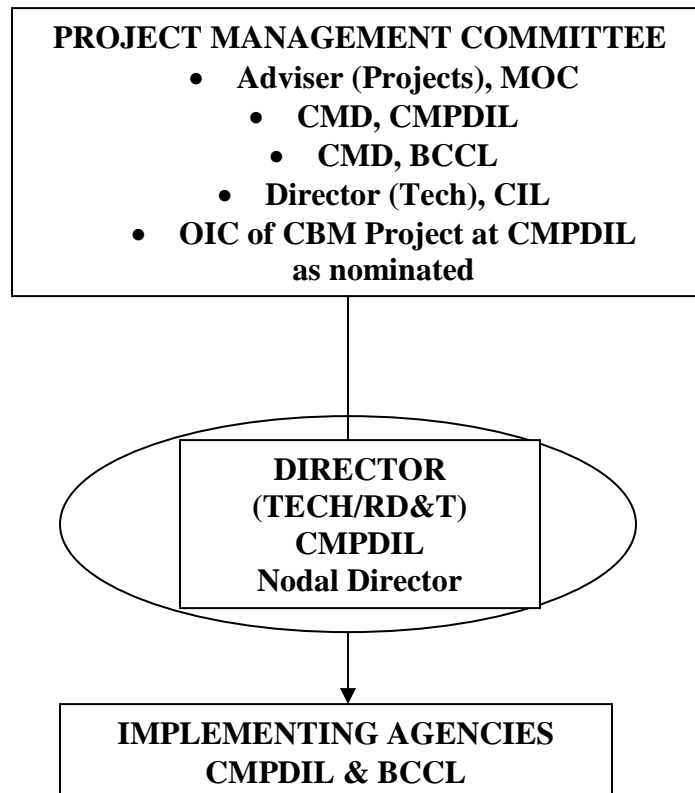


Figure 2: Implementation arrangement as S&T project beyond December, 2008

- As far as information dissemination activities are concerned a Clearing House has been established at CMPDI (HQ) at Ranchi. Further to ensure its smooth growth a collaboration agreement has been signed with United States Environmental Protection Agency, which will provide necessary guidance/assistance to the officials of the clearing house for the period 2009-11.
- Finally as far as the wider impact of the project on national level in terms of power is concerned, harnessing of this additional energy source will obviously contribute to increased availability per capita of energy of the local population. It is well known that availability of commercial energy is important trigger to faster economic development and hence a better living standard.

#### **3.5.4 SOCIAL IMPACT ASSESSMENT**

Besides environmental benefits and providing clean additional source of energy one of the major priorities of UNDP/GEF for the projects funded by them are the social benefits such as employment generation, poverty alleviation and other social benefits that is passed on to the people at local, regional and national level. The Moonidih CBM project is one of such projects where in funds have been provided by GEF/UNDP and it is for this reason the social impact of this project is elaborated below:

- It has to be borne in mind that Moonidih CBM project is still in the nascent stage and it will be rather premature to expect spectacular impacts at this stage. But the silver lining in the horizon is quite clear. When the project attains the desired goal it is bound to generate additional power and resultant additional employment opportunities & social benefits in not too distant future. Also CBM gas surplus to power generation can be marketed for domestic use locally as is being done by GEECL in Raniganj coalfield creating business and job opportunities at local level.
- But even if we look to what the project has achieved even at this stage there is enough to rejoice. It has brought valuable smile in hundreds of faces in Moonidih who now enjoy uninterrupted power supply and good voltage in their homes. In this connection some workers selected from hundreds of those who now get power supply from CBM project were interviewed by the consultants on 14.05.2009 at Moonidih project site. The finding of talk held is mentioned herewith for information.

1<sup>st</sup> Beneficiary:

Name – Shivanand Ram, Age 38 years,

Filter Mechanic, 16, D.M. Colony

Mr Ram stays in the colony with his wife and two children.

2<sup>nd</sup> Beneficiary:

Name - Satyanarayan Prasad, Age 42 Years  
Electrician  
A-36, CPP Colony  
Mr Prasad stays in the colony with his wife and two children.

3<sup>rd</sup> Beneficiary:

Name – Jamal Khan, Age 48 years  
Qr. No. 22, D.M. Colony  
Mr. Jamal Khan has three daughters and one son besides his wife staying in the colony.

4<sup>th</sup> Beneficiary:

Name – Amrit Lal Bauri, Age 39 years  
Foreman,B- 28 CPP Colony  
Mr Bauri stays with his wife and two children.

The face of all the workmen brightened when asked as to how they felt about the CBM project light they were enjoying. They expressed their extreme happiness to get uninterrupted power supply and good voltage all the time. This light helped their family immensely in cooking, enjoying T.V/Radio programmes and other domestic work. Most importantly their children are able to give more time for their studies and home work. All the interviewed worker were thankful to the project for this facility (CBM power) and that all sang in unison that more such projects should come up and light up other homes else where also.

The team was particularly amazed to know the awareness of the Beneficiaries about the environmental benefits of CBM power.

It may also be incidentally mentioned that the CBM project at Moonidih was officially inaugurated by the Union Minister of State for Coal (Independent charge) on 26.06.2009 who has lauded the coming up of this project and availability of additional clean source of energy from the project. Some photographs taken while interview of power beneficiaries at Moonidih was being taken by the consultants are placed herewith along with News clipping appearing in Telegraph, Jharkhand dated 27.06.2009 following up Minister inauguration of CBM power for industrial use on 26.06.2009.

**PHOTOGRAPHS OF BENEFICIARIES OF CBM PROJECT WHOSE INTERVIEW WAS TAKEN BY CONSULTANTS.**



News Clipping on CBM Project, Moonidih as appearing in Telegraph, Jharkhand, dated 27.06.09

## Jaiswal Flags off Methane Project

Union Minister of state, Independent charge, Coal, Sri Prakash Jaiswal today officially inaugurated the coal bed methane (CBM) project of Bharat Coking Coal Limited (BCCL) at Moonidih in Dhanbad.

The electricity generated by the Moonidih plant will be used to supply water from Kapalghat area to the different colonies of BCCL workers. For the past one year, the plant had been supplying electricity to light up houses of more than 300 coal workers on a trial basis.

Jaiswal also laid the revival stone of the captive power plant in the colliery that has the capacity to generate 20MW electricity. This plant is unique in the sense that it uses the wastes of coal washery to produce electricity. It had been functioning for a long time but remained closed due to a number of reasons for about a decade.

Speaking on the occasion, Jaiswal said that CBM could prove to be an important source of energy.

“The development of the country cannot take place without energy”, said Jaiswal, adding that the project could also a play a pivotal role in helping BCCL make up its losses.

Speaking about the goals that the central government has set for itself, he said that massive industrialization is one of the priorities.

“After the Lok Sabha election, the government has emerged stronger and no injustice or atrocity of any type will be tolerated anywhere in the country”, Jaiswal warned.

This was Jaiswal’s maiden visit to the state after being elected to the Lok Sabha recently.





## **4.0 OBSERVATIONS & RECOMMENDATIONS**

- 4.1** In the era of scarce energy resources vis-à-vis the demand of the growing population and rapid industrial development in the country this project has brought to the fore an additional clean fuel resources which has the potential to contribute significantly to the energy basket of the country. The initiative taken by the GoI in collaboration with GEF/UNDP for taking up this project of Coalbed Methane (CBM) recovery and commercial utilization appear to be an outstanding thing to happen in Global efforts to mitigate the GHG and resultant environmental degradation.
- 4.2** Despite substantial delays the project has been extremely successful in achieving the laudable objective of utilizing this clean source of energy with all round benefits in terms of improving the safety, efficiency and economics of mining operations concurrent with environmental benefits.
- 4.3** The project has brought to the country state-of-art technology for planning and execution of such projects in Indian conditions.

It is expected that this project will be a fore runner in generating useful data on CBM recovery and utilization besides imparting experience and confidence in Private and Public investors in India to replicate such projects for gassy underground mines and substitution of coal & diesel by utilization of CBM in its place.

It may be mentioned that during discussions at Delhi on 11<sup>th</sup> May 2009, MOC has confirmed that they would continue to have such projects in future also.

CMPDI the main implementing agency along with the partner BCCL should continue the CBM project in Moonidih, and other parts of Jharia Coalfield such as Jarma, Singra etc.

- 4.4** The project has suffered long delays due mainly to under provisioning in the budget which had to be met by downsizing the requirements of the project equipments and work programmes requiring repeated modifications in the project profiles. This necessitated fresh approvals and consequent delays. It is certainly not the intention to criticize and find faults with the Project Report of UNDP/GEF consultants. On the contrary consultants analysis of the project details indicate that provisions of equipments was rightly made in the PR. The only thing that possibly missed was providing a mechanism for cost escalation in the event of delay in procurement for a highly specialized niche of equipments in India .

Project Report had rightly made provisions for 02 vertical and 02 horizontal drills for the project. These were reduced to 01 in each case due to fund crunch. It is felt that availability of the same numbers of drills provided in the P.R. would have definitely helped in faster execution of the drilling programme and the CBM Project activities.

The project report does appear to be a conceptual type. A follow up detailed exercise would have helped. Possibly sufficient time was not available to International consultants to draw out detailed technical specifications, realistic procurement schedule, cost of equipments and world market scenario of availability of equipments and commissioning in Indian conditions.

**4.5** The choice of appointing UNIDO as a procurement agency though done in the best interest of the project because of their world of experience, in this case proved in retrospect a major constraint. The procurement procedure of UNIDO was found to be quite rigid and at times inadequate to face the threats and challenges of prevailing international sellers market. The absence of penal provisions in UNIDO rules to bring to book errant and defaulting bidders has been a serious handicap in procurement process. Bidder have even backed out after making supply commitments and remained scot-free in absence of provisions asking Bank Guarantee/Earnest money etc from them. Also suitable price escalation and flexibility in tender processing would have helped in price negotiation process and equipment procurement. The team earnestly hopes that UNIDO will take these suggestions positively.

**4.6** During discussions with ONGC officials at Bokaro it was gathered that they are facing considerable difficulty in acquiring land for each CBM well (1 hectare land required per CBM borehole). This is primarily due to inflated claims of compensation and job by several persons who did not even possess ownership title of plot. Relevant details of ownership were not even available in the government records. The problem of payment of compensation intensifies in laying pipe lines and approach road construction where in several plot of land are involved.

They were of the view that horizontal, surface to inseam multilateral under balanced drilling, CBM well can substantially reduce the land acquisition problem besides giving following other advantage:

- 1) No hydraulic fracturing
- 2) Higher well productivity rate which could be 10 to 20 times more than the rate of conventional vertical wells.

The consultants feel that while surface drilling of boreholes could continue, the technology of horizontal multi lateral boreholes should also be simultaneously perfected along with that of surface drilling of boreholes.

**4.7** While excellent work is already being done by CMPDI in implementing CBM well drilling at Moonidih it may further help if services could be acquired of a consultant who has wide experience of planning and management of exploration projects in Jharia coalfield. He should have intimate knowledge of CBM occurrence in Jharia coalfield and elsewhere also for identifying future CBM/CMM potential blocks for exploration in Indian coalfields.

**4.8** CBM operations should be continued in other blocks of Damodar Valley coalfields and other coalfields of India with the objective of replication of this technology and generating enough power for coal mining operation by CIL. One

could possibly look for eventual establishment of a separate company within CIL to look after the interest of CBM development in coalfields, under CIL command.

- 4.9** In terms of providing fund in the Project Report for Training of the Personnel, it is felt that the right policy would have been to expose a few selected personnel to long and detailed training to make these selected personnel sufficiently competent to train other in operational work for efficient implementation of the project has given on the job training to executives and non-executives of CMPDI/BCCL to implement such projects elsewhere also.
- 4.10** It has also substantially upgraded the course study for CBM studies in the Indian School of Mines University. The capabilities of CIMFR has also been substantially improved to carry out laboratories studies and testing on much greater scale than that existed before CBM project under review was taken up. The progress achieved by ISMU in developing advance courses on CBM and by CIMFR in developing modern laboratory facilities for determining in-situ gas content, permeability and porosity of borehole cores and construction of adsorption isotherms, (all these tests being required for determining CBM potentiality). These have generally been an outcome and bear close relationship with the CBM project under implementation at Jharia coalfield. These are welcome steps and the endeavor should be to strive for additional capacity build up for testing and technology upgrading by CIMFR. During discussions with CIMFR officials on 15.05.2009 at Dhanbad it has been assured by them that Adsorption Isotherm apparatus which was originally scheduled to be procured in October, 2000 would be procured in next 2-3 months.
- 4.11** After executing the drilling programme as envisaged now the gas production of 21000 - 24500 M<sup>3</sup> per day at Moonidih and 3000 M<sup>3</sup> per day at Sudamdih (as against earlier 10-12000 cum) will be achieved. These together will total to around 24000 - 27500 M<sup>3</sup> per day against the present planned use of 9000 - 10000 M<sup>3</sup> per day for 1 MW generation at Moonidih and that of 3000 M<sup>3</sup> per day at Sudamdih totaling to around 13000 M<sup>3</sup> per day. This will imply that alternative use of surplus CBM will have to be thought off by installing more generating capacity and or by marketing the gas for other usages. Outsourcing the marketing to a suitable agency can be considered for the purpose
- 4.12** A detailed flow chart of all project activities indicating clear time frame for all activities should be drawn after full analysis of target vis-à-vis technological, manpower (including specifically trained) and budget requirements. This has to be prepared taking into the account the likely constraints and solutions thought off. The completion of activities should be monitored and flow chart updated accordingly
- 4.13** UNIDO has indicated that the supplier of the Steering tool M/s RSS, UK is highly unreliable. This company has proposed the cost sharing for Directional drilling expert during installation and re-commissioning of the steering tool along with underground drilling unit. The underground drilling has already suffered tremendously due to delayed supply and repeated failure of steering tool during

commissioning at mine. It is felt that there is no point in waiting any longer. Instead CBM Project should take action to procure another tool from internationally reputed manufacturer with adequate implementation and training safe guard.

## 5.0 LESSONS LEARNT

- The project has come at very appropriate time when world is clamoring for measures to check climate change. CH<sub>4</sub> a powerful GHG, released due to mining into atmosphere, if captured and utilized would act as an energy source and reduce global warming and mining hazard in underground mines.
- Successful completion of project at Moonidih has enhanced the national capability of CBM/CMM recovery technology and brought it at par with international practices. The data generated by the project has clearly established that CMM recovery from Indian coal basin is commercially possible in a viable and profitable manner.
- Upgrading of lab facilities at CIMFR Dhanbad and skill of the scientific personnel at CIMFR and CMPDI has provided the mechanism for testing of coal cores in the country and predicting gas in place & reservoir in model for taking investment decision in large scale CBM/CMM recovery and utilization projects. Induction of CBM as a subject in ISMU will provide know how for geologists/engineers to explore and exploit CMM in advance of coal mining.
- The constraint faced by the project has brought to the fore the pit falls to be avoided while formulating future projects. Provision for a detailed project report, detailed design, specification of equipment list of supplier, proper time schedule with major milestone cleared highlighted is a must. Mechanism for budget revision particularly over long gestation project, adoption of even-handed procurement procedure while remaining open and fair but requiring suitable penalty clause for non-serious suppliers.
- A greater emphasis on in-house training of the personnel with assistance of equipment suppliers will be key factor in faster expansion of the technology in India.

## **6.0 LIST OF ANNEXURE**

- I. Terms of Reference
- II. Itinerary of the Evaluation Mission
- III. List of Document Referred
- IV. Updated status of CBM Recovery Equipment Procurement (As per Completion Report of CMPDI)
- V. Updated details of Co-funding in GEF format
- VI. Revised Cost Estimate 2009, including Details of Expenditure up to December'08.
- VII. Details of Advanced updated Course Studies on CBM Adopted by ISM, Dhanbad.
- VIII. Details of the Upgraded laboratory and other Facilities Available as of Now.
- IX. Details of Computation of Power Generation Cost

**TERMS OF REFERENCE FOR TERMINAL EVALUATION  
UNDP/GEF PROJECT 00012918 (IND/98/G34)  
COALBED METHANE RECOVERY AND COMMERCIAL UTILIZATION**

**SCOPE OF THE EVALUATION – SPECIFIC ISSUES TO BE ADDRESSED**

The scope and outline of the evaluation is as follows:

**1. Executive summary**

- Brief description of project
- Context and purpose of the evaluation
- Main conclusions, recommendations and lessons learned

**2. Introduction**

- Purpose of the evaluation
- Key issues addressed
- Methodology of the evaluation
- Structure of the evaluation

**3. The project(s) and its development context**

- Project start and its duration
- Problems that the project seek to address
- Immediate and development objectives of the project
- Main stakeholders
- Results expected

**4. Findings and Conclusions**

In addition to a descriptive assessment, all **criteria marked with (R) should be rated** using the following divisions: Highly Satisfactory, Satisfactory, Marginally Satisfactory, Unsatisfactory

**4.1. Project Formulation**

- Conceptualization/Design (R). This should assess the approach used in design and an appreciation of the appropriateness of problem conceptualization and whether the selected intervention strategy addressed the root causes and principal threats in the project area. It should also include an assessment of the logical framework and whether the different project components and activities proposed to achieve the objective were appropriate, viable and responded to contextual institutional, legal and regulatory settings of the project. It should also assess the indicators defined for guiding implementation and measurement of achievement and whether lessons from other relevant projects (e.g., same focal area) were incorporated into project design.
- Country-ownership/Driveness. Assess the extent to which the project idea/conceptualization had its origin within national, sectoral and development plans and focuses on national environment and development interests.
- Stakeholder participation (R) Assess information dissemination, consultation, and “stakeholder” participation in design stages.

- Replication approach. Determine the ways in which lessons and experiences coming out of the project were/are to be replicated or scaled up in the design and implementation of other projects (this also related to actual practices undertaken during implementation).
- Other aspects to assess in the review of Project formulation approaches would be UNDP comparative advantage as IA for this project; the consideration of linkages between projects and other interventions within the sector and the definition of clear and appropriate management arrangements at the design stage.

## 4.2. Project Implementation

- Implementation Approach (R). This should include assessments of the following aspects:
  - (i) The use of the logical framework as a management tool during implementation and any changes made to this as a response to changing conditions and/or feedback from M and E activities if required.
  - (ii) Other elements that indicate adaptive management such as comprehensive and realistic work plans routinely developed that reflect adaptive management and/or; changes in management arrangements to enhance implementation.
  - (iii) The project's use/establishment of electronic information technologies to support implementation, participation and monitoring, as well as other project activities.
  - (iv) The general operational relationships between the institutions involved and others and how these relationships have contributed to effective implementation and achievement of project objectives.
  - (v) Technical capacities associated with the project and their role in project development, management and achievements.
- Monitoring and evaluation (R). Including an assessment as to whether there has been adequate periodic oversight of activities during implementation to establish the extent to which inputs, work schedules, other required actions and outputs are proceeding according to plan; whether formal evaluations have been held and whether action has been taken on the results of this monitoring oversight and evaluation reports.
- Stakeholder participation (R). This should include assessments of the mechanisms for information dissemination in project implementation and the extent of stakeholder participation in management, emphasizing the following:
  - (i) The production and dissemination of information generated by the project.
  - (ii) Local resource users and NGOs participation in project implementation and decision making and an analysis of the strengths and weaknesses of the approach adopted by the project in this arena.
  - (iii) The establishment of partnerships and collaborative relationships developed by the project with local, national and international entities and the effects they have had on project implementation.

(iv) Involvement of governmental institutions in project implementation, the extent of governmental support of the project.

- Financial Planning: Including an assessment of:
  - (i) The actual project cost by objectives, outputs, activities
  - (ii) The cost-effectiveness of achievements
  - (iii) Financial management (including disbursement issues)
  - (iv) Co-financing
- Sustainability. Extent to which the benefits of the project will continue, within or outside the project domain, after it has come to an end. Relevant factors include for example: development of a sustainability strategy, establishment of financial and economic instruments and mechanisms, mainstreaming project objectives into the economy or community production activities.
- Execution and implementation modalities. This should consider the effectiveness of the UNDP counterpart and Project Co-ordination Unit participation in selection, recruitment, assignment of experts, consultants and national counterpart staff members and in the definition of tasks and responsibilities; quantity, quality and timeliness of inputs for the project with respect to execution responsibilities, enactment of necessary legislation and budgetary provisions and extent to which these may have affected implementation and sustainability of the Project; quality and timeliness of inputs by UNDP and GoC and other parties responsible for providing inputs to the project, and the extent to which this may have affected the smooth implementation of the project.

#### 4.3. Results

- Attainment of Outcomes/ Achievement of objectives (R): Including a description *and rating* of the extent to which the project's objectives (environmental and developmental) were achieved using Highly Satisfactory, Satisfactory, Marginally Satisfactory, and Unsatisfactory ratings. If the project did not establish a baseline (initial conditions), the evaluators should seek to determine it through the use of special methodologies so that achievements, results and impacts can be properly established.
- This section should also include reviews of the following:
  - Sustainability: Including an appreciation of the extent to which benefits continue, within or outside the project domain after GEF assistance/external assistance in this phase has come to an end.
- Contribution to upgrading skills of the national staff

#### 5. Recommendations

- Corrective actions for the design, implementation, monitoring and evaluation of the project
- Actions to follow up or reinforce initial benefits from the project



- Proposals for future directions underlining main objectives

## 6. Lessons learned

This should highlight the best and worst practices in addressing issues relating to relevance, performance and success.

## 7. Evaluation report Annexes

- Evaluation TORs
- Itinerary
- List of persons interviewed
- Summary of field visits
- List of documents reviewed
- Questionnaire used and summary of results
- Comments by stakeholders (only in case of discrepancies with evaluation findings and conclusions)

In addition to elaborating on the categories listed in Item III, the evaluation team should also comment upon the following specific issues:

- Report on the progress against each Objective, Output and Activity (including sub-activities) listed in the project document. How far the project has met with the overall objectives and how will these be completed beyond the life of the project, i.e. 31 December 2008. The indicators in the logframe should be used for assessing the progress;
- On Page 7 of the Project Document is listed the “Expected Situation at the end of the Project”. A commentary is required on this;
- Policy impact of the project, if made, on the Coal Mine Methane and Coal Bed Methane sector, including any change in decision making at the MoC level, if any happened. Whether offering the CBM blocks by MoC is in continuation/ or as a result of this project;
- Equipment procurement being a major component of the project, a commentary may be provided on the equipment selection, the global equipment scenario and the adequacy/inadequacy of the equipment budget, if any;
- Comments on the processes/procedures explaining delays in procurement of equipment;
- Comment on the “Exit Policy” of the project and how the future administrative arrangements will be in place for completion of remaining activities once GEF and UNDP funding is withdrawn beyond 31 December 2008;
- Enabling ground created as a result of this project for CBM replication in the country, including interest shown by the private sector, if any.
- Comments on the Commercial viability of the CBM recovery and utilization and how the scenario looks like (with or without the project). A data generated by the project authorities in the form of Project Completion Report needs to be validated.

- Enabling conditions created as a result of the project for new safety protocols/ standards established/land-marks crossed, if any. If any equipment clearance procedures by Director General Mine Safety have been simplified as a result of project intervention;
- Comments on how the GEF's overall objective of Greenhouse Gases Emission reduction will be met with – (1) during the life of the project; and (2) for the replication potential. A data generated by the project authorities through the Project Completion Report needs to be validated;
- Capacity building generated, the approach adopted, and its impact on the sector – for replication or otherwise, including the confidence level of Implementing Agencies to handle the unfinished agenda of the project and to carry on replication activities;
- Trainings received and its impact;
- Problems of the project, if any, relating to project budget, equipment listing/ surveying, adequacy of training budget;
- Appropriateness of the institutional arrangement and whether there was adequate commitment to the project. Will the project be sustainable on its conclusion?
- Utilization of resources (including human and financial) towards producing the outputs and adjustments made to the project strategies and scope;
- Amount of co-funding (GoI, UNDP and others) and its impact on the activities;
- Comments on Information dissemination activities undertaken for the development and benefit of the sector, including establishing the Clearing House and Library and the role played by the stakeholders in the project.
- The team is expected to write and include a Success Story (not more than two pages) after interacting with the mining community, beneficiaries/ beneficiary organizations that can be useful for the advocacy purposes.

**Cross Cutting Issues:**

Considering that UNDP is concerned about poverty reduction, local governance and promotion of gender equity, the team may look at these cross-cutting issues and comment if the project had any linkages and any achievement on these objective has been through.

The team is free to include any other additional comments that are felt worth reporting.

**ITINERARY OF THE EVALUATION MISSION**

10.05.2009

- Departure of Dr. R. P. Verma from Ranchi and arrival at Delhi Airport by Flight No. IC 810

11.05.09

- Joined by Dr. M. M. Seam at Delhi.
- Meeting with Mr. S. N. Srinivas Programme Officer and Anil Arora, Asstt. Programme Officer, UNDP
- Meeting with Mr. N. N. Gautam, Project Advisor-CBM
- Meeting with Mr. Pankaj Srivastava, M & E Analyst, UNDP
- Meeting with Mr. Philipe Scholtes, Regional Director & Representative, UNIDO
- Meeting with Dr. S. P. Seth, Special Secretary, MOC, & National Project Director
- Mr. P. R. Mondal, Advisor (Projects), MOC

12.05.09

- Departure from Delhi & Arrival at Ranchi by Flight IC 809
- Meeting with 1) Mr. A. K. Dhar, Chief Project Manager, CBM Project 2) Mr. Rajiw Lochan, Suptdg. Geologist, CBM Project, 3) Mr. R. N. Sur, Finance Manager, CBM Project.

13.05.09

- Departure from Ranchi for Dhanbad
- Meeting with 1) Mr. C. K. Prasad, Group GM & Project Manager, ONGC 2) Mr. Chakravarti, CE (Drilling), ONGC, 3) Mr. Partho Sen, Chief Geologist, ONGC. 4) Mr. Shafi, SE (Production), ONGC
- Visit to ONGC'S workshop of Hydro-fracturing & Cementation Units

14.05.09

- Visit to Moonidih Project & meeting with 1) Mr. R. K. Nigam, GM, Moonidih, 2) Mr. P. Kumar, Nodal Officer, CBM Project, Moonidih, 3) Mr. Shambhu Prasad, Suptdg. Engineer (Drilling), Nodal Officer, CBM Project BCCL, 4) Chief Surveyor & other staff of Moonidih Project.
- Visit to CBM well sites.
- Visit to CBM based Generator Station at Moonidih
- Interviewing of following 4 workmen of Moonidih to illicit their views on CBM power supply arrangement at Moonidih:
  - Shivanand Ram, No. 16, D. M. Colony
  - Satya Narayan Prasad, Electrician, A-36, CPP Colony
  - Mr. Jamal Khan, Qr. No. 22, D.M. Colony
  - Mr. Amrit Lal Bauri, Foreman, Qr. No. B-28, CPP Colony

15.05.09

- Meeting with Prof (Dr.) Atul K Varma, Deppt. Of Applied Geology, ISMU
- Meeting with
  - 1) Dr. Amlendu Sinha, Director, CIMFR
  - 2) Dr. A. K. Singh, Scientist and Head, Methane Emission and Degasification
  - 3) Dr. V. A. Mendhe, Scientist (CBM/ Coal Geology), CIMFR
  - 4) Dr. Harendra Kr. Singh, Scientist, CIMFR

- Meeting with Mr. R. B. Chakravarti, Dy. DG (Central Zone), DGMS
- Meeting with Mr. Rakesh Sinha, Director (Tech/Operations), BCCL

16.05.09 (Saturday)

Reporting and departure from Dhanbad & arrival at Ranchi

17.05.09 (Sunday)

Reporting & departure of Dr. MM Seam from Ranchi by Flight No. IC 810 and arrival at Delhi

26.05.09

- Arrival of Dr. M. M. Seam at Ranchi from Delhi by Flight No. IC 809
- Joined by Dr. R. P. Verma at Ranchi
- Meeting with 1) Mr. A. K. Dhar, Chief Project Manager, CBM Project 2) Mr. Rajiw Lochan, Suptdg. Geologist, CBM Project & 3) Mr. R. N. Sur, Finance Manager, CBM Project.

27.05.09

- Meeting with Mr. A. N. Sahay, Director (Tech/RD&T), CMPDI, Ranchi.
- Discussions & Preparation of Report with CBM Project officials at CMPDI, Ranchi continued.

28.05.09

- Meeting with Mr. A. K. Singh, Chairman-cum-Managing Director, CMPDI
- Reporting continued.

29.05.09

- Reporting continued.
- Departure of Dr. M. M. Seam from Ranchi on 29.05.09 by IC 810 for Delhi.

30.05.09 to 06.06.09

- Independent home based reporting by Dr. MM Seam at Delhi and Dr. RP Verma at Ranchi

07.06.09 (Sunday)

- Arrival of Dr. MM Seam from Delhi to Ranchi by Flight IC 809
- Joined by Dr. R. P. Verma at Ranchi

08.06.09

- Discussions and Preparation of Report with CBM Project officials at CMPDI, Ranchi

09.06.09

- Discussions & Preparation of Draft Report at CMPDI, Ranchi continued.

10.06.09

- Finalization of Draft Report at CMPDI, Ranchi.
- Departure of Dr. M. M. Seam from Ranchi by IC 810 for Delhi.

11-12.06.09

- Continuation of Draft Report Formulation by Dr. Seam at Delhi and Dr. Verma at Ranchi

16-18.06.09

- Finalization of the Draft Report by Dr.Seam at Delhi and Dr. Verma at Ranchi and its submission to UNDP

26 & 29.06.09

- Dr. Verma visited CMPDI for work on Social Impact Assessment

30.06.09 – 04.07.09

- Finalization of the Final Report by Dr.Seam at Delhi and Dr. Verma at Ranchi.

10.07.09

- Submission of Final Report



**LIST OF DOCUMENTS REVIEWED**

1. Project Report No. IND/98/G34/A/1 G/A/1 G/99 of UNDP/GEF on Coalbed Methane Recovery and Commercial Utilization.
2. TOR
3. Mid Term Review Report of the UNDP/GEF Project IND/98/G34 : Coalbed Methane Recovery and Commercial Utilization by JHA Van Don Akker, International Consultant & A. K. Dube, National Consultant (Final Version – 17xi.04)
4. Completion Report on UNDP/GEF/GoI (Project No. IND/98/G-34 & MT/S&T/CE-27 on Coalbed Methane Recovery and Commercial Utilization.
5. Mandatory Guidance & Evaluators of UNDP Programme
6. Minutes of the National Steering Committee Meetings
7. Minutes of Tripartite Review Meeting – UNDP/GEF Project IND/98/G34 held at New Delhi on 11<sup>th</sup> Dec.'2000.
8. Minutes of Tripartite Review Meeting – UNDP/GEF Project IND/98/G34 held at New Delhi on 11<sup>th</sup> Dec.' 2002.
9. Highlight of CBM Project for the year 2008-09 (prepared by CMPDI)
10. Progress Report of UNDP/GEF/GoI CBM Project for the month of November'2008 to May'2009.
11. CMPDI Director's Report on UNDP/GEF/GoI CBM Project for 2008-09
12. Minutes of 1<sup>st</sup> meeting of the UNDP/GEF/GoI CBM Project Management Committee held on 21<sup>st</sup> April'09 at BCCL, Dhanbad.
13. UNDP, New Delhi Mission Report Summary dated 28.11.08 by Mr. Anil Arora for the period 16.11.2008 to 20.11.2008

## ANNEXURE-IV

### Updated Status of CBM Project Equipments Procurement (as per CBM Project Completion Report)

#### 1.0 Procurement of **Surface Vertical well CBM recovery** equipment by procurement agency UNIDO and services by CMPDI

Pkg No	Equipment	Original Date of procurement	Date of supply	Original Budget	Final Cost (US\$)	Remarks
11	Vertical Drill Rig Unit	Oct'2000	August, 2004	2,309,076	2,241,821	Commissioned in Sept 2005
12A	Drill Collars & Stabilizers	Oct' 2000	January, 2005	267,535	139,487	
12B	Drill Pipes	Oct' 2000	April, 2005		278,427	
13	Drill Bits	Oct' 2000	January, 2005	130,000	126,181	
17	Cementation Unit	Oct' 2000	June, 2003	880,600	880,600	Commissioned in Dec'2003
18	Casing	Oct' 2000	May, 2005	185,600	180,199	
19	Geophysical Logger	Oct' 2000	October, 2007	651,700	2,948,936	Services hired USD344,913 paid by UNIDO, balance borne by CIL
20	Hydro-fracturing Unit	Oct' 2000	June, 2003	4,359,254	4,359,254	Commissioned in Feb'04
21	Pumping Units	Oct' 2000	November, 2005	540,000	524,323	Commissioned in June/Oct'08
22	Well Head & Frac Valve	Oct' 2000	June, 2003	105,727	105,727	

#### 2.0 Procurement of **Underground Long hole CMM recovery** equipment by procurement agency UNIDO

Pkg No	Equipment	Orig. Date of procurement	Date of supply	Original Budget (US\$)	Final Cost (US\$)	Remarks
1	Long Hole Drill Unit	Jan'2001	February, 2006	927,000	9,25,885	Functionality test done in December, 2007
3	Down hole motor	Jan'2001	October, 2005	82,400	99,537	
4A	NQ Drill Rods & Accessories	Jan'2001	November, 2007	70,257	70,257	
4B	Steering Tool & Accessories	Jan'2001	June'08	360,500	416,489	Commissioning attempted in July'08 and September'08 without any success
5	Drill Bits	Jan'2001	August, 2002	18,100	18,100	
9	Production Equipment Accessories	Jan'2001	October, 2005	85,900	79,291	



### 3.0 Procurement of **Lab equipment** by procurement agency UNIDO

Pkg No	Equipment	Orig. Date of procurement	Date of supply	Original Budget US\$	Final Cost US\$	Remarks
23	Echo meter	October, 2000	Dec' 2002	21,057	20,444	
25	Whole Core Permeameter	October, 2000	June, 2003	153,574	153,574	
26	Equilibrium Moisture Apparatus	October, 2000	January, 2003	10,914	10,595	

### 4.0 Procurement of **Lab equipment** by procurement agency CIMFR

Pkg No	Equipment	Orig. Date of procurement	Date of supply *	Original Budget US\$	Final Cost US\$	Remarks
35	Adsorption Isotherm Apparatus Unit	October, 2000		94,584	84,584	Ordering under process

\* During discussion with CIMFR on 15<sup>th</sup> May, 2009 it has been confirmed that the equipment shall be procured in the coming 2 – 3 months.

Equipments	Original Date of procurement	Date of supply	Original Budget US\$	Final Cost US\$	Remarks
Mobile field desorption Lab	October, 2000	November, 2005	35,000	18,576	Running
Gas Chromatograph	October, 2000	November, 2005	16,900	16,779	Running

### 5.0 Procurement of **Utilization equipment** by procurement agency UNIDO

Pkg No	Equipment	Orig. Date of procurement	Date of supply	Original Budget (US\$)	Final Cost (US\$)	Remarks
6A	Gas Control Units	January, 2001	June'08 (for vertical well)	230,000	277,866	Dec'08 (for Underground well)
6	Surface Exhausters	January, 2001	October, 2002	145,252	145,252	Part supplied & thereafter party went bankrupt
Pkg No	Equipment	Orig. Date of procurement	Date of supply	Original Budget (US\$)	Final Cost (US\$)	Remarks
7	HDPE Pipes	April, 2002	Dec'2004	165,000	160,208	
8	Fusion Machine	April, 2002	March, 2007	48,250	47,810	Commissioned in May, 2007
10	Safety System	January, 2001	October, 2005	26,900	27,122	
24	Gas Gathering Collection System	October, 2000	October, 2005	47,500	41,446	

6.0 Procurement of **Utilization equipment** by procurement agency CMPDI

Equipments	Original Date of procurement	Date of supply	Original Budget (INR)	Final Cost (INR)	Remarks
Gas Based Power Generators	March,2002	August, 2007	140,00,000	187,54,000	
Gas Compression and Refueling Unit with Dispenser	June, 2002	March, 2008	144,00,000	96,68,000	
Gas based engine trucks/ Conversion kits	July, 2002	December,2008	82,00,000		Under tendering

## ANNXURE- V(A)

## Financial Planning Co-financing

Co financing (Type/Source)	IA own Financing (mill US\$)		Government (mill US\$)		Other*			Total (mill US\$)		Total Disbursement (mill US\$)	
	Planned	Actual	Planned	Actual	Agency	Planned	Actual	Planned	Actual	Planned	Actual
- Grants	ONGC CIL	2.699 0.30	5.714	5.714	GEF UNDP	9.198 1.210	9.198 1.210	18.082	20.82		18.11
- Loans / Concessional (compared to market rate)											
- Credits											
- Equity - Investments											
- In kind support											
- Others											
Total		2.999	5.714	5.714		10.408	10.408	18.082	20.82		18.11

														<b>ANNEXURE V(B)</b>	
<b>Revised Cost Estimate 2009</b>														<b>Summary 2009</b>	
Source	Estimates as per RCE (June'04)		Existing Expenditure up to Dec'08		Balance		Additional Provision beyond Dec'08 & upto Dec'09	Estimates RCE Dec'08 upto Dec'09	Variance RCE Dec'08 (up to dec'09)	Overall Varinace to dec'09 due to					
Annexure References of the respective columns														Annexure II	
A	B	C					F	G	I=G-B						
	in Rs. Crs.	in Equivalent mUSD	in Rs. Crs.	in Equivalent mUSD	in Rs. Crs.	in Equivalent m USD	in Rs. Crs.	in Rs. Crs.	in Rs. Crs.	in Rs. Crs.	Escalation	Change In Scope/Addition	Exchange Rate Variation	Deletion	
A	UNDP-CCF (Intl Experts etc)	5.45	1.21	5.36	1.19	0.08	0.02		5.86	0.41			0.41		
B	UNDP-GEF(Intl. Equipment etc)	41.44	9.20	41.04	9.14	0.27	0.05		44.56	3.13			3.13		
C	ONGC Contribution	12.16	2.70	12.16	2.70	0.00	0.00		12.16	0.00					
D	a)Coal India Ltd Contribution (Note 1)			0.82	0.18	-0.82	-0.18	14.18	15.00	15.00	15.00				
E	GoI (Cash) S&T Grant								0.00	0.00					
	a)Rupee Component	9.54	2.12	5.09	1.13	4.48	1.00	26.02	31.11	21.56		23.14		-1.57	
	b)FE Component :														
	(i) Utilisation Equipment	3.87	0.86	2.84	0.86	1.04	0.23	1.04	3.88	0.01	0.01				
	(ii) International Equipment procured by UNIDO	4.64	1.03	4.77	1.03	0.00	0.00		4.77	0.13			0.13		
	Sub-total FE Component	8.51	1.89	7.61	1.89	1.04	0.23	1.04	8.65	0.13					
	TOTAL GOI(CASH) S&T	18.06	4.01	12.70	3.02	5.52	1.23	27.06	39.75	21.70	0.01	23.14	0.13	-1.57	
	<b>Sub-Total A+B+C+D</b>	<b>77.10</b>	<b>17.11</b>	<b>72.08</b>	<b>16.24</b>	<b>5.05</b>	<b>1.12</b>	<b>41.24</b>	<b>117.34</b>	<b>40.24</b>	<b>15.01</b>	<b>23.14</b>	<b>3.66</b>	<b>-1.57</b>	
F	GOI(KIND) (BCCL Contribution)	6.99	1.55	6.99	1.56	0.00	0.00	0.00	6.99	0.00		0.00			
G	Part of the revenue cost met out of the income generated from the project on account of utilisation of exploited CBM in initial time period.(BCCL Contribution)	8.33	1.85	1.40	0.31	6.94	1.54	6.94	8.34	0.01					
	<b>TOTAL</b>	<b>92.43</b>	<b>20.52</b>	<b>80.46</b>	<b>18.11</b>	<b>11.98</b>	<b>2.66</b>	<b>48.18</b>	<b>132.67</b>	<b>40.24</b>	<b>15.01</b>	<b>23.14</b>	<b>3.66</b>	<b>-1.57</b>	
									140.62					40.24	
Note1:Funds provided for Geophysical Logging Expenses have been considered for the 3rd & 4th Well Scheduled to be drilled in Calender 2009 under "Additional Prov Beyond Dec'08															
RNS/E/Desktopfolder/Sur DRAFT RCE Dec08 For Approval upto Dec'09 & up to Dec'09															

**DETAILS OF ADVANCED UPDATED COURSE OF STUDIES ON CBM ADOPTED BY ISMU, DHANBAD.**

**GLC 51214 Coal and CBM Exploration**

**Coal Exploration**

1. Varieties of coal and origin, analyses of coal, coal petrography,
2. Coal classification
3. Organization of coal exploration project. Different methods of coal exploration Photogeological and remote sensing, geological, sedimentological and coal petrological
4. Geophysical methods : Geophysical logging, in-seam seismic survey
5. In-seam drilling. Methodology involved in the preparation of geological cross sections, floor and roof contours, isopach and isochore of coal seams and partings, seam-folio maps, seam-structure map, statistical diagrams, panel diagrams.
6. Detailed studies of cleat and joints.
7. Assessment of reserve potential and standard procedure of coal reserve estimation
8. Economics of coal exploration

**CBM Exploration**

1. Coal bed methane generation and accumulation
2. Geological and petrographic influences on coal, Pore geometry, Micropore, Mesopore and macropore, cleat system
3. Sorption – principles, sorption isotherms – types and interpretation, CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub> adsorption – desorption, hysteresis, langmuir isotherm, Swelling of coal matrix isotherm construction.
4. CH<sub>4</sub> content determination in coal seams
5. Coal bed methane reservoir analysis, comparison between conventional gas reservoir and coal bed methane reservoir, Permeability klinkenberg, shrinkage, stress and depth effects on permeability, water composition as permeability indicator, gas flow diffusion in micropores, Darcy flow in cleats, sorption time, CBM reservoir characterization methods, enhanced recovery.
6. Water production and disposal, injection wells
7. Potential CBM basis and production, hydraulic fracturing of coal seams, CBM exploration.
8. In-situ gasification, carbon dioxide sequestration.

**SIXTH SEMESTER**

**GLC26102 COALBED METHANE & GAS HYDRATE EXPLORATION 3-0-0**

**Coal bed methane**

1. Coal bed methane generation and accumulation
2. Geological and petrographic influences on coal, Pore geometry, Micropore, Mesopore and macropore, cleat system.
3. Sorption – principles, sorption isotherms – types and interpretation, CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub> adsorption – desorption, hysteresis, Langmuir isotherm, Swelling of coal matrix isotherm construction.
4. CH<sub>4</sub> content determination in coal seams
5. Coal bed methane reservoir analysis, comparison between conventional gas reservoir and coal bed methane reservoir, Permeability, Klinkenberg, shrinkage, stress and depth effects on permeability, water composition as permeability indicator, gas flow diffusion in micropores, Darcy flow in cleats, sorption time, CBM reservoir characterization methods, enhanced recovery.
6. Water production and disposal, injection wells
7. Potential CBM basis and production, hydraulic fracturing of coal seams, CBM exploration.
8. In-situ gasification, carbon dioxide sequestration

**Gas Hydrate**

1. Gas hydrate, occurrence and origin; structure of gas hydrate, Types of gas hydrate
2. Geological setting of Hydrate, Stability of gas hydrates, Gas hydrate reservoir
3. Volume of gas in hydrate, inhibitors
4. Geological exploration of gas hydrate
5. Prospect and potentialities of gas hydrate in India

**CIMFR FACILITIES FOR CBM RELATED STUDIES**

The CIMFR has equipped itself with following techniques and lab equipment to carry out full fledged investigation into the potential of a coal mine block.

**1. DETERMINATION OF IN-SITU GAS CONTENT AND SORPTION TIME**

The Direct Method is used in CIMFR to determine the in-situ gas content of coal. The basic procedure for gas content determination by direct method involves measurements in the field and also in the laboratory, as well as a set of calculations.

**Equipment**

The basic equipment used for performing gas content measurements consists of specially fabricated gas tight cylindrical desorption canisters fitted with pressure gauge and a needle valve and a manometer type of apparatus for measuring gas volume. The desorption canisters are maintained at reservoir temperature by aid of a heating unit and a temperature controller's rotary grinding machine is used to crush the coal samples to below 200 mesh BSS for measurement of residual gas.

**Experience**

Coal cores samples retrieved during drilling of about 135 boreholes so far been tested by CIMFR.

**2. CONSTRUCTION OF ADSORPTION ISOTHERM**

High-pressure adsorption iso therm estimates the amount of gas adsorbed by coal samples and it also determines the recoverable quantity of methane with decreasing pressure.

**Equipment**

The instruments used at CIMFR to determine adsorption isotherm of coal samples consist of the following elements;

- Water bath
- Control Panel
- Reference bombs
- Sample bombs
- Vacuum Pump

Water bath is used to maintain isothermal conditions for the reference and sample bombs. The centrolineal regulates the flow of the gas t the reference and sample bombs and monitor gas pressure. The reference bombs are never separated from the system and its purpose is to store a known volume of gas at known pressure and temperature. Sample bombs are used to keep the coal samples to determine the adsorption isotherm. The gas soared in reference booms is connected to the sample bombs and allowed to adsorb the gas molecule by the coal sample in the sample bombs. Vacuum pump is used to evacuate the system for measuring of dead volume

**Experience**

About 100 samples have been analyzed for evaluation of their Sorption capacity by CIMFR scientists.

### **3.COMPOSITION OF DESORBED GAS**

The gas chromatograph available for this purpose is fitted with a Flame Isolation Detector(FID) and Thermal Conductivity Detector(TCD),FID is a highly selective gas detection system used primarily for the analysis of hydrocarbon gases such as natural gas,propane,butane,ethylene and low concentration of chloratd compounds. It is unaffected by the presence of carbon di-oxide or carbon monooxide.TCD is also one of the most common and effective method of gas detection.

The laboratory has procured gas generators for carrier gases.Caliberation gases are always available.

### **4.PROXIMATE ANALYSIS**

Standard laboratory procedure(IS 1350 Part-1,1984) as laid down by Indian Standard Institution is followed for proximate analysis of coal samples.

### **5.COAL PETROGRAPHY**

Studies on maceral composition .vitrnite reflectance,lithotype and microcleats using MPV 2 & 3 microscopes by ICCP standards are undertaken.

### **6. DETERMINATION OF PERMEABILITY AND POROSITY**

Gas/ Liquid Permeameter /porosimeter is a highly rapi , accurate system for non-destructive measurement of permeability and effective porosity of rock core samples. A computer data acquisition system automatically calculates the permeability and porosity and records the data saving it to a spreadsheet file. Test cores of varying diameters can be easily accommodated by switching core holder internal parts. Cores are easily and quickly inserted and removed by screwing the end plugs. Maximum confining pressure is 10000psig(68.9Mpa) at room temperature and maximum flowing pressure(PORE) thru the core samples is 2500 psig (17.2Mpa)at room temp. With the low por pressure (0.69Mpa absolute or 0.85 psig or 0.59pa).For measurement at high temperature ,facilities are available for treatment of the rock core samples. Following test can be conducted:

- Steady-state Permeability Measurement
- Unsteady-state Permeability Measurement
- Pycnometer for Porosity Measurement

### **7. CLEAT ANALYSIS USING OPTIMUS IMAGE PROCESSING SOFTWARE**

Optimum image processing software is used for measurement of mega and micro cleat aperture, cleat intensity, cleat density, cleat orientation. cleat spacing, density of cleat mineralisation and type of cleat percentage determination.

### **8.PHYSICO-MECHANICAL PROPERTIES**

Studies on determination and evaluation of physico-mechanical properties of the rock/coal core samples are also undertaken. Such test are conduced to evaluate strength properties required for hydro-fracturing design etc. These test are conducted in accordancce with IS Standards. These tests are:

- Density(Unit weight dry and saturated)
- Uniaxial Compressive Strength(dry and saturated)
- Uniaxial tensile strength
- Triaxial strength
- Deformability Characteristics( Young's Modulus)



## ANNXURE-VIII

<b>Cost of CBM/CMM recovery from one producing well &amp; Cost of Power generation (250 kW) at Moonidih</b>			
SI#	Items	Cost in Rs	Remarks
1	Capital Cost of completion of one well in all respect up to CBM recovery. (in Crores) Life of one well considered 10 years.	15.12	
2	Capital Cost of completion of one well for 1 year (in Lakhs) Assuming life of well 10 years No of useful working days being used in Gas production and power generation	151.18	1512/10  360
3	Capital Cost of completion of one well for one day (in Rupees)	41,995	15118000/360
4	Current gas production per day	5,000 m <sup>3</sup> /day	
5	Variable cost of running the plant per day in Rs	8,000	
6	Total Cost of CBM/CMM Recovery per day (SI#3+SI#5) (in Rupees)	49,995	
7	Cost 1 Cubic M CBM/CMM Recovery (SI#6/SI#4)	10.00	49995/5000
8	Cost of 250kW Gas engine Generator, its installation and gas supply pipe line etc.in Rs	50,00,000	
9	Cost of 250kW Gas engine Generator, its installation and gas supply pipe line etc per year in Rs (Considering the well life 10years)	5,00,000	
10	Cost of 250kW Genset, its installation and supply gas pipe line per day, in Rs	1,389	500000/360
11	Total cost for Power generation per day in Rs	51,384	49995+1389
12	<b>Cost of one cubic meter CBM gas recovery and Power generation equipments</b>	10.28	51384/5000
13	Cost of 103 cubic meter per hour Gas required for generation of 250 kW power ,in Rs, considering standard consumption rate/hr	1,058.52	10.28x103
14	<b>Cost of 1 kWh (Rs/Unit)</b>	4.23	1058/250

The cost of one well is normally around Rs 5 Crores but being a R&D demonstration project there has been a lot of delay on account of procurement of equipment & capacity building and delay in completion of field activities, brought about due to learning of this new technology, resulting in higher cost. It is likely that in later wells, cost would be reduced considerably and, therefore, the cost of power generation would consequently be reduced considerably.

In this Project case, in spite of being a R&D demonstration project at a pilot scale, the cost of production of CBM is Rs 10.28 per cubic M. The sale price of CBM in Indian market is USD 7 per million BTU which is Rs. 10.50 per cubic meter against our cost of production of Rs. 10.28 per cubic meter, which will reduce considerably in coming wells.