UNITED NATIONS DEVELOPMENT PROGRAMME
Project of the Government of the

PEOPLE'S REPUBLIC OF CHINA

PROJECT DOCUMENT

Project Number:	CPR/92/G31/A/~~1G~~/01
Project Title:	Development of Coalbed Methane Resources in China
Duration:	Three (3) years
Project Site:	Songzao, Kailuan and Tiefa
ACC/UNDP Sector:	Environment (1030)
Sub-sector:	Energy and Environment
Government Sector:	Energy
Executing Agency:	UN Department of Economic and Social Development
Implementing Agency:	Ministry of Energy
Starting Date:	April 1992
Government Input:	RMB Yuan 56.2 million
Financial Source:	Global Environment Facility (GEF) S$
Total UNDP Budget:	US$ 10,000,000

Brief Description

The project will assist China in controlling emission of methane, a potent greenhouse gas and thereby aims to better protect the global and local environment. This aim will be achieved by technical and institutional preparation for the formulation of the national strategy to develop the methane industry, by introduction and demonstration of a wide variety of technologies and techniques required, and by sensitization of policy makers of the Government both at central and local levels about environmental and economic significance of rational recovery and use of methane resources. Three benefits will result from the project: improved air quality for the local and international communities, improved safety environment for miners and a new clean-burning energy source.

On behalf of:	Signature	Date
The Government:		5 June 1992
Executing Agency:		5 June 1992
UNDP:		5 June 1992

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US$ 1 = RMB Yuan 5.4

A. CONTEXT

1. DESCRIPTION OF ENVIRONMENTAL SITUATION

Methane's role in the atmosphere is of great concern because its emissions are increasing rapidly. Comprehensive global measurements of atmospheric methane concentrations show that over the past 300 years its concentration has more than doubled and that it is currently increasing by about 1 percent annually. There are a number of atmospheric impacts associated with these emissions, including global warming, an increase in tropospheric ozone and smog formation, and possibly stratospheric ozone depletion.

Methane is an important greenhouse gas that is 20 to 60 times more potent than carbon dioxide on a mass basis. Compared to carbon dioxide, methane is also a short-lived gas; it has an atmospheric residence time of 8 to 12 years, compared to over 200 years for carbon dioxide. This means that the warming associated with methane emissions is realized in the first few decades after its emission while the warming from carbon dioxide is realized gradually over centuries. The short residence time also implies that reductions in methane emissions will have more noticeable short-term impacts on atmospheric concentrations and that smaller reductions will be needed to stabilize atmospheric concentrations.

Past and future increases in methane concentrations have been highly correlated with increases in global populations and human activities that release methane to the atmosphere. The major human-related sources of methane are rice cultivation, livestock (including ruminant emissions and animal waste), biomass burning, coal mining, oil and natural gas production and transport, and landfills. Human activities account for about 60 percent of total emissions.

Stabilizing methane emissions will require reductions of about 15 to 20 percent of emissions from human activities. Significantly, these reductions are much lower than those required to stabilize other greenhouse gases. In addition, many of these reductions can be achieved profitably or at low cost, because methane is the principal component of natural gas and it is a useful energy source when captured and used productively.

Coal mining is estimated to account for about 10 percent of total human-related methane emissions. Methane is a byproduct of coal formation, and it is released during mining. In fact, because methane is explosive in low concentrations in air, underground coal mines are typically ventilated and exhaust their methane emissions to the atmosphere to reduce the risk of explosion. Technologies are available to recover useful methane before, during or after coal mining operations, however, thereby producing an additional energy source and reducing atmospheric emissions. Coal mines in many countries

are employ these technologies, although they do not use the recovered methane in many cases.

China is one of the world's largest emitters of methane from coal mining, accounting for an estimated one-third of methane emissions from this source. China's contribution is large because it is the largest producer of coal in the world and most of its coal is produced in underground mines which tend to have higher emission levels. Of China's 600 state run mines, 279 are classified as high gas or outburst mines, and the number is increasing yearly as mining depths increase.

Currently, China has 110 state run coal mines with methane recovery systems in place. These mines recovered 434 million m^3 of gas in 1990 (over 3 percent of China's total natural gas production). Only 40 mines have systems in place to use the recovered methane, however, and more than 30 percent of the recovered high-quality gas was vented to the atmosphere in 1990. With the application of better technologies for both methane recovery and use, China's coal mines could recover more gas and develop more effective utilization strategies, thereby reducing atmospheric emissions.

2. DESCRIPTION OF CHINA'S ENERGY SECTOR

The expansion of methane recovery and use at China's coal mines is consistent with the objectives of China's energy sector, which has made tremendous efforts for more than 40 years to develop its energy resources. As Table 1 shows, total energy production in China has increased dramatically from 32 million tons of raw coal in 1950 to 1.1 billion tons in 1990. Coal has fueled this growth, consistently accounting for 70 percent or more of total energy consumption, as compared to only 25-30 percent of total energy consumption in countries such as the Soviet Union, the United States, and Japan.

With total production at 1.1 billion tons, China is the largest coal-producing country in the world. Forty-four percent of China's coal is produced in 600 large mines managed by the central government. The remaining 56 percent comes from more than 60,000 locally owned mines, which have grown rapidly in an era of economic reform. Locally owned mines are typically smaller and less mechanized and tend to emit less methane each than central mines. Thus, this project focuses on reducing methane emissions through improving methane recovery and use at the centrally-managed mines.

Table 1 also illustrates that natural gas output has not grown significantly over the last decade, and currently accounts for only 2 percent of energy supply. Production in 1990 was only 15 billion m^3, which is less than 2 percent of U.S. gas supply. Low exploration budgets, declining production in major fields, and limited infrastructure for

gathering, transmission and utilization are the primary reasons for low natural gas use.

TABLE 1: ENERGY PRODUCTION IN CHINA, 1950-1990

YEAR	COAL		PETROLEUM		NATURAL GAS		HYDROPOWER	
	Mil. tons	% of total enrgy	Mil. tons	% of total enrgy	Mil. m^3	% of total enrgy	Bil. kwh	% of total enrgy
1950	43	96.8%	0.2	0.9%	7	0.0%	0.8	2.3%
1955	93	95.9%	1.0	1.9%	17	0.0%	2.4	2.2%
1960	397	95.6%	5.2	2.5%	1,040	0.5%	7.4	1.4%
1965	232	88.0%	11.3	8.6%	1,100	0.8%	10.4	2.6%
1970	354	81.6%	30.7	14.1%	2,870	1.2%	20.5	3.1%
1975	482	70.6%	77.1	22.6%	8,850	2.4%	47.6	4.4%
1980	620	69.4%	106.0	23.8%	14,270	3.0%	58.2	3.8%
1981	622	70.2%	101.2	22.9%	12,740	2.7%	65.5	4.2%
1982	666	71.3%	102.1	21.8%	11,930	2.4%	74.4	4.5%
1983	715	71.6%	106.1	21.3%	12,210	2.3%	86.4	4.8%
1984	789	72.4%	114.6	21.0%	12,430	2.1%	86.8	4.5%
1985	872	72.8%	124.9	20.9%	12,930	2.0%	92.4	4.3%
1986	894	72.4%	130.7	21.2%	13,760	2.1%	94.5	4.3%
1987	928	72.6%	134.1	21.0%	13,890	2.0%	100.0	4.4%
1988	980	73.1%	137.1	20.4%	14,260	2.0%	109.2	4.5%
1989	1,054	74.1%	137.6	19.3%	15,049	2.0%	118.3	4.6%
1990	1,080	74.2%	138.3	19.0%	15,298	2.0%	126.7	4.8%

Source: China State Statistical Bureau, China Statistical Yearbook, 1991

Heating value assumptions:
Coal = 5,000 kilocalories per kilogram
Petroleum = 10,000 kilocalories per kilogram
Natural gas = 9,310 kilocalories per cubic meter
Hydropower = 860 kilocalories per kilowatt-hour

China's energy supply patterns--in particular the production of more than one billion tons of coal annually and the shortage of natural gas, the cleanest fossil fuel--have serious local and global environmental impacts. The emissions

of methane and carbon dioxide are of global significance, because they are important greenhouse gases. In addition, China suffers from severe local air pollution problems due to its coal use, including high levels of SO_2, NO_x and particulate emissions. Chinese cities, such as Shenyang and Chongqing, have some of the highest particulate and SO_2 concentrations in the world.

Coalbed methane, a type of natural gas, is deleterious to the environment if it is vented to the atmosphere, but is a remarkably clean fuel when burned. Natural gas combustion produces no SO_2 or particulate and only half of the CO_2 associated with coal combustion.

3. HOST COUNTRY STRATEGY

The eighth five-year plan (8th FYP) covering the years 1991-1995 calls for modest energy growth. Coal production is projected to increase by 2 percent per year to 1.2 billion tons, and other energy sources (such as oil and electricity) are also projected to increase at similar levels. Natural gas is projected to grow faster than other hydrocarbons during the 8th FYP, and reach 20 billion m^3 in 1995. It will still represent only slightly more than 2 percent of total energy supply in 1995, however. Thus, under the 8th FYP, there is unlikely to be significant reduction in the environmental damage caused by coal through fuel substitution.

The potential of one of China's clean energy resources--coalbed methane--is not fully considered in the 8th FYP. China's coal industry has accumulated enormous expertise and experience in recovering coalbed methane in the course of mining. However, methane extraction has always been considered an adjunct to mine safety and not a significant energy source in its own right. MOE's target of increasing coalbed methane recovery from 434 million m^3 from 110 mines to 500 million m^3 from 140 mines in 1995 derives almost exclusively from mine safety considerations. 30% of the methane recovered at present is ultimately vented to the atmosphere, rather than used as energy.

Based on the experience of other countries and on its own resource estimates, China has enormous potential to increase recovery and use of coalbed methane. China's conventional gas resources are estimated at 43 trillion m^3 and are concentrated primarily in Sichuan Province. According to MOE estimates, coalbed methane resources could add more than 30 trillion m^3. These resources, moreover, are distributed throughout the country, with a large proportion in the Northern, Eastern, and Northeastern regions which are the most heavily populated, polluted, and energy-intensive.

Currently in the world, there are advanced methods of methane recovery, particularly using vertical wells, that could produce large amounts of coalbed methane, both in

conjunction with mining and in stand-alone gas producing operations. The introduction of these technologies, together with relatively simple adjustments to China's in-mine recovery practices, could increase coalbed methane production by many orders of magnitude.

MOE, State Planning Commission, a number of coal mining administrations (CMAs), and some municipalities have studied the development of the coalbed methane industry in foreign countries and are conducting experiments with new technologies. For the most part, however, these groups lack the financial resources to demonstrate the technologies on a wide scale, and, as importantly, the confidence that they can successfully be adapted to Chinese conditions.

With a stronger commitment, and the transfer of new assessment, recovery and utilization technologies, coalbed methane recovery could grow by as much as 25-30 percent annually, contributing 1.5 billion cubic meters by 1995 and 5 to 6 billion cubic meters by the year 2000. Outside assistance and training is a necessary catalyst for this kind of growth.

4. PRIOR OR ONGOING ASSISTANCE

In its efforts to more fully explore and develop its energy resources, the Government has obtained sizeable technical assistance over the last 10 years from UNDP, as well as capital assistance from the World Bank (IBRD). Major projects are listed below, with all loan amounts shown in U.S. dollars.

4.1 UNDP Projects

PROJECT NUMBER	PROJECT NAME	LOAN AMT.
CPR/80/049	Training Center for Oil Exploration & Development (completed)	$ 903.5K
CPR/81/033	Oil Well Sand Control	$ 603.6K
CPR/80/005	Geophysical Prospecting for Petroleum in Areas of Carbonate Deposition	$3,915.1K
CPR/84/013	Chemical Oil Recovery in Daqing Oilfield (completed)	$ 420.9K
CPR/85/029	Geophysical Data Processing Software System for Petroleum Exploration	$2,184.0K
CPR/85/030	Exploration and Exploitation of Petroleum in Nanbao Basin	$1,181.3K

CPR/85/044	Marine Engineering	$1,552.4K

This assistance has been mainly concentrated on petroleum sector. Under the Third Country Programme covering a period of 1991-1995, UNDP has shifted the focus of technical assistance to utilization of coal resources in an efficient and environmental beige way. A sub-programme CPR/91/210 - Efficiency and Environmental Improvements in Coal Utilization has been formulated. This project is an integral part of the sub-programme. Another project closely linked and complementary to this project in the sub-programme is CPR/91/215 - Exploration of Deep Coalbed Methane Resources. The latter aims at strengthening the technical capacity of the Chinese geologists and engineers in optimal exploration and recovery of methane resources in deep and usually unminerable coal seams. Both project have strong environmental orientation and will provide China with a new and clean-burning energy source. Technologically, the GEF funded one is more related to mining operation and will contribute considerably to the occupation safety while the other will benefit more from technology and techniques widely used in the oil industry. An appropriate arrangement has been made in the subprogramme to ensure effective coordination of two projects.

4.2 IBRD Projects

PROJECT NAME	EFF. DATE	LOAN AMT
Petroleum Development	Sept 1985	$162 mill.
Zhongyuan-Wenliu Petroleum	Sept 1985	$101 mill.
Karamay Petroleum	Oct. 1984	$100 mill.
Changcun (Luan) Coal Mining	Oct. 1985	$126 mill.
Liaodong Bay Petroleum Appraisal & Tech. Assist.	Sept 1986	$ 30 mill.
Weiyuan Gas Field Tech. Assistance	Jan. 1986	$ 25 mill.

5. INSTITUTIONAL FRAMEWORK FOR SUBSECTOR

The institutional framework pertaining to coalbed methane in China is quite complex. China's coal sector is the key focus of this project because of the beneficial relationship between coalbed methane recovery and coal mine safety. In addition to the coal sector, the Ministry of Geology and Mineral Resources (MGMR), the China National Petroleum Corporation (CNPC) and some municipal gas companies are also likely to have some involvement in the development of the coalbed methane industry in China. Thus, while the MOE coal

sector will be the main focus of the project, efforts will be made to incorporate these other sectors into the project to ensure maximum sustainability and to limit duplication of effort.

Under the existing organization of China's coal industry, MOE handles policy and oversight issues related to coal production, while concrete operations are controlled by two major corporations reporting to MOE: the China National Coal Corporation (CNCC) and the China Northeast and Inner Mongolia Coal Corporation (CNIMCC). There are 108 coal mining administrations (CMAs) under the coal corporations, managing some 650 mines.

The CNCC manages the operation of the China Coal Science and Technology Research Institute, which has branches located throughout China. The branches of relevance to this project include:

- Xi'an: Responsible for coal geology and coalbed methane exploration and assessment;
- Fushun: Responsible for coal mine safety and coalbed methane drainage and recovery design; and,
- Chongqing: Responsible for coal mine safety and coalbed methane drainage and recovery design.

Within MOE, responsibilities for the operation of Chinese coal mines has been divided among several departments. Those departments of relevance to the expanded recovery and use of coalbed methane are:

- Safety and Environmental Protection: Responsible for energy sector safety of production, environmental protection, and formulation and supervision of technical policies;
- Planning: Responsible for screening and approving new capital investment projects;
- Comprehensive Utilization: Responsible for development of production and markets for coal-derived products; and,
- International Cooperation: Responsible for liaison with international aid organizations.

Local governments may also play an important role in the future development of China's coalbed methane resources, because they are responsible for the residential energy consumers who represent coalbed methane's major potential market. Several municipal governments could potentially use coalbed methane recovered by nearby CMAs to meet urban gas needs, and some, such as Chongqing and Shenyang, are aggressively pursuing this option.

B. PROJECT JUSTIFICATION

1. PRESENT SITUATION

Methane is a potent greenhouse gas, and its concentration in the atmosphere is increasing rapidly. It is emitted by both natural and anthropogenic sources, and coal mining accounts for about 10 percent of emissions from anthropogenic sources. Emission reductions of about 15-20 percent are required from anthropogenic sources in order to stabilize atmospheric methane concentrations, and coal mining is an attractive potential reduction source for both technical and economic reasons.

As discussed previously, it is possible to recover and use the methane from mining instead of releasing it to the atmosphere. Numerous technologies are available for both recovery and use, and many of these approaches are not fully used in developing countries. China, as the world's largest emitter of methane from coal mining, is an important target of programs to encourage the expanded recovery and use of this resource. In addition, because the recovery of methane from mining has important mine safety benefits and produces a new, clean-burning energy source, these activities will result in numerous benefits to the Chinese economy and environment.

In 1990, China recovered about 434 million m^3 of methane from the 110 mines with recovery systems--well under 10 percent of the estimated volume emitted in conjunction with coal mining. The remaining methane was liberated to the atmosphere through ventilation shafts. Only about 300 million m^3, or 70 percent of recovered methane was used, while the rest was vented to the atmosphere. Moreover, only 40 of the 110 mines with recovery systems use any of the recovered methane.

Currently, coalbed methane is used primarily by CMA employees for residential cooking, and it is provided by the CMAs at a very low costs as a form of social welfare. In only a very few instances--notably the Fushun Coal Mining Administration and the Zhongliangshan mine in Chongqing--is coalbed methane sold as a commodity to urban residents outside the CMAs. Some municipal governments are anxious, however, to promote the substitution of gas for coal in residences.

Industry accounts for close to 90 percent of natural gas consumption in China but only uses a small proportion of coalbed methane recovered by China's mines. The principal industrial uses of coalbed methane are small carbon black plants run by the CMAs and a small gas-turbine generator located at Fushun. The potential for additional industrial applications is large.

According to Chinese safety regulations, mines must install methane recovery systems if emissions from the working face exceed 5 m^3/min or total mine emissions exceed 10 m^3/mine; and they must report methane concentrations that exceed 1 percent

in mine workings. For gassy or outburst-prone mines, methane recovery systems are primarily designed, constructed, installed, and maintained by the mining administrations themselves, with the assistance of design and research institutes.

All of the existing recovery systems in Chinese coal mines use in-mine methods. Between 1970 and 1987, seven experimental vertical wells were drilled to recover coalbed methane, but they did not achieve the projected results for various reasons, including inappropriate drilling and completion techniques and lack of enough geologic information to properly site the wells in the most favorable areas. Methane recovery in advance of mining via in-mine cross-measure boreholes accounted for 55 percent of total gas recovered in 1990. The use of horizontal boreholes to recover methane from the target coal seams recovered another 42 percent of the gas, and goaf drainage accounted for 5 percent, due to the high risk of spontaneous combustion in China's coal mines.

Chinese methane recovery rates could be considerably higher. The Jim Walter Resources mines in Alabama, which are equivalent to an average-sized Chinese CMA, recover as much methane as the entire Chinese coal industry. And whereas Chinese mines recover methane with quality of between 35 and 75 percent purity, Jim Walter pipeline quality gas of over 95 percent methane purity.

In addition, in the United States, vertical wells methods account for more than 75 percent of all methane recovered by coal mines and have been proven effective at producing large quantities of high purity gas at a lower cost than in-mine methods. Where surface conditions and geologic characteristics are appropriate, Chinese mines could also recover large amounts of methane in either of these manners.

Some of the reasons for low recovery rates are economic, political as well as technical including:

1. Lack of supportive policies: In the past, the departments of concern have not fully recognized the comprehensive benefits of coalbed methane recovery and use. As a result, effective policies to spur coalbed methane recovery and development are not complete. For example, most of the funding available for methane recovery systems comes from mine safety budgets, not energy supply budgets. In fact, mines are forced to look at methane drainage as a cost of coal production and not a source of additional revenue. In addition, mines do not receive any credit for methane recovered during mining and have little incentive to expand recovery systems unless these improvements are directly related to improving safety or productivity.

2. Capital shortages: The price of coal is held at very low levels in China, and in many cases the price received for

the coal is lower than the production costs. As a result, the coal sector is heavily subsidized and mines lack the surplus capital to invest in upgrading coal production or methane recovery systems. With fuller recognition by government and mines, additional funding would be available for projects.

3. Price disincentives: Because of low gas prices, it is difficult for mines to make money on gas sales to residential users. Some cities, notably Chongqing, have increased their residential gas prices to levels where coalbed methane sales have become economically attractive.

4. Lack of techniques and equipment for coal seams with low permeability: Most gas is recovered from low permeability seams using "relaxation" techniques. Pre-mining drainage is not employed due to lack of the necessary technologies and equipment.

Both internal reform and outside technical assistance are required to realize the potential for coalbed methane utilization in China, with all of its environmental and economic benefits. Recovery programs could be improved by optimizing system designs and layouts, improving underground drilling and other practices, and improving pumping and gas drainage techniques and technologies. All of these changes could be made through the introduction of relatively low-cost technologies and available techniques. The purpose of this project is to provide the initial impetus for both of these developments.

2. EXPECTED END-OF-PROJECT SITUATION

The project is designed to partially solve the problems outlined above, and to ensure continued progress and sustainability through the following measures:

1) Development of a demonstration project at the Songzao Mining Administration that improves methane recovery and includes a pre-investment plan for a powerplant to utilize the recovered methane. This objective will require upgrading the techniques and technologies currently used for methane recovery at Songzao, as well as careful pre-investment evaluation and design of an optimal power generation plan. If the pre-investment study indicates that investment would be attractive, the proposal will be presented to international development agencies for funding.

2) Preparation of a detailed assessment and database of China's coalbed methane resources, which will improve knowledge of proven reserves, evaluate their production potential, and assess utilization options. The assessment will be prepared in a manner that transfers the techniques and technologies necessary to continue the work in

additional coal basins following project termination. The assessment will not only address technical and managerial issues but also pay enough attention to the financial and commercial viability of developing coalbed methane resources so as to provide information attractive to potential private investors and joint-venture partners.

3) Demonstration of the ability to drill vertical wells in advance of mining at the Kailuan Mining Administration. This component will necessitate transfer of technologies and techniques for drilling rapidly and efficiently, casing and completing in a manner which does not damage the coal, and effectively producing gas.

4) Demonstration of the ability to design and implement an integrated methane recovery system at the Tiefa Mining Administration, which will include the use of gob wells drilled from the surface, advanced methods of sealing gob areas underground, and improved horizontal drilling techniques inside the mines.

5) Training of personnel from the Fushun and Chongqing Research Institutes, the central government (SPC and MOE), the coal corporations (CNCC and CNIMCC), the Fushun, Chongqing and Xi'an coal research institutes, mining administrations, coal geology companies, and municipal gas companies and planning divisions.

These five components have been designed to address the major technical and economic issues related to coalbed methane recovery and use. It is expected that the completion of these components will have the following results:

- Improved environmental quality (both globally and locally) associated with additional gas production and use, including reduced atmospheric methane and (both greenhouse gases), and lower SO_2, NO_x, and particulate (all serious local environmental pollutants);

- Demonstration that Chinese mines can improve methane recovery using a variety of available technologies and techniques;

- Development of more efficient and effective uses of recovered methane, resulting from increased gas production, exposure to the full range of utilization options, and training in system selection, optimization and design;

- In-depth understanding of methane resources and productivity in several key coal basins, enabling the government to create comprehensive development strategies and plans;

- Improved mine safety and productivity associated with more effective methane recovery at mines and more modern and appropriately designed recovery systems;

3. TARGET BENEFICIARIES

The purpose of this project is to demonstrate a wide variety of techniques and technologies that can be employed by Chinese coal mines to reduce atmospheric methane emissions and recover the clean-burning methane that is released by coal mining. In so doing, this project will contribute to the reduction of harmful global and local environmental pollutants and will thereby benefit both local communities and the global community.

In terms of its local impacts, the expanded recovery and use of methane from Chinese coal mines will benefit mine workers and their families, as well as residents in the communities that surround the coal mines. With technical assistance to facilitate methane recovery and use, many Chinese in mining areas will be able to replace coal used in cooking and other inefficient uses with clean-burning natural gas. Such shifts will result in lower SO_2, NO_x, and particulate emissions and will significantly improve air quality and human health.

This project will also result in lower emissions of methane and CO_2, both of which are potent greenhouse gases. By reducing methane emissions and contributing to the stabilization of atmospheric methane concentrations, China will be contributing to the mitigation of the greenhouse effect. Thus, this project will ultimately benefit the global community, which could suffer in unforeseen ways from the warming of the Earth's atmosphere.

Finally, in the near-term, this project will have direct benefits for the following groups:

- The Songzao, Tiefa and Kailuan Coal Mining Administrations, which will implement methane recovery and use projects. These mining administrations and their surrounding communities will directly benefit from the investments made under the project and will realize increased energy supply, reduced environmental pollution, and improved mine safety through the project;

- The Fushun and Chongqing Research Institutes will be trained in new methods of methane recovery and use, assessment and gas prediction. These institutes will be well-positioned to make a major contribution to methane recovery at Chinese mines;

- The Xi'an Research Institute will be trained in new methods of methane resource assessment and evaluation. This institute will be able to continue making improved assessments after project termination;

- Drilling teams from the CNCC and CNIMCC, as well as some research centers under the control of the CNPC, will be trained in surface recovery techniques;

4. PROJECT STRATEGY AND INSTITUTIONAL ARRANGEMENTS

4.1 Project Strategy

One strategy of this project will be to upgrade the technical and managerial level of the groups that carry out the management and supervisory functions related to the recovery and use of methane from mining. Survey work will be carried out by the Executing Agency and selected subcontractors together with MOE at the beginning of implementation of the project activities to assess training needs and to work out appropriate training programmes. These various functions are undertaken by government agencies (MOE and SPC), the coal corporations, the CMAs, and the research institutes. Among the activities that must be targeted for upgrading are:

- the technical design of methane recovery systems;
- the technical assessment of utilization plans and technical approval of proposals;
- financial support for projects; and,
- the pursuit of research in areas related to gas prediction, recovery and use.

The second strategy of this project will be to improve operational practices in the field, which are principally carried out by CMAs which responsible for the installation, operation and maintenance of methane recovery systems and the implementation of utilization projects. Technical and managerial capabilities vary a great deal among the CMAs; some are aggressively pursuing methane recovery and use and experimenting with new technologies and approaches while others are not. Even the most progressive CMAs are limited by their lack of exposure to new technologies and techniques and by a lack of investment capital, which frequently causes them to cut corners and fail to achieve projected results.

The third strategy will be to increase interest in and support for coalbed methane as a natural gas source at the national and municipal levels. Many municipalities--such as Shenyang and Chongqing--are aggressively promoting gas use and developing new gas sources. Similarly, various departments within the State Planning Commission and MOE are focusing on opportunities to expand gas use. These groups will be kept informed of results achieved under the project throughout the implementation process. Those groups will have better understanding about the potential for coalbed methane to contribute to China's energy and environmental objectives so

that they can encourage its more aggressive development through funding and policy incentives.

4.2 Institutional Arrangements

In order to implement the project, the Ministry of Energy (MOE) has established a Project Steering Committee that will consist of one ministerial level director and three deputies. MOE will also establish a Project Management Office with a staff of two to three people to handle day-to-day implementation of the project, report progress to the committee, and accomplish any tasks identified by the committee.

The responsibilities of the Project Steering Committee with include:

- Coordination among the various units involved in the project to handle any necessary policy decisions and manage the direction of the project;
- Formulation and implementation, in consultation with UNDP and the executing agency, of the work plan for the project;
- Mobilization of the necessary domestic inputs for the project;
- Dissemination of project results;
- Review and approval of the terms of reference for the subcontracts under the project; and
- Organization and approval of training activities, including overseas study tours and fellowships and domestic workshops and seminars.

For all demonstration project activities, day-to-day operational decisions will be made in the field by the involved coal mining administrations. At the beginning of the project implementation, the Executing Agency together with the project authorities and Chief Technical Advisor (CTA) will prepare a detailed workplan in which a series of benchmarks will be established for efficient and effective monitoring by the Government and UNDP.

In order to ensure the effective coordination of different project activities and foreign consultants, the executing agency will hire a Chief Technical Advisor (CTA) who will act as liaison between the parties and will be responsible for activities such as managing the subcontractors, scheduling personnel, designing and administering training, and technical coordination reporting. UNDP may also hire a advisor who will

participate in the project reviews and provide recommendations to UNDP on project direction and implementation.

Further, it is anticipated that individual subcontracts shall be awarded to manage the implementation of the outputs and activities defined under the Immediate Objectives related to the demonstration activities at Songzao, Kailuan, and Tiefa. This is consistent with industry practice and will greatly simplify the completion of these objectives. It was determined that the separate demonstration projects should be subcontracted individually because of the unique technical requirements of each objective and the likelihood that different firms would have different capabilities. In particular, it is possible that those firms with the most experience in vertical drilling in advance of mining would not have the experience necessary to effectively demonstrate methane recovery technologies used in conjunction with mining, such as in-mine horizontal drilling. Drafts of the statement of work portion of the terms of reference for the individual subcontracts are included in Annex x, and final terms of reference shall be developed by the Steering Committee, the executing agency and the CTA. The terms of reference for the subcontracts shall define the respective responsibilities of the contractors, the executing agency and the Chinese counterparts.

5. REASONS FOR UNDP ASSISTANCE

This project has been funded under the Global Environmental Facility Fund because of the importance of reducing methane emissions to the atmosphere and China's large contribution to these emissions from its coal mines. The Chinese need technical assistance in areas such as resource assessment, improved recovery technologies, and utilization system design and optimization in order to access larger financial resources from domestic and international sources that will enable them to fully exploit their coalbed methane resources. UNDP and its executing agencies have a long history of providing this type of technical assistance in China's energy sector and has strong expertise in this area.

6. SPECIAL CONSIDERATIONS

This project is being undertaken because of its enormous environmental benefits and the potential to demonstrate to China and other developing countries that there are cost-effective mechanisms available for reducing atmospheric methane emissions from coal mining. As a result of this project, China--the world's largest emitter of methane from coal mining--will be prepared to make significant emission reductions and to realize substantial benefits in several areas. As mentioned previously, this project will result in local and global environmental benefits of significant proportions through the recovery of waste methane and the

provision of natural gas to Chinese end-users that are currently burning coal in an inefficient manner. Of equal importance, however, this project will demonstrate to China that this type of project can be economically attractive and can also help to accomplish other important objectives. Thus, this project will contribute to the transformation of China's approach toward environmental protection by focusing the government on cost-effective projects with multiple benefits.

Among the other benefits China will realize are improved mine safety and increased energy supplies. Many Chinese mines experience unsafe methane levels and will benefit from the improved efficiency of methane recovery systems. In addition, China needs additional sources of natural gas, both for environmental reasons and because the country has a severe energy shortage. China's residential energy users and urban residents will benefit from the expanded recovery and use of methane from coal mines for cooking, heating and other uses.

7. COORDINATION ARRANGEMENTS

All parties involved in the project recognize the importance of coordination within the involved ministry, and between the ministry and other government agencies and other groups active in the areas of the recovery and use of methane from coal mining.

As mentioned in section B.4.2, MOE has established a Project Steering Committee to handle coordination arrangements within the Ministry.

Further, the Government and UNDP will coordinate with other ongoing UNDP coalbed methane projects, most particularly the proposed deep coalbed methane project being undertaken in the subprogramme CPR/91/210 - Efficiency and Environmental Improvements in Coal Utilization. While the project will operate independently in terms of sites, activities, and equipment procurement, efforts will be made to include participants identified through the deep methane project in training, seminars, and conferences so as to realize economies of scale and most effectively disseminate coalbed methane information throughout China.

Finally, MOE and the U.S. Environmental Protection Agency (USEPA) will coordinate their ongoing bilateral cooperative activities in the area of coalbed methane recovery and utilization with this project. The USEPA and MOE have been cooperating on coalbed methane for almost two years under Annex 4 to the U.S.-PRC Environmental Protocol. The two sides have visited each other and exchanged information about coalbed methane development in the each country. A new agreement is expected to be signed in 1992 to continue their cooperation in the years to come. Both USEPA and MOE will keep UNDP and its executing agency informed of significant

developments and activities undertaken through the bilateral cooperation.

8. COUNTERPART SUPPORT CAPACITY

MOE has the manpower and support facilities necessary to carry out project activities. The decision by MOE to establish the Project Steering Committee will ensure effective coordination among experts in different units within the ministry. Further, MOE has demonstrated that its staff has the technical and managerial competence to manage day-to-day project operations.

MOE also has a strong relationship with the research institutes that provide support in the areas of methane resource evaluation, and the design, construction and installation of methane recovery and use facilities for coal mines. These institutes will participate in various project components, as well as provide the ministry with technical back-stopping. Specifically, the technical capabilities of the institutes are as follows:

- Fushun has a special methane department with long experience in mining safety, that has specialized in methane reservoir engineering and methane recovery techniques. The department is staffed by 57 technical personnel, of which 11 have senior technical titles. It also has a well-equipped laboratory.

- Chongqing has specialized in mining safety, particularly in the prevention and control of gas outbursts. The institute has a special department with 30 technical personnel and produces excellent instruments for research and development as well as for practical application in the recovery of methane during mining.

- Xi'an completed the key national coalbed methane assessment, which was done under the 7th Five-Year Plan, and it has strong experience in coal geology, methane reserve evaluation and reservoir engineering. There are currently 30 senior engineers and 60 engineers working on methane-related projects in the institute.

Finally, the management and technical capabilities at each of the pilot mines are sufficient to ensure effective and successful project implementation. Each of the mining administrations has demonstrated commitment to methane recovery and use and a desire to improve their technical capabilities. The experience of the mining administrations is as follows:

- Songzao is a rapidly developing mining area with proven coal reserves of about 0.8 billion tons and estimated

methane reserves of 23 billion tons. In 1990, the mining administration produced more than 3 million tons of coal and recovered almost 60 million m^3 of methane. Current mine expansion activities should increase coal production to 5.4 million by 2000. The mining administration anticipates a corresponding increase in methane emissions. The Songzao mines are among the gassiest in China and account for almost 15 percent of all of the methane recovered by Chinese mines.

The Songzao Mining Administration is strongly committed to improving its methane recovery techniques to cope with higher gas emissions and has also done a great deal of work to investigate gas utilization options. The mining administration has prepared an initial pre-feasibility study of the use of recovered methane to generate electricity. The UNDP project will build on ongoing methane recovery activities at the mine and undertake a detailed feasibility study of the opportunity to generate power with the recovered gas, so as to prepare the mining administration for investment in such a power generation project.

- Kailuan has been mining coal for more than 100 years and produced 17 million tons of high quality coal in 1990. The coal reserves are estimated at 7.6 billion tons and the methane reserves are estimated at 8 billion m^3. Three mines currently have methane recovery systems in place, which produced about 9 million m^3 in 1990. The mining administration received 19 million yuan in 1990 to fund a methane recovery demonstration project using vertical drilling technology. The ongoing vertical drilling activities will form the basis of the demonstration project developed under this project.

- Tiefa is a rapidly developing mining area with proven coal reserve of about 2.2 billion tons and estimated methane reserves of 28 billion m^3. In 1991, the mining administration produced 10 million tons of coal. Currently, there are 7 methane recovery systems in place, which recovered 10 million m^3 of methane in 1990. The mining administration is experimenting with the use of vertical wells drilled into gob areas. These activities, plus the active in-mine degasification program, will form the basis of the demonstration of integrated mine degasification developed under this project.

C. DEVELOPMENT OBJECTIVE

The development objective of this project is to assist China in protecting the global and local environment by developing aggressive plans to recover and use more coalbed methane from its coal mines. This objective is consistent

with the 8th FYP, which calls for increased recovery and use of methane from coal mines. The targets of the 8th FYP are very conservative, however, and will not result in the level of resource development that is justified by global environmental issues, as well as by China's energy and local environmental situation.

The project will demonstrate that significantly larger amount of methane can be recovered and used at Chinese coal mines if more aggressive policies and programmes for resource development are implemented and appropriate technologies and techniques are deployed. Through this project, the Chinese will be exposed to new technologies and techniques for resource assessment, methane recovery, and methane utilization. Successful demonstration of improved recovery techniques, comprehensive resource evaluation, and design of optimal utilization programs will establish the magnitude and value of China's coalbed methane resource for both domestic planning institutions and international development agencies for funding.

D. IMMEDIATE OBJECTIVES

1.0 Immediate Objective 1:

To develop a comprehensive methane recovery and utilization program for the Songzao Coal Mining Administration that can be funded by an international development agency and that will reduce methane emissions to the atmosphere.

1.1 Output 1: Plan recommending experimental and advanced methods for underground gas recovery at the Datong 1 and Shihao mines.

1.1.1 Define the terms of reference and select subcontractor by MOE and executing agency to develop plan and carry out activities under outputs 1.1 - 1.6. (See Annex V for job descriptions and Annex VI for draft TORs)

1.1.2 Work with Chinese counterparts to collect and evaluate available data and future plans as provided by mine and the Chongqing Institute.

1.1.3 Design database for input and analysis of data.

1.1.4 Arrange and conduct study tour abroad for 5 Chinese specialists (from the Songzao Mining Administration, the Chongqing Research Institute, and the Fushun Research Institute) to observe and analyze methods of underground gas drainage systems in other countries.

1.1.5 Recommend improvements for underground gas recovery and transport systems, gas drainage plants, including additional safety and monitoring systems, and underground drilling programs.

1.2 Output 2: Upgraded underground drilling, gas recovery and transport systems, including safety and monitoring equipment at Datong 1 and/or Shihao mines.

1.2.1 Design optimal drilling, gas recovery and transport system, including:

a. proposed panel layout
b. underground gas drainage equipment (i.e., layout, standpipes, fittings, connections)
c. drilling stations and borehole design
d. dewatering systems
e. measuring stations

1.2.2 Prepare workplan and equipment list.

1.2.3 Identify, specify, requisition, purchase, deliver, install, commission, and test equipment. (See Annex IV for equipment requirements)

1.2.4 Implement test drilling program: drill 8 boreholes at one drilling station.

1.2.5 Evaluate results of experimental underground gas drainage equipment and drilling program, and develop plan to expand program to one longwall panel.

1.2.6 Implement program on one longwall panel.

1.2.7 Conduct on-site training for mine personnel involved in operation and maintenance of all equipment and systems.

1.3 Output 3: An automatic gas drainage plant, including safety and monitoring systems at Datong 1 and/or Shihao mines.

1.3.1 Design new automatic gas drainage plant to suit local conditions, including:

-- optimal gas compressor and water pump systems
-- automatic system to regulate and control suction level
-- automatic system to control venting of gas to the atmosphere
-- control-desk to operate devices and measure/register the basic necessary parameters (methane concentration, gas flow rate, suction, pressure, temperature)
-- necessary safety equipment, including flame arrestors, non-return valves, and gas-water separators

1.3.2 Identify, specify, requisition, purchase, deliver, install, commission, and test equipment. (See Annex IV for equipment requirements)

1.3.3 Conduct on-site training for mine personnel involved in operating and maintaining all equipment and systems.

1.4 Output 4: Improved monitoring and control systems at six other existing gas drainage plants at Songzao.

1.4.1 Evaluate existing data for other Songzao coal mines and design optimal systems for safety and monitoring.

1.4.2 Study tour abroad for 5 Chinese specialists from the mining administration and the Chongqing and Fushun Research Institutes to investigate available safety and monitoring equipment. This study tour will be coordinated with activity 1.1.4 and will involve the same personnel.

1.4.3 Identify, specify, requisition, purchase, deliver, install, commission and test equipment. (See Annex IV for equipment requirements)

1.4.4 On-site training for all personnel involved in the operation and maintenance of the equipment

1.5 Output 5: Pre-investment study and optimal design of a system for integrating mine methane recovery systems and for mixing the gas.

1.5.1 Evaluate and collect existing data for Songzao mines, including likely markets for and uses of the gas (coordinated with 1.7.5).

1.5.2 Design centralized system for seam gas transport and utilization and evaluate its costs.

1.6 Output 6: Report assessing program results and potential to apply similar techniques and technologies at other mines in Songzao.

1.6.1 Evaluate results of drilling programme, operational aspects of all new equipment and effectiveness of all new techniques employed at Datong 1 and Shihao mines.

1.6.2 Evaluate results of improvements at existing gas drainage plants and effectiveness of new technologies and techniques.

1.6.3 Prepare an assessment of the overall effectiveness of the drainage system modifications made at Songzao and the potential to (1) expand efforts at other Songzao mines, and (2) transfer program results to other Chinese mines.

1.6.4 Hold a national workshop in Beijing to present the results of the program and discuss its applicability elsewhere in China.

1.7 Output 7: A pre-investment study, prepared to international lending agency standards, which evaluates the feasibility of using methane from the Songzao mines to generate electricity, and determine the site and optimal capacity of the powerplant to most effectively and efficiently use the recovered methane at Songzao.

1.7.1 Select, commission and field a team of 5 foreign experts and Chinese counterparts to prepare pre-investment study of the gas-fired powerplant. (See Annex V for job descriptions and Annex VIII-2 for outline of feasibility assessment)

1.7.2 Develop a workplan for the assessment which identifies key activities and determines Chinese and foreign responsibilities for completion of tasks.

1.7.3 Evaluate ongoing recovery improvement activities (under Outputs 1.1-1.5) so as to segregate existing and projected gas production into pipeline quality fuel (95% methane) and dilute fuel (methane/air mixtures).

1.7.4 Prepare a detailed statistical description of the variances in fuel quality and quantity.

1.7.5 Conduct a market analysis to determine local and remote energy needs (by type and quantity) and the relative economic values of these energy needs. List energy demands and relative economic values for each utilization option, including power generation, pipeline transportation, residential use, and industrial use.

1.7.6 Evaluate the state-of-the-art equipment availability and equipment suppliers for power generation using methane from coal mines, with respect to cost, prior direct and first-hand experience with unconventional gaseous fuels, equipment conversion efficiency, delivery schedules, and operator training.

1.7.7 Optimize the system design with respect to cost and fuel utilization efficiency.

1.7.8 Collect costs (Chinese) for all components, including delivery and distribution of fuel or energy, and develop a final cost estimate to get the system installed and commissioned.

1.7.9 Develop an economic model to determine profitability of the system on both a short-term (1 year) and a long-term (12-15 year) basis. Model should consider rate of return, annual utilization of the system, fuel cost, operation & maintenance costs, and applicable cost escalations.

1.7.10 Conduct a risk assessment to quantify the probability of either (1) full scale interruption of the

fuel supply for any period, (2) deterioration of fuel quality, and (3) variances in the mining schedule which would cause a loss of fuel.

1.7.11 Evaluate the financial viability of the project entity, the Songzao Mining Administration.

1.7.12 Prepare document and present findings to national government and international development agencies in national and international forums so as to attract international investment.

2.0 Immediate Objective 2:

To facilitate the production of coalbed methane using vertical well drilling technologies in advance of mining at the Kailuan Mining Administration in order to mitigate the emissions of methane to the atmosphere.

2.1 Output 1: Expanded scope of the current vertical well drilling and testing program at Kailuan Mining Administration

2.1.1 Define the terms of reference and select the subcontractor by MOE and the executing agency. The selected contractor will work closely with the Chinese counterparts to develop plan and carry out activities under outputs 2.1 - 2.5. (See Annex V for a draft terms of reference)

2.1.2 Acquire and review the Phase I results of the Advanced Resources International (ARI)/Kailuan Mining Administration project to drill and complete two experimental exploratory wells.

2.1.3 Based on the above review, implement changes as necessary in the procedures for completion of the Phase I testing of the two experimental wells, such as using a beam pump to remove water to demonstrate that production of coalbed methane is possible.

2.1.4 Review available geologic data and in consultation with Kailuan CMA experts develop a workplan for an expanded Phase I testing program, which includes selection of sites for 5 additional exploratory coreholes.

2.1.5 Identify, specify, requisition, purchase, deliver, install and commission equipment required for the expanded testing program. (See Annex IV for equipment requirements)

2.1.6 Drill five coreholes, perform desorption tests on the coal-bearing intervals, case, complete, log, and test.

2.1.7 Perform additional laboratory tests on coals such as:

a. adsorption tests
b. real-time desorption
c. vitrinite reflectance
d. maceral identification
e. proximate analysis
f. float-sink tests
g. triaxial stress tests

2.2 Output 2: Workplan for Phase II five-spot production test.

2.2.1 Analyze, integrate and evaluate data from all coreholes drilled under Phase I.

2.2.2 Assess and rank the potential for economic production of coalbed methane from the seven areas explored.

2.2.3 Select the site of a five-spot production test with the highest probability of sustained, economic production of coalbed methane.

2.2.4 Prepare report summarizing conclusions and outlining the Phase II workplan.

2.3 Output 3: A completed five-spot production test.

2.3.1 Drill four wells and core, log, case, complete, fracture, and test the coal intervals.

2.3.2 Perform desorption tests on the coal intervals, as well as other laboratory tests listed in 2.1.7 above.

2.3.3 Test permeability and gas producibility in the five-spot test area.

2.3.4 Analyze data and produce a report on the results of the tests conducted under 2.3.2 and 2.3.3.

2.4 Output 4: Plan for commercial development of the coalbed methane resources of the Kailuan Mining Administration.

2.4.1 Estimate the recoverable coalbed methane reserves of the five-spot production test area.

2.4.2 Estimate the reserves and assess the recoverability of coalbed methane in the explored areas outside of the five-spot production test area.

2.4.3 Develop a plan for expanded exploration and development of coalbed methane, including a

comprehensive utilization strategy developed with the cooperation of both the Kailuan Mining Administration and the Tangshan municipality.

2.4.4 Design and engineer gathering systems, compressor stations, gas processing facilities, and transmission pipelines necessary for the economic exploitation of the coalbed methane resource.

2.5 Output 5: Train 4 managers from the Kailuan Mining Administration that will be responsible for developing and managing an ongoing commercial coalbed methane production facility.

2.5.1 Develop and conduct a study tour of coalbed methane production facilities in the U.S.A.

2.5.2 Develop and conduct a workshop concerning the economic and technical issues associated with development, production and transmission of gas from commercial coalbed methane fields.

3.0 Immediate Objective 3:

To facilitate the development of an integrated gas drainage system that will mitigate the emissions of methane by recovering saleable coalbed methane at the Tiefa Mining Administration by using in-seam, horizontal drainholes in advance of mining and vertical wells drilled from the surface to drain properly sealed goaf areas.

3.1 Output 1: Drilled and completed longholes in a developed longwall panel in the Tiefa Mining Administration's Xiaonan Mine.

3.1.1 Define the terms of reference and select a subcontractor to implement all of the activities in cooperation with the Chinese counterparts at Tiefa as defined under outputs 3.1 - 3.7. (See Annex V for job descriptions and Annex VI for draft TORs)

3.1.2 Identify, specify, requisition, purchase, deliver, install,and commission any additional equipment required for horizontal drilling, completion, and monitoring. (See Annex IV for an equipment list and requirements)

3.1.3 Assist counterparts in the drilling and completion of the horizontal drainholes in a panel that has been prepared for mining in the Xiaonan Mine.

3.1.4 Provide on-site training to the Chinese drilling team in efficient and effective methods of drilling horizontal drainholes.

3.2 Output 2: Horizontal drainholes connected to an underground gathering systems readied for connection to transmission system.

3.2.1 Design an underground gathering system that connects the completed horizontal drainholes and provides a means of transporting the recovered methane out of the mine.

3.2.2 Develop a plan for the installation of this system.

3.2.3 Identify, specify, requisition, purchase, deliver, install, and commission any additional equipment required for connection and installation of the underground gathering system. (See Annex IV for an equipment list and requirements)

3.2.4 Provide on-site training to the Chinese drilling team in efficient and effective methods of designing, installing and connecting horizontal drainholes to gathering systems.

3.3 Output 3: One to three vertical boreholes that will serve as conduits between underground gathering systems and surface facilities and will be converted to goaf drainage wells after the mining has taken place.

3.3.1 Evaluate the feasibility of using vertical boreholes that can be initially used as conduits for transporting gas from in-mine boreholes to surface and later converted to goaf wells, and determine the optimal number and location of these boreholes, as well as a development plan.

3.3.2 Identify, specify, requisition, purchase, deliver, install, and commission equipment required for drilling and completion of the vertical borehole and connection to the underground gathering system. (See Annex IV for an equipment list and requirements)

3.3.3 Drill the necessary vertical boreholes in the identified locations.

3.3.4 Provide on-site training to the Chinese drilling team in efficient and effective methods of designing, drilling and completing a vertical borehole that will serve as conduit for gas drained from horizontal boreholes to the surface and later conversion of the borehole to a goaf drainage well.

3.3.5 When appropriate under the mining plan, assist the Chinese counterparts in converting the boreholes to goaf wells.

3.4 Output 4: Three vertical goaf wells completed and tested at the Tiefa CMA's Daxing Mine.

3.4.1 Arrange and conduct a study tour for 5 managers/engineers of the Tiefa Mining Administration and the Fushun Research Institute to visit surface goaf recovery operations in the United States.

3.4.2 Determine the optimal location for three vertical goaf wells at Daxing mine and develop a plan for installing these goaf wells.

3.4.3 Identify, specify, requisition, purchase, deliver, install and commission any additional equipment required for vertical well drilling and monitoring. (See Annex IV for an equipment requirements)

3.4.4 Assist in the drilling and completion of goaf wells at the Daxing mine.

3.4.5 Provide on-site training to the Chinese drilling team in efficient and effective methods of drilling goaf wells.

3.5 Output 5: Properly sealed and monitored goaf areas in the underground vicinity of the wells.

3.5.1 Design an engineering plan for the proper sealing of the underground goaf areas that will be drained by the wells.

3.5.2 Identify, specify, requisition, purchase, deliver, install, commission gas quality monitoring equipment. (See Annex IV for equipment requirements)

3.5.3 Implement the plan for sealing and monitoring the goaf.

3.5.4 Provide on-site training for mine personnel who will be charged with operation and maintenance of equipment and with the sealing and monitoring of goaf areas.

3.6 Output 6: Surface facilities for the collection and transmission of gas conducted to the surface via vertical boreholes from the underground horizontal drainholes and the goaf wells.

3.6.1 Develop an engineering plan for the installation of surface facilities to collect, process and transmit coalbed methane via pipeline to end user.

3.6.2 Identify, specify, requisition, purchase, deliver, install, and commission surface facilities. (See Annex IV for equipment requirements)

3.6.3 Provide on-site training to the Chinese counterparts in the operation and maintenance of the surface system.

3.7 Output 7: Development plan for wider application of an integrated program utilizing horizontal drainhole and vertical goaf well technology within the Tiefa Mining Administration.

3.7.1 Determine criteria for selection of suitable mines for development of vertical goaf well drainage programs.

3.7.2 Assess mining conditions at the Tiefa mines using the criteria and the database produced in Objective 4, to select additional candidates for wider application of an integrated horizontal drainhole and vertical goaf well drainage technology.

3.7.3 Hold a national workshop in Beijing at which the results of the Tiefa program are presented and discussed (in conjunction with 1.6.4).

4.0 Immediate Objective 4:

To assess the potential for coalbed methane development in the coal mining areas of China and to construct a database that will serve as a basis for development of programs to mitigate emissions of methane from coal mining to the atmosphere.

4.1 Output 1: Comprehensive database for five coal mining administrations in which detailed data on resources, economic recovery, and gas utilization options will be input. (List of mining administrations and criteria for selection are presented in Annex VIII-1.)

4.1.1 Compile and translate existing resources, recovery, and utilization data and information (see Annex VIII-1 for detailed list of desired types and sources of data).

4.1.2 Field 4 international consultants to review results accomplished by Xi'an Institute and available data to identify areas for improvements and develop a work plan for national assessment activities.

4.1.3 Field a database specialist and design database for input of data.

4.1.4 Identify, select and acquire necessary PC-based software for database development.

4.1.5 Input acquired data in the database system.

4.1.6 Assess quality and completeness of the data and information.

4.2 Output 2: Additional data acquired by implementation of drilling, coring, and underground sampling programs.

4.2.1 Identify methods for acquiring the required additional information and data, and develop a plan for its acquisition.

4.2.2 Develop priorities for work schedule and for mobilization of field teams. Tiefa and Songzao should be highest priorities.

4.2.3 Prepare a list of required equipment not available in China for data acquisition program.

4.2.4 Identify, specify, requisition, purchase, deliver, install, and commission required equipment and train in operation and maintenance after installation. (see Annex IV for equipment requirements)

4.2.5 Implement plan to acquire data through a drilling, coring and underground sampling program.

4.2.6 Provide on-site training in equipment operation and maintenance and efficient techniques for drilling, coring and sampling.

4.2.7 Input newly acquired data into database.

4.3 Output 3: Additional data acquired through field survey and investigation of the 5 selected administrations on the use, cost and price structure of natural gas.

4.3.1 Identify, select and commission Chinese counterparts in each mining administration;

4.3.2 Identify sources of data to be collected concerning residential cooking and heating, and industrial uses such as chemical feedstock, power generation, and industrial heat.

4.3.3 Determine the following by visiting each mining administration the price of gas, distribution costs for both existing and new systems, and expansion plans for distribution systems.

4.3.4 Prepare development plan (including utilization and pricing aspects) which can serve as a basis for funding proposals to the Chinese government or international development agencies. (See Annex VIII-1 for a list of

options to be considered and organizations to be contacted.)

4.3.5 Input newly acquired data into database.

4.4 Output 4: Additional data acquired by field visits and surveys of the 5 CMAs regarding existing recovery methods and the potential to improve recovery methods.

4.4.1 Identify, select and commi ..ion Chinese counterparts in each mining administration.

4.4.2 Identify and classify methane recovery methods by the mining administrations.

4.4.3 Visit each administration to determine:

a. types of recovery systems being used
b. volume of methane being recovered
c. effectiveness and efficiency of methane recovery
d. potential for expansion of the existing system
e. options for implementation of additional systems
f. costs for expansion and/or changes

4.4.4 Input newly acquired data into the database.

4.5 Output 5: Detailed assessment of the resources of coalbed methane, recovery potential and utilization options in the five selected mining administrations.

4.5.1 Develop methodology for classifying the resources, recovery potential and utilization options. (For a detailed discussion of the topics to be covered by the methodology, see Annex VIII-1)

4.5.2 Analyze and evaluate the data in the database, using the methodology developed under 4.5.1.

4.5.3 Prepare a development plan for each administration and compile into an overall assessment report.

4.5.4 Produce hard copy and machine readable national database to be archived at Xi'an Institute.

4.5.5 Prepare a manual for the planning, data acquisition, and assessment of potential for coalbed methane development in a mining administration.

4.6 Output 6: Preliminary assessment of the resources of coalbed methane, recovery potential and utilization options in an additional 15 selected mining administrations. (see Annex VIII-1 for complete list of mining administrations)

4.6.1 Select Chinese counterparts for the 15 additional mining administrations.

4.6.2 Compile and translate existing resources, recovery, and utilization data and information.

4.6.3 Select 5 mines for demonstration of field data acquisition techniques.

4.6.4 Acquire data from drilling, coring, and underground sampling techniques in selected mines.

4.6.5 Input and analyze existing and newly acquired data, and produce updated hard copy and machine readable national database.

4.6.6 Assess the potential for coalbed methane development in the administrations, using the methodology developed under Output 4.5.

4.6.7 Prepare a preliminary development plan for each administration and compile into an overall assessment report.

4.6.8 Combine reports prepared under 4.5.3 and 4.6.7 and publish a summary report in English and Chinese on the potential for coalbed methane development in administrations evaluated.

4.7 Output 7: Workshops and seminars on assessment of potential for coalbed methane development in gassy mines in China.

4.7.1 Conduct seminar and workshop in Beijing using manual developed in Output 4.5 for the 20 mining administrations after completion of 4.6.1.

4.7.2 After completing output 4.6, conduct an international seminar and workshop on the assessment of potential for coalbed methane development in gassy coal mines. Chinese participants will be from state and locally owned mines in China.

4.7.3 Study tour abroad for 6 Chinese specialists to learn procedures and practices of coalbed methane resource investigation.

5.0 Immediate Objective 5:

Sensitization of top policy makers and specialized training to upgrade capacity of government and mines personnel in areas of methane resource evaluation, recovery and use.

5.1 Output 1: High-level decision makers exposed to state-of-the-art technologies and techniques for coalbed methane recovery and utilization.

5.1.1 Arrange and conduct 2 study trips abroad (Australia and Japan, the United States, and Europe) for senior officials from MOE, SPC and other authorities concerned.

5.1.2 Hold an international conference in Beijing on coalbed methane utilization throughout the world, when MOE and UNDP will introduce results of the project. The Government will put forward project proposals with the view to attracting foreign private investors for joint-venture in development of coalbed methane resources.

5.2 Output 2: New conceptual designs for the recovery of methane from high gas and outburst mines.

5.2.1 Select, commission and field team of 3 foreign experts and Chinese counterparts from the Fushun and Chongqing Research Institutes. (See Annex V for job descriptions)

5.2.2 Field visit to representative mining administrations and the Fushun and Chongqing Research Institutes to discuss in detail the methods of gas recovery and current designs.

5.2.3 Prepare an annotated bibliography on the status of gas recovery techniques used internationally.

5.2.4 Foreign and Chinese experts work together at Chinese institutes to develop a "best management practices" manual on gas recovery and design new methods of gas control for Chinese conditions.

5.2.5 Hold 3 regional workshops to present new designs and determine applicability in mines throughout China.

5.3 Output 3: Train 4 engineers and technicians from the Langfang fracturing center, the Nanchong well completion center, and the Coal Geology companies in coalbed methane production using vertical wells. Coordinate this effort with the ongoing project CPR/87/15.

5.3.1 Select, commission and field team of 2 foreign experts to assist the Langfang and Nanchong centers in

upgrading their coalbed methane production techniques for purposes of training geology teams and the Fushun and Chongqing branches of the Coal Science Research Institutes in these techniques.

5.3.2 Provide two-month fellowships abroad for 1-2 engineers from Langfang and 2 senior engineers from the Coal Geology companies in hydraulic fracturing of coalbed methane wells.

5.3.3 Provide two-month fellowships abroad for 1-2 engineers from Nanchong and 2 senior engineers from the Coal Geology companies in well completion for coalbed methane wells.

5.3.4 Develop large-scale in-country training program at the Langfang and Nanchong centers.

5.4 Output 4: Six specialists from the Fushun and Chongqing Research Institutes and coal geology companies trained in the techniques and technologies of vertical well drilling.

5.4.1 Train 3 engineers from Fushun and Chongqing Institutes and coal geology companies at the Langfang center in hydraulic fracturing of coalbed methane wells.

5.4.2 Train 3 engineers from Fushun and Chongqing Institutes and coal geology companies at the Nanchong center in well completion techniques for coalbed methane wells.

5.4.3 Prepare a manual on best management practices for vertical well drilling techniques, including necessary geologic and other preparatory work, and drilling, completion, testing, fracturing and production practices.

5.4.4 Arrange a workshop with the Fushun and Chongqing Institutes to discuss vertical well drilling technologies and possible applications at Chinese coal mines.

E. INPUTS

1. GOVERNMENT INPUTS

1.1 Personnel

The Government will assign national personnel as required to carry out project activities (i.e., staff to participate in the projects at the Songzao, Kailuan, and Tiefa Mining Administrations and the national assessment). The assigned staff both at the field locations and in headquarters must be sufficient in both numbers and proficiency to provide project management and supervisorial coverage, as well as to insure continuous logistical support to the project activities.

1.1.1 Project Management

• National Project Director	1
• Deputy Project Directors	3
• Pilot Project Field Managers	4
• Project Steering Committee Staff	4
• Interpreters/Translators	2

1.1.2 Songzao Pilot Project

• Gas Drainage Specialists	10
• Mining Engineers	6
• Ventilation Engineers	3
• Drilling Personne	20
• Miners	15
• Mechanical Engineers	5
• Electrical Engineers	4
• Power Generation Engineers	4
• Civil Engineers	3
• Economists	2
• Financial Analysts	2
• Geologists	3
• Craftsmen	4
• Workers (for various tasks)	10
• Interpreters	10

1.1.3 Kailuan Pilot Project

• Geologists - economic, wellsite	6
• Petroleum Engineers	
• Production Engineers	4
• Mining Engineers	4
• Drilling Personnel	30
• Mechanical Engineers	4
• Electrical Engineers	
• Civil Engineers	2
• Gas Use Specialists	4
• Economists	2
• Financial Analysts	2
• Craftsmen	4
• Workers (for various tasks)	10
• Interpreters	1-2

1.1.4 Tiefa Pilot Project

• Mining Engineers	4
• Gas Drainage Specialists	4
• Ventilation Engineers	2
• Mechanical Engineers	6
• Electrical Engineers	2
• Miners	20
• Production Engineers	6
• Goaf Experts	3

- Geologists 4
- Gas Utilization Specialists 4
- Drilling Teams - Underground and Surface 4
- Craftsmen 4
- Workers (for various tasks) 10
- Interpreters 1-2

1.1.5 National Assessment

National Chinese Team
- Geologists 8
- Mining Engineers 4
- Gas Utilization Specialists 4
- Power Generation Engineers
- Gas Drainage Specialists 4
- Drilling and Coring Team 6
- Economist 3
- Laboratory Workers 10
- Interpreters 1-2

Assessment Site Teams
- Geologists 3
- Gas Drainage Specialists 2
- Mining Engineers 2
- Gas Use Specialists 2
- Mechanical Engineers 6
- Drilling and Coring Personnel 20
- Workers (for various tasks) 10

SUBTOTAL - ALL PERSONNEL - 342 ¥2470000 RMB

1.2 Domestic Equipment

1.2.1 Songzao Pilot Project

- In-ground Water Tanks 30000
- Lightning Protection
- Piping for transporting methane to surface 4500000
- Piping for transporting methane to gas plant 3387800
- Additional drilling equipment as needed 2730500
- Circulating water system 500000
- Automatic methane pipeline monitors 2400000
- Civil Works 1000000
- Associated Materials 1903000

SUBTOTAL - SONGZAO ¥16721300RMB

1.2.2 Kailuan Pilot Project

- Casing and fittings as needed
- Cement, Pumps and Cementing Equipment 3100000
- Fracturing Equipment 4220000

- Lightning Protection
- Civil Works 2700000
- Associated Materials 1180000

SUBTOTAL - KAILUAN ¥11200000RMB

1.2.3 Tiefa Pilot Project

- Casing and fittings as needed
- Cement, Pumps and Cementing Equipment
- Gob Sealing Materials
- Necessary Pumps and Compressors
- Piping for transporting methane to surface 1872000
- Piping for transporting methane to gas plant 1600000
- Additional drilling equipment as needed 1372000
- Circulating water system
- Automatic methane pipeline monitors
- Lightning Protection
- Civil Works 1300000
- Associated Materials

SUBTOTAL - TIEFA ¥6144000RMB

1.2.4 National Assessment

- Casing and fittings as needed
- Additional drill rods 1220000
- Drilling expendables 4000000
- Additional test equipment as needed 2800000

SUBTOTAL - ASSESSMENT ¥8020000RMB

SUBTOTAL - ALL EQUIPMENT ¥42085300RMB

1.3 Domestic Services

1.3.1 General

- Translation and Interpreting
- Printing and Copying
- In-land transportation of Vertical Drill Rig
- Transportation of Personnel as necessary
- Communications Capability in Remote Locations

SUBTOTAL - GENERAL _____RMB

1.3.2 Songzao Pilot Project

- Construction and Maintenance of Civil Works (i.e., pumphouse, gas plant) 1427600
- Special Roadway for Methane Drainage 3729600
- Underground Gas Drainage Stations 1282200
- On-site Transportation 1000000
- Other Necessary Support

SUBTOTAL - SONGZAO ¥7439400RMB

1.3.3 Kailuan Pilot Project

- Drill Pads and Road Construction 300000
- Lab Testing as Needed 2141400
- Construction and Maintenance of Civil Works 1000000
- On-Site Transportation 200000
- Other Necessary Support 4056000

SUBTOTAL - KAILUAN ¥7697400RMB

1.3.4 Tiefa Pilot Project

- Drill Pads and Road Construction
- Special Roadway for Methane Drainage Underground 240000
- Underground Drainage Stations 440000
- Construction and Maintenance of Civil Works
- On-Site Transportation
- Other Necessary Support 1200000

SUBTOTAL - TIEFA ¥4040000RMB

1.3.5 National Assessment

- Data Entry
- Transportation of Drill Rig between sites
- Drill Pads and Road Construction
- Lab Tests as necessary
- On-site Transportation
- Other Necessary Support 1580000

SUBTOTAL - ASSESSMENT ¥1580000RMB

SUBTOTAL - ALL SERVICES ¥20756800RMB

2. UNDP INPUTS

2.1 Personnel

(See Annex V for job descriptions and Annex VI for TORs)

2.1.1 Detailed job descriptions for consultants and the terms of reference for subcontracts will be prepared by the executing agency,the National Project Director and the Chief Technical Advisor.

2.1.2 The subcontractors shall provide the following personnel:

PERSONNEL	MAN-MONTHS	TRIPS
SONGZAO PILOT PROJECT		

• Gas Drainage Specialist	12.0	7
• Mining Engineer	1.0	1
• Mechanical Engineer	11.0	6
• Electrical Engineer	7.5	4
• Drilling Advisors (2 people)	4.5	3
• Technology Engineer	3.0	1
SUBTOTAL - SONGZAO	$594,000	
KAILUAN PILOT PROJECT		
• Geologist	6.0	3
• Petroleum Engineer	7.0	6
• Production Geologist	1.5	1
• Mining Engineer	1.5	1
• Production Engineer	2.0	2
• Drilling Advisors (2 people)	8.0	4
SUBTOTAL - KAILUAN	$414,000	
TIEFA PILOT PROJECT		
• Mining Engineer	6.0	5
• Drilling Advisors (2 people)	6.0	4
• Goaf Expert	3.0	2
• Gas Production Engineer	3.5	3
• Mining Geologist	1.5	1
SUBTOTAL - TIEFA PERSONNEL	$330,000	

The following consultants will be fielded to carry out, together with the Chinese counterparts, activities on national assessment:

NATIONAL ASSESSMENT		
• Economic Geologist	9.0	4
• Mining Engineer	7.5	4
• Gas Recovery Specialist	7.5	4
• Gas Use Specialist	7.5	4
• Geologist	4.0	3
• Coring/Drilling Team (2 people)	12.0	4

• Financial Expert	2.0	1
. Database design	2.0	2
SUBTOTAL - NATIONAL ASSESSMENT	$ 768,000	

2.1.3 The following additional individual consultants will be required:

PERSONNEL	MAN-MONTHS	TRIPS
• Chief Technical Advisor	9.0	6
• Gas Utilization Specialist	5.0	1
• Power Engineer	3.0	1
• Engineering Economist	3.0	1
• Gas Drainage Specialist	6.0	3
• Financial Analyst	2.0	1
• Coalbed Methane Generalists	4.0	2
• Mining Engineer	3.0	2
• Technology Engineer	3.0	2
• Hydraulic Fracturing Specialist	1.5	1
• Well Completion Specialist	1.5	1
SUBTOTAL - CONSULTANTS	$620,000	

2.2 Training (See Annex III for details)

DESCRIPTION	MAN-MONTHS
2.2.1 FELLOWSHIPS	
20 fellowships of 12 weeks each	60
2.2.2 STUDY TOURS	
7 study tour groups, with 41 people	32
SUBTOTAL - TRAINING	$873,000

2.3 Equipment (See Annex V for equipment requirements)

DESCRIPTION	$ U.S.
2.3.1 EXPENDABLE EQUIPMENT	
Songzao Pilot Project	$ 315,000
Kailuan Pilot Project	$ 75,000
Tiefa Pilot Project	$ 125,000
National Assessment	$ 125,000
SUBTOTAL - EXPENDABLES	$ 640,000
2.3.2 NON-EXPENDABLE EQUIPMENT	
Agency Purchased Equipment	$ 600,000
Songzao Pilot Project	$2,085,000
Kailuan Pilot Project	$ 500,000
Tiefa Pilot Project	$ 860,000
National Assessment	$ 900,000
SUBTOTAL - NON-EXPENDABLES	$4,945,000
SUTBTOTAL - ALL EQUIPMENT	$5,585,000

UNDP equipment and materials are for the most part items which are not available in China. Additionally, they are seldom ever used in China and their beneficial use is not understood or appreciated. These items are deemed essential to the task.

2.4 Miscellaneous:	$27,000
2.5 Contingency	$100,000
2.6 Support cost for the Executing Agency:	$700,000
Grand Total	$10,000,000

F. RISKS

The development objective of this project is complimentary to the overall stated goals of the Chinese government to develop and use coalbed methane in a more comprehensive fashion. However, the plans that are presently contemplated by the Chinese for increasing coalbed methane development are not commensurate with the size of the resource or its potential for rapid and substantial development and utilization. The risk of failing to meet the development objective of assisting the Chinese in protecting the local and global environment by increasing the utilization of coalbed

methane is low due to the modular structure [five self-contained Immediate Objectives] of the project. This modular structure allows the project to be managed in subcontracted units, thus isolating operational risks, leaving the project exposed only to broader, more diffuse, risks related to policy and institutional impediments. These risks are:

1) Risk of failing to overcome institutionalized technical limitations that effectively reduce the amount and quality of coalbed methane that can be economically produced under various mining conditions, and that impose restrictions on the range of options for gas utilization;

2) Risk of failing to broadly disseminate concepts and technology that can be appropriately applied in various mining and economic conditions throughout the coal mining administrations of China;

3) Risk of failing to effect changes in policy within the central government and coal mining administrations which currently include price disincentives and undervalue the coalbed methane resource.

Evaluation of Risk Components

1. Technical limitations are manifest in the inability of the Chinese government through its specialized coal mining institutes to assess the vast potential for economic development and utilization of the coalbed methane resources in the nation as a whole, and the responsible coal mining administrations to systematically assess, develop, and utilize the resource from a coalfield by employing standardized but often inappropriate technology. These limitations can be overcome by:

   - introduction of concepts appropriate for design, planning and execution of an assessment program in partnership with the appropriate Chinese counterparts (outputs of Immediate Objective 4)

   - by providing required training, equipment, and technical assistance for collection and analysis of data appropriate for assessment (outputs of Immediate Objective 4)

   - by using methodologies and providing technologies that are economically viable and are readily available in international markets for the development, production, and utilization of the resource (outputs of Immediate Objectives 1, 2, and 3)

   - by providing training in the use of new technologies and study tours that introduce new concepts to technical management (outputs of Immediate Objectives 1, 2, and 3)

Likelihood for failure in this component of risk is low.

2. Dissemination of information among the mining administrations is uneven. Development of a program that addresses the needs of the geographically separated and economically disparate mining administrations requires that a wide variety of Chinese personnel be contacted and involved in various phases of the project. This is accomplished by having foreign project teams visit and perform various demonstration and training functions in each of the major gassy coal basins in China, in partnership with the appropriate Chinese counterparts. In addition, as each Immediate Objective is met, a final regional or national workshop is held to insure that ideas are exchanged and the results of the demonstration projects are widely disseminated.

   Likelihood for failure in this component of risk is low.

3. The most difficult risk to overcome is the one posed by lack of policy and economic incentives that support the recovery and use of coalbed methane. It is believed that through the careful execution of the demonstration projects the benefits of coalbed methane recovery will be recognized by the participating mining administrations in the form of lower mining costs, higher levels of worker safety, and the development of a saleable by-product. A coalbed methane resource assessment and a concomitant market survey in five Chinese mining administrations will provide a detailed analysis of the cost and price structure and the potential for coalbed methane development. With cooperation of Chinese officials, this study will be used to formulate a development plan, which in turn will serve as the basis for proposals to the Chinese government and international development agencies for widespread application of the successful components of the demonstration projects (outputs of Immediate Objective 5).

   Likelihood of failure in this component of risk is moderate in the short-term and will become less as the demonstrations projects proceed and the economic, safety and environmental benefits become more apparent.

The overall risk of failing to achieve the stated development objective of assisting the Chinese in protecting the local and global environment by increasing the recovery and use of coalbed methane is low.

G. PRIOR OBLIGATIONS AND PREREQUISITES

1. The Government will allocate funds in its national budgets as indicated in Section E, Government Inputs.

2. The Government and its ministries, agencies and administrations will provide the equipment and personnel as indicated in Section E, Government Inputs.

3. The Government shall establish a Project Steering Committee, headed by a ministerial level director, and including at a minimum three deputies.

4. The Government will coordinate the selection and designation of counterparts from the various ministries, institutes, and mining administrations as required by the activities described in this document. Any Chinese personnel chosen as counterparts to participate in the various activities listed in the Immediate Objectives or participating in training programs will remain involved in the project through its duration. Whenever practical, training programs will be conducted in China, located in facilities provided by the Government appropriate for the training subjects.

5. The Government agrees to make available to the consultants or project staff the data that is required for implementation of the project. In addition, this data will be translated into English by Government supplied translators.

6. The Government will supply translators that have the necessary technical background to translate for technical consultants and project team members during the course of their work in China.

7. The Government will provide for in-country transportation of equipment, and project team members where practicable. Where public transportation must be taken by consultants and project staff members, the necessary arrangements will be made by the Government to ensure timely and appropriate forms of travel are available.

8. During visits to remote locations or mining administrations, the Government will provide housing and food for the consultants and project staff at prices that are consistent with UN daily subsistence allowances.

9. The Government will provide facilities for conducting the workshops listed in the activities section of the project document. The government will be responsible for designation of the Chinese attendees according to the requirements and guidelines for qualifying participates, as set forth by the organizers of each workshop. The Government will provide transportation, housing, and daily subsistence for the Chinese attendees. Translators will be provided by the Government to ensure ease of communication between the Chinese and foreign attendees.

10. Wherever possible, the Government will make available to

the consultants and project staff, international communication capabilities so as to ensure that timely communication is possible between consultants and/or project staff located in the project areas (specifically, remote mining administrations) and their managers located in headquarters in China or elsewhere.

The project document will be signed by UNDP, and UNDP assistance will be provided, subject to UNDP receiving

satisfaction that the prerequisites listed above have been fulfilled or are likely to be fulfilled. When anticipated fulfillment of one or more prerequisites fails to materialize, UNDP may, at its discretion, either suspend or terminate its assistance.

H. PROJECT REVIEW, REPORTING AND EVALUATION

1. The project will be subject to tripartite review (joint review) by representatives of the Government, UNDP, and the executing agency at least once every 12 months from the start of full implementation. The National Project Director and/or Senior Project Officer of the United Nations' executing agency shall prepare and submit to each tripartite review meeting a Project Performance Evaluation Report (PPER). Additional PPERs may be requested, if necessary, during the project.

2. A project terminal report will be prepared prior to final evaluation. It shall be prepared in draft sufficiently far in advance so as to allow review and technical clearance by the executing agency, at least four months prior to the post-project alveolation.

3. The project shall be subject to a evaluvation 24 months after the start of full implementation. The organization, terms of reference, and timing will be decided after consultation between the parties to the project document.

I. LEGAL CONTEXT

1. This project document shall be the instrument referred to as such in Article I, or the Standard Basis Assistance Agreement between the Government of the People's Republic of China and the United Nations Development Programme signed by the parties on 29 June 1979. The host country Implementing Agency shall, for the purpose of the Standard Basic Assistance Agreement, refer to the Government Cooperating Agency described in the agreement.

2. The following types of revision may be made in the project document with the signature of the UNDP resident representative only, provided he or she is assured that the

other signatories of the project document have no objections to the proposed changes:

a) Revisions in, or addition of, any of the annexes of the project document;

b) Revisions which do not involve significant changes in the immediate objectives, outputs or activities of the project, but are caused by the rearrangement of inputs already agreed to or by cost increase due to inflation;

c) Mandatory annual revisions which rephase the delivery of agreed project inputs or increase due to inflation; and,

d) Mandatory annual revisions which rephase the delivery of agreed project inputs or increased expert or other costs due to inflation. This should take into account agency expenditure flexibility.

J. BUDGETS

see attached tables

K. ANNEXES

I. WORK PLAN

II. SCHEDULE OF PROJECT REVIEWS, REPORTING AND EVALUATION

III. TRAINING PROGRAMME

IV. EQUIPMENT REQUIREMENTS

V. JOB DESCRIPTIONS

VI. TERMS OF REFERENCE FOR CONSULTANTS AND SUBCONTRACTS

VII. JUSTIFICATIONS FOR USE OF UNDP RESOURCES FOR EQUIPMENT

VIII. TECHNICAL ANNEXES

1. NATIONAL ASSESSMENT BACKGROUND INFORMATION

2. OUTLINE OF FEASIBILITY ASSESSMENT REQUIREMENTS

3. TECHNICAL BACKGROUND ON DEMONSTRATION SITES

ANNEX II

Schedules for project reviews, reporting and evaluation

The project will be subject to periodic tripartite reviews, evaluation and performance reporting in accordance with the policies and procedures established by UNDP for monitoring and evaluation of project and programme implementation.

The following is a tentative schedule for tripartite and terminal tripartite reviews, project performance reporting and evaluation.

Type of Review	Date
-- 1st Project Performance Evaluation Report	Aug. 1992
-- 1st Tripartite Review Meeting	Sep. 1992
-- 2nd Project Performance Evaluation Report	June 1993
-- 2nd Tripartite Review Meeting	July 1993
-- 3rd Project Performance Evaluation Report	Apr. 1994
-- 3rd Tripartite Review Meeting	May 1994
-- Draft Project Terminal Report	Jan. 1995
-- Project Terminal Report	May 1995
-- Post-project Evaluation	June 1995

(section to be completed)

ANNEX III
TRAINING PROGRAM

Study Tours

TASK	# OF PEOPLE	LENGTH	# OF MAN-MTH	LOCATION	DESCRIPTION
Output 1.1.4/1.4.2	5	3 wks	4	U.S.	In-mine gas recovery and power generation for Songzao personnel and research institutes
Output 2.5.1	4	3 wks	3	US	Coalbed methane production facilities for Kailuan personnel
Output 3.4.1	5	3 wks	4	US	Gob well methane recovery for Tiefa personnel and research institutes
Output 4.7.3	6	4 wks	6	US	Resource assessment methods for research institutes
Output 5.1.1	8	3 wks	6	US and Australia	High level personnel (SPC, MOE, CNCC, CNIMCC) visit mines, research labs and government agencies
Output 5.1.1	7	3 wks	5	Europe and Japan	Same as above
Output 5.2.3	6	3 wks	4	US and Europe	Research institutes visit research labs and mines

TOTAL	41		32		

Fellowships

TASK	# OF PEOPLE	LENGTH	# OF MAN-MTH	LOCATION	DESCRIPTION
Output 5.3.3	4	3 mts	12	US	Hydraulic Fracturing
Output 5.3.3	4	3 mths	12	US	Well Completion
Output 1.2.1 Output 3.2.2	4	3 mths	12	USA, Australia	Recovery System Design
Output 5.2.5	3	3 mths	9	USA	Economic Appraisal and Project Formulation and Evaluation
Output 4.1	4	3 mths	12	USA or UK	Resources Assessment
Total	19	15 mths	57		

In-Country Training

Songzao:

Output 1.2.7	Operations and maintenance of underground drilling stations
Output 1.3.3	Operations and maintenance of automatic gas drainage plants
Output 1.4.4	Operations and maintenance of safety and monitoring equipment

Tiefa:

Output 3.1.4	In-mine longhole drilling design and installation
Output 3.2.4 and	Operations and maintenance of in-mine methane recovery systems and

3.3.4	transportation of gas to surface
Output 3.4.5	Design, installation, and O&M on surface gob wells
Output 3.5.4	In-mine gob sealing techniques
Output 3.6.3	Design and O&M of surface recovery and processing systems

National Assessment:

Output 4.2.6	Drilling, coring and sampling techniques

Workshops

TASK	LOCATION	AUDIENCE	HOST	DESCRIPTION
Outputs 1.6.4 and 3.7.3	Beijing	National	MOE	In-mine methane recovery and use, focusing on Songzao and Tiefa achievements
Output 2.5.2	Beijing	National	MOE	Commercial coalbed methane developments using vertical technology, focusing on Kailuan achievements
Output 4.7.1	Beijing	20 assess-ment CMAs	MOE, Xi'an Research Inst.	National Assessment Workshop on methodologies
Output 4.7.2	Beijing	Internt'l	MOE, Xi'an	International Methods of Resource Assessment
Output 5.1.2	Beijing	Internt'l	MOE	Coalbed methane recovery and use practices throughout the world
Output 5.2.6	Fushun, Chongqing, elsewhere	Regional	Research Institutes	New Coalbed methane recovery designs for application in conjunction with mining
Output 5.4.4	Beijing	National	MOE	Vertical Well drilling techniques and effects on mining operations

ANNEX IV: EQUIPMENT REQUIREMENTS

NON-EXPENDABLE EQUIPMENT	PROVIDED BY:	UNDP COST	GOV'T COST
Objective 1: Songzao Pilot			
In-mine Drill Rig (3, spares)	SUBC	$500,000	
Outburst Preventors (9)	SUBC	$108,000	
Automatic Water Separators (15)	SUBC/GOVT	$ 75,000	
Complete Gas Drainage Plant: Compressors with Direct Connected Motors, Recirculating Water Pumps, Switchroom with Monitoring and Control Apparatus and Equipment, Vertical Glass-Ball Flame Arrestors	SUBC	$850,000	
Complete Automatic Monitoring and Control System for Existing Plants: Methanometers, Gas Flow Meters, Pressure Monitors, Temperature Monitors, Associated Sensors and Equipment (each set - $60,000, need 6 sets)	SUBC	$360,000	
Vertical Glass-Ball Flame Arrestors (2), Non-return Valves, Stack and Dewatering System: each set = $20,000, need 6 sets	SUBC	$120,000	
Automatic Water Separators with Connectors (2 per plant): each set = $6,000, need 6 sets	SUBC	$ 72,000	
Automatic Methane Pipeline Monitors	GOV'T		
Civil Works (Complete Buildings)	GOV'T		
Inground Water Tanks	GOV'T		
Lightning Protection	GOV'T		
Associated Materials	GOV'T		
Circulating Water System	GOV'T		
SUB-TOTAL		$2,085K	

Objective 2: Kailuan Pilot			
Conventional Top-Drive Coring and Drilling Equipment, Mud-Logging and Geophysical Logging Equipment	UNDP	$600,000	
Adsorption and Desorption Equipment, Wellheads, Gathering, Compressor Station Pressure Gauges and Continuous Monitoring and Recording Equipment	SUBC	$500,000	
Pumps and Cementing Equipment	GOV'T		
Fracturing Equipment	GOV'T		
Lightning Protection	GOV'T		
Civil Works	GOV'T		
Associated Materials	GOV'T		
SUBTOTAL		$1,100K	
Objective 3: Tiefa Pilot			
In-mine, longhole, conventional drill rig with capacity of xx meters to be used for horizontal drainhole drilling.	SUBC	$350,000	
Continuous Gas Quality Monitoring System	SUBC	$ 50,000	
Materials needed for horizontal blow-out preventors	SUBC	$ 60,000	
Wellheads, Flowmeters, Pressure Gauges, Blowers generator, Flame Arrestors, Lightning Protection	SUBC	$400,000	
Pumps and Cementing Equipment	GOV'T		
Fracturing Equipment	GOV'T		
Pumps and Compressors	GOV'T		
Additional Drilling Equipment	GOV'T		
Circulating Water System	GOV'T		
Automatic Methane Pipeline Monitors	GOV'T		
Civil Works	GOV'T		

Associated Materials	GOV'T		
SUBTOTAL		$ 910K	
Objective 4: National Assmnt			
PCs, Accessories, Software	SUBC	$100,000	
Wireline Coring Rig, Mudlogging Equipment, Adsorption and Desorption Equipment	SUBC	$800,000	
Additional Test Equipment	GOV'T		
Associated Materials	GOV'T		
SUBTOTAL		$ 900K	
TOTAL NON-EXPENDABLE		$4,945K	

EXPENDABLE EQUIPMENT	PROVIDED BY:	UNDP COST	GOV'T COST
Objective 1: Songzao Pilot			
Standpipe, Fittings, Valves, Connectors, Dewatering Systems each set = $400 (60 sets)	SUBC	$240,000	
Rods, Coring Equipment, Bits	SUBC	$ 50,000	
Fishing and Safety Tools	SUBC/GOVT	$ 25,000	
Piping Materials (underground and surface)	GOV'T		
Miscellaneous Drilling Expendables	GOV'T		
SUBTOTAL		$315,000	
Objective 2: Kailuan Pilot			
Drill Bits and Rods (coring and rotary), Strata Bits	SUBC	$ 75,000	
Casings and Fittings	GOV'T		
Cement, Cementing and Fracturing Expendables	GOV'T		
Miscellaneous Drilling Expendables	GOV'T		
SUBTOTAL		$ 75,000	
Objective 3: Tiefa Pilot			
Standpipes, Fittings, Valves and Connectors	SUBC	$ 50,000	
Drill Bits and Rods	SUBC	$ 75,000	
Casings and Fittings	GOV'T		
Cement, Cementing and Fracturing Expendables	GOV'T		
Gob Sealing Materials	GOV'T		
Piping Materials	GOV'T		
SUBTOTAL		$125,000	
Objective 4: National Assmnt			

Drill Bits (coring and rotary), Rods: 25 holes @ $5,000 each	SUBC	$125,000	
Casings and Fittings	GOV'T		
Drilling Expendables	GOV'T		
Miscellaneous Test Equipment	GOV'T		
SUBTOTAL		$125,000	
TOTAL - EXPENDABLES		$ 640K	

TOTAL - ALL EQUIPMENT

ANNEX IX
POTENTIAL FUTURE INVESTMENT OPPORTUNITIES

World Bank Projects

Sichuan Gas Development and Conservation Project

Possible source of investment funding for power generation equipment at Songzao Mining Administration in Sichuan Province. Project is being implemented by the Sichuan Petroleum Administration and the China National Petroleum Corporation. Project will be pre-appraised in June 1992 and appraised in November or December 1992. In order to be considered, MOE must have preliminary government approval for the Songzao project in place by the pre-appraisal and a draft feasibility assessment (Output 1.7) completed by the appraisal. Under the workplan included in Annex I, the draft feasibility assessment should be completed prior to appraisal.

World Bank Contact: Selina Shum

Liaoning Environment Project

Project is focusing on environmental investments in four cities--Shenyang, Anshan, Fushun and Benxi. Currently, most of the investments will be in wastewater treatment. The project is currently being identified and should be appraised in the second quarter of 1993. It is likely that there will be an air quality project developed after this project in Liaoning, particularly in Shenyang.

Project staff is interested in incorporating a feasibility assessment of coalbed methane potential in Liaoning province into the environment project, with likely major investment in development under the planned air quality project if coalbed methane is economical. MOE and other project management should coordinate with World Bank staff to ensure that the feasibility study is included in the environment project and to provide results from the Tiefa project and the national assessment as they become available.

World Bank Contact: Geoff Read

Asian Development Bank

Tangshan Environmental Project

ADB staff is strongly interested in including Kailuan coalbed methane development within the scope of the project in the interest of providing Tangshan with clean fuel. The

project, administered by Tangshan Municipality, currently consists of 13 components, including replacement or upgrading of coal boilers at industrial plants, installation of pollution control facilities at the plants, and construction of municipal wastewater and solid waste disposal facilities.

Feasibility consultants for the project are due to start work in June and July, and ADB anticipates that the investment phase will begin in the summer of 1993. ADB requests that the UNDP coalbed methane project include a pre-investment study for utilization of Kailuan coalbed methane in Tangshan. If the study outcome is favorable, ADB would plan to include coalbed methane utilization into the project early next year. ADB staff has already had encouraging contacts with Tangshan, the Ministry of Energy, and Kailuan Coal Mining Administration about the project.

ADB Contact: Mr. Ali Azimi, Manila

COUNTRY : CHIN.	DATE P CD: 03/06/92	PAGE 1

PROJECT NUMBER : CPR/92/G31/A/50/01	SHADOW BUDGET	LAST REV: 03/06/92
PROJECT TITLE : DEVELOPMENT OF COALBED METHANE RESOURCES IN CHINA		

PROJECT BUDGET COVERING UNDP CONTRIBUTION (in U.S. dollars)

PROJECT COMPONENTS	TOTAL AMT M/M	1992 AMT M/M	1993 AMT M/M	1994 AMT M/M	1995 AMT M/M
*010 PROJECT PERSONNEL					
*11 Experts:					
011-051 CHIEF TECHNICAL ADVISOR	153,000	51,000	51,000	35,000	16,000
	9.0	3.0	3.0	2.0	1.0
011-052 GAS USE SPECIALIST	170,000	54,000	68,000	48,000	
011-053 POWER ENGINEER	42,000	14,000	14,000	14,000	
	3.0	1.0	1.0	1.0	
011-054 ENGINEERING ECONOMIST	42,000	14,000	14,000	14,000	
	3.0	1.0	1.0	1.0	
011-055 GAS DRAINAGE SPECIALIST	90,000	30,000	30,000	30,000	
	6.0	2.0	2.0	2.0	
011-056 FINANCIAL ANALYST	60,000	30,000	30,000		
	4.0	2.0	2.0		
011-057 Methane generalists	60,000	30,000	15,000	15,000	
	4.0	2.0	1.0	1.0	
011-058 ECONOMIC GEOLOGIST	122,000	45,000	45,000	32,000	
	8.0	3.0	3.0	2.0	
011-059 RECOVERY SPECIALIST	114,000	54,000	30,000	30,000	
011-060 GEOLOGIST	66,000	33,000	33,000		
011-061 MINING ENGINEER	150,000	48,000	54,000	48,000	
	10.5	3.5	4.0	3.0	
011-062 TECHNOLOGY ENGINEER	48,000		32,000	16,000	
	3.0		2.0	1.0	
011-063 HYDRAULIC FRACTURING SPEC.	24,000		24,000		
011-064 WELL COMPLETION SPEC.	24,000		24,000		

COUNTRY : CHINA	DATE PRINTED: 03/06/92	PAGE 2

PROJECT NUMBER : CPR/92/G31/A/50/01	SHADOW BUDGET	LAST REV: 03/06/92
PROJECT TITLE : DEVELOPMENT OF COALBED METHANE RESOURCES IN CHINA		

PROJECT BUDGET COVERING UNDP CONTRIBUTION (in U.S. dollars)

PROJECT COMPONENTS	TOTAL AMT M/M	1992 AMT M/M	1993 AMT M/M	1994 AMT M/M	1995 AMT M/M
011-065 DATABASE SYSTEM	30,000	15,000	15,000		
011-066 CORING/DRILLING EXPERT	168,000	60,000	78,000	30,000	
11-99 Subtotal (*)	1,363,000 50.5	478,000 17.5	557,000 19.0	312,000 13.0	16,000 1.0
*16 Mission costs:					
016-001 MISSION COSTS	114,000	6,000	48,000	48,000	12,000
16-99 Subtotal (*)	114,000	6,000	48,000	48,000	12,000
019 COMPONENT TOTAL (**)	1,477,000 50.5	484,000 17.5	605,000 19.0	360,000 13.0	28,000 1.0
*020 SUBCONTRACTS					
021 011 GAS DRAINAGE SPE. (2)	186,000	86,000	50,000	50,000	
021 012 MINING ENGINEER (1)	18,000	18,000			
021 013 MECHANICAL ENGINEER (2)	168,000	68,000	70,000	30,000	
021 014 ELECTRICAL ENGINEER (2)	108,000	18,000	60,000	30,000	
021 015 DRILLING ADVISORS (3)	72,000		72,000		
021 016 TECNOLOGY ENGINEER (1)	42,000		42,000		
021 017 EXPENDABLES	315,000		315,000		
021 018 NON-EXPENDABLES	2,085,000	585,000	1,000,000	500,000	
021 021 GEOLOGIST (1)	90,000	30,000	60,000		
021 022 PETROLEUM ENGINEER (2)	120,000	18,000	80,000	22,000	
021 023 PRODUCTION GEOLOGIST	24,000			24,000	
021 024 MINING ENGINEER	24,000			24,000	
021 025 PRODUCTION ENGINEER (1)	36,000		36,000		
021 026 DRILLING EXPERTS (2)	120,000	120,000			

PROJECT NUMBER : CPR/92/G31/A/50/01 | SHADOW BUDGET | LAST REV: 03/06/92
PROJECT TITLE : DEVELOPMENT OF COALBED METHANE RESOURCES IN CHINA

PROJECT BUDGET COVERING UNDP CONTRIBUTION (in U.S. dollars)

PROJECT COMPONENTS	TOTAL AMT M/M	1992 AMT M/M	1993 AMT M/M	1994 AMT M/M	1995 AMT M/M
021 027 EXPENDABLES	75,000	75,000			
021 028 NON-EXPENDABLES	500,000	500,000			
021 031 MINING ENGINEER (1)	102,000		102,000		
021 032 DRILLING EXPERTS (2)	96,000		96,000		
021 033 COAF EXPERTS (2)	48,000		48,000		
021 034 GAS PRODUCTION ENGINEER	60,000		60,000		
021 035 MINING GEOLOGIST (1)	24,000		24,000		
021 036 NON-EXPENDABLES	860,000		560,000	300,000	
021 037 EXPENDABLES	125,000		125,000		
029 COMPONENT TOTAL (**)	5,298,000	1,518,000	2,800,000	980,000	
*030 TRAINING					
031 001 HYDRAULIC FRACTURING	90,000		90,000		
031 002 WELL COMPLETION	90,000		90,000		
031 003 RECOVERY SYSTEM DESIGN	90,000		90,000		
031 004 PROJECT EVALUATION	80,000			80,000	
031 005 GAS RESOURCES ASSESSMENT	90,000		90,000		
032 001 IN-MINE GAS RECOVERY (SONG)	40,000	40,000			
032 002 VERTICAL DRILLING (KAILUAN)	30,000		30,000		
032 003 GOB WELL GAS RECOVERY (TIEFA,	40,000		40,000		
032 004 RESOURCE ASSESMENT METHODS	63,000		63,000		
032 005 HIGH-LEV SENSITIZATION (US)	70,000		40,000	30,000	
032 006 CBM STORAGE AND USE	50,000			50,000	
032 007 DRILLING TECHNIQUES	40,000		40,000		
039 COMPONENT TOTAL (**)	773,000	40,000	573,000	160,000	
*040 EQUIPMENT					
041 000 EXPENDABLES	125,000	25,000	50,000	50,000	

: CHINA 1G

: CPR/92/G31/A/80/01
: DEVELOPMENT OF COALBED METHANE RESOURCES II

DOW BUDGET | LAS
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ET COVERING UNDP CONTRIBUTION (in U.S. dollars)

PROJECT COMPONENTS		TOTAL AMT M/M	1992 AMT M/M	1993 AMT M/M	1994 AMT M/M	1995 AMT M/M
ION-EXPENDABLE EQUIPMENT		1,500,000	600,000	450,000	450,000	
COMPONENT TOTAL	(**)	1,625,000	625,000	500,000	500,000	
SCELLANEOUS		127,000	9,000	9,000	109,000	
L MISCELLANEOUS		127,000	9,000	9,000	109,000	
COMPONENT TOTAL	(**)	700,000	700,000			
AGENCY SUPPORT COST		700,000	700,000			
001 AGNECY SUPPORT COST		10,000,000	3,376,000	4,487,000	2,109,000	28,000
		50.5	17.5	19.0	13.0	1.0
COMPONENT TOTAL	(**)	10,000,000	3,376,000	-4,487,000	2,109,000	28,000
		50.5	17.5	19.0	13.0	1.0
9 [illegible] TYPE TOTAL	(***)	10,000,000	3,376,000	-4,487,000	2,109,000	28,000
		50.5	17.5	19.0	13.0	1.0
99 UNDP TOTAL	(***)					

700.00

2676,000

8% of this needs to be spread out.