

ASIAN DEVELOPMENT BANK

TAR: OTH 37018

TECHNICAL ASSISTANCE

FOR THE

TURKMENISTAN-AFGHANISTAN-PAKISTAN

NATURAL GAS PIPELINE PROJECT (Phase II)

December 2003

CURRENCY EQUIVALENTS

(as of 1 December 2003)

Currency Unit	–	Pakistan rupee (PRe/PRs)
PRe1.00	=	\$0.017
\$1.00	=	PRs57.11

ABBREVIATIONS

ADB	–	Asian Development Bank
EIA	–	environmental impact assessment
GSPA	–	gas sale and purchase agreement
HGA	–	host government agreement
IEE	–	initial environmental examination
UGS	–	underground gas storage

NOTE

In this report, "\$" refers to US dollars.

This report was prepared by N. Jung.

I. INTRODUCTION

1. The Turkmenistan-Afghanistan-Pakistan Natural Gas Project envisages the construction of a natural-gas transmission pipeline of about 1,700 kilometers to transport about 30 billion cubic meters of gas annually from the Dauletabad gas fields in southeast Turkmenistan to consumers in Afghanistan, Pakistan, and, possibly, India. The cost of the project is estimated at about \$3.3 billion. Project implementation will take about 5 years, after the cooperating countries and other partners finally agree on project design, operating parameters, and contractual agreements. The heads of state of Turkmenistan, Afghanistan, and Pakistan met in Islamabad on 29–30 May 2002, and decided to cooperate on project implementation. A steering committee consisting of the oil and gas ministers from the three countries was established to follow up and supervise project development.

2. At its first meeting on 9–10 July 2002 at Ashgabat, the steering committee requested the Asian Development Bank (ADB) to be a development partner and to grant a regional technical assistance (TA) for various project-related studies. ADB agreed to finance a techno-economic feasibility study to cover pipeline routing, preliminary design, cost estimates, and rapid environmental impact assessment, and to assess volume-price sensitivity.¹ ADB also agreed to carry out a market study on demand for natural gas in Pakistan and northern India, and a risk analysis and risk mitigation study on concerns of gas-consuming countries and of consumers in case gas supply is disrupted along its route.²

3. The proposed TA³ is a follow-up of the recommendations of the latter study. Underground reservoirs are proposed to be built in Pakistan to store sufficient quantities of natural gas to meet unforeseen disruptions and shortages. Fact-finding was carried out on 16 – 17 September. A number of activities still need to be carried out to complete the project study. The three countries have to finalize the draft model host government agreement (HGA), gas sale and purchase agreement (GSPA), and transportation agreement. Bids will be solicited from private companies interested in joining the consortium that will build and operate the pipeline. Solicitation will be done through advertising in international oil and gas and other trade journals. Road shows and seminars will disseminate information about the project among international oil and gas and major pipeline companies. Legal advice will also be required to formalize the various agreements between the governments and consortium.

4. The project could significantly boost the economies of the countries involved, and enhance stability and improve living standards in Central and South Asia. The project is a pioneering effort to link the gas-rich Central Asian economies with the energy-deficient economies of South Asia. The project is also the first attempt to find an outlet for natural gas from Central Asia to new markets in East. However, project realization faces significant political and technical challenges. The steering committee has met six times, and the participating countries have exhibited a strong spirit of cooperation and determination to advance the project. The TA reflects the essence of ADB's approach to regional cooperation. As an active development partner, ADB will help mobilize technical expertise and financial resources.

¹ The consultants have submitted the draft feasibility report for TA 6066-REG (ADB. 2002. *Technical Assistance for the Feasibility Studies of the Turkmenistan – Afghanistan – Pakistan Natural Gas Pipeline Project*. Manila). The draft report is being reviewed by ADB and the three governments. The study indicates that even if Pakistan were the only buyer of the gas, the project would still be financially and economically viable.

² The studies were approved at the fourth and fifth steering committee meetings in February and April 2003.

³ The TA was listed in *ADB Business Opportunities* (Internet edition) on 1 September 2003.

II. ISSUES

5. If relations between the countries deteriorate, a country upstream of the pipeline system might deliberately disrupt gas supply to downstream countries, causing major economic losses.

6. The pipeline will pass through the southeastern part of Turkmenistan to southern Afghanistan (Herat-Kandahar) to Quetta and on to Multan and Pakpattan in Pakistan. The buried pipeline or other pipeline infrastructure facilities could be sabotaged by unlawful elements in Afghanistan or on the Afghanistan-Pakistan border. The Government of Pakistan, therefore, needs assurance that gas supply will not be disrupted in such an event.

7. ADB's risk mitigation study suggested the following measures to counter deliberate supply disruptions:

- (i) A contractual provision in the gas sales and purchase agreement could bind Turkmenistan and the pipeline consortium to suspend deliveries to Afghanistan and/or Pakistan in case of supply disruption until the damaged facilities have been repaired.
- (ii) The countries could have cross-holdings in subsidiary pipeline companies as well as end-user companies in each other's territories.
- (iii) Standby storage facilities of natural gas could be arranged in Pakistan to continue gas supply for, say, about two weeks, thus allowing the disruptive issue to be resolved or alternate fuel supplies to be arranged.

8. Gas demand in Pakistan, particularly in the north, is subject to major seasonal variations. During the winter (for about three months), gas supply for power generation and industrial use is severely curtailed because of increased demand for domestic space heating. The situation is further aggravated by reduced hydropower generation. Underground storage would help mitigate such shortages.

III. THE TECHNICAL ASSISTANCE

A. Purpose and Output

9. Depleted and partly depleted reservoirs, typically sandstone and limestone, may be suitable for storage of natural gas as in the United States and Europe. Gas stored in this manner is normally used for peak shaving operations and as a buffer in case of interruption of gas production and/or of the transmission system upstream from the gas storage facilities.

10. The TA will consist of (i) part A—a study on gas storage in Pakistan, and (ii) part B—advisory services to finalize the various project agreements and disseminate project information among major oil and gas and gas transportation companies.

11. Under part A, a techno-economic feasibility study will identify reservoirs (depleted oil and gas fields and salt caverns) in Pakistan most suitable for storing natural gas to cater to seasonal demand fluctuations and for emergency use in case project pipeline supply is disrupted. The TA will be implemented in two stages. In the first, possible reservoirs will be selected to limit the number of reservoirs to be studied in greater detail during the second stage. In the second stage, a study will be conducted of reservoir characteristics, injection and/or extraction facilities, required gas injection/production facilities, connection to existing and proposed gas infrastructure (including the project pipeline system), and estimated cost and time to ready these

reservoirs. The scope of work for stage 2 will depend on the results of stage 1. Two or three of the most promising reservoirs will be compared. The feasibility study will also examine the possibility of using a combination of smaller reservoirs, in different locations, for their optimum integration with existing and planned gas infrastructure.

12. Under part B, the three draft agreements (para. 2) will be reviewed, discussed in detail with the three governments, and finalized. Bids will be solicited from major oil and gas/pipeline companies, and the most suitable will be selected to lead the consortium.

B. Methodology and Key Activities

1. Part A: Gas Storage Study

13. Stage 1 of part A will focus on assessing the following reservoir characteristics:

- (i) **Size.** The reservoir needs to be uniform and large enough to hold the required working volume of cushion gas.
- (ii) **Containment.** This is the reservoir's ability to store gas without incurring losses or causing contamination of the gas.
- (iii) **Well productivity.** The required volume of gas should be produced from the reservoir using existing facilities.
- (iv) **Location and distance.** The technical feasibility and financial and economic viability of the reservoir for gas storage should be determined vis-à-vis the location of the gas transmission system and other gas infrastructure facilities (including the project pipeline system).

14. Stage 2 of part A will entail detailed evaluation of short-listed reservoirs, using the following criteria: geology and size, lithology and reservoir characterization, porosity, permeability, gas initially in place, gas water contact (if any), well productivity, historic reservoir performance, reservoir pressure development, and reserves. Gas compression facilities, and other ancillary systems/facilities required to integrate the selected reservoirs with the gas infrastructure, will also be evaluated. Cost estimates and an implementation schedule to develop and integrate these reservoirs will be prepared. Environmental issues associated with the reservoirs will be identified and assessed.

2. Part B: Advisory Services

15. Lawyers will be engaged to help the three governments finalize the HGA and the GSPA. To facilitate bid solicitation and disseminate information and relevant details of the project, it will be advertised in international magazines and promoted in road shows.

C. Cost and Financing

16. The total TA cost is estimated at \$825,000. ADB will cover the foreign exchange costs of \$690,000 and local currency costs of \$10,000 equivalent. The TA will be financed on a grant basis by ADB's TA funding program. The Government of Pakistan will provide \$125,000 equivalent for office accommodation, transport, support services, and counterpart staff for part A. TA cost estimates are in Appendix 2.

17. Any computer programs, databases, and other information developed by the consultants will be provided to the steering committee, Government of Pakistan, and ADB upon TA completion.

D. Implementation Arrangements

18. ADB will be the TA Executing Agency for the TA. Under ADB's supervision, Pakistan's Ministry of Petroleum and Natural Resources will be the Implementing Agency for part A, and the steering committee for part B.

19. The TA will require 12 person-months of input for part A by a firm of international consultants to be selected using the simplified technical proposal procedure and quality- and cost-based selection method in accordance with ADB's *Guidelines on the Use of Consultants*. The consultant will have expertise in reservoir studies and geology, and conceptual and front-end engineering design for gas storage using depleted oil/gas reservoirs; and experience in functionality regarding working volumes, deliverability, injectivity in oil/gas fields and salt caverns, and reservoir/petroleum engineering, notably field development and management of high-pressure gas pipeline and gas treatment facilities. Three person-months of individual international consultancy will be required to coordinate the work among all stakeholders, including the three governments and their various agencies, particularly with respect to Pakistan and its gas sector agencies. The terms of reference for the consultants are in Appendix 3.

20. To help the three governments finalize the model HGA, GSPA, and transportation agreement under part B, an international firm of lawyers with expertise in large natural gas/pipeline projects will be engaged in consultation with the Office of the General Counsel.

21. The HGA will grant and guarantee the pipeline consortium the rights and concessions it needs to implement the project, in return for which the government will receive a transit fee. Under the GSPA the gas off-taker will agree to buy, and the supplier agree to supply, the gas, which is to pass through the pipeline. Under the transportation agreement the pipeline consortium will agree to transport gas for the buyer (or the seller), which will receive a transportation fee (or tariff) in return.

22. The TA is expected to begin in March 2004 and be completed by October 2004. For part A, the international consultant will submit an inception report in one month after appointment. A draft final report will be submitted for review of all stakeholders and ADB within 6 months of the inception mission. The final report will be submitted within a month of receipt of comments and after taking into account the comments on the draft final report. All the reports will be presented to the steering committee. Ten copies each in Russian and Dari will be prepared separately for the use of Turkmenistan and Afghanistan. Under part B, the law firm will finalize and present to the steering committee a set of final agreements (HGA, GSPA, and transportation agreement) by June 2004.

IV. THE PRESIDENT'S DECISION

23. The President, acting under the authority delegated by the Board, has approved the provision of technical assistance not exceeding the equivalent of \$700,000 on a grant basis for the Turkmenistan-Afghanistan-Pakistan Natural Gas Pipeline Project (Phase II), and hereby reports this action to the Board.

TECHNICAL ASSISTANCE FRAMEWORK

Design Summary	Performance Indicators/Targets	Monitoring Mechanisms	Assumptions and Risks
Goal (i) Encourage storage of natural gas to secure its supply and mitigate the risk of supply disruption or shortages when demand peaks	Ensured availability of natural gas for 10–15 days in case of disruption to pipeline Increased supply of gas during winter	Reports by the project consortium and reports by gas companies Reports by the project consortium and reports by gas companies	
Purpose Identify the most suitable reservoirs	Appropriate size, containment well, productivity, and location	TA study as confirmed by the steering committee and Asian Development Bank (ADB) review missions	Availability of adequate data Existence of suitable reservoirs
Outputs Study and locate suitable reservoirs to store natural gas in two phases: (i) Prepare a long-list of all available reservoirs (ii) Short-list the most suitable reservoirs for the study Agreements finalized between the governments, consortium, and gas sellers and buyers Expressions of interest received from private sector	Techno-economic feasibility study acceptable to all partners Acceptance by all governments of the agreements Expressions of interest received	ADB review missions Consultants' periodic reports Review by staff Review by staff	Continued commitment of the Government of Pakistan to provide all data/assistance for the study Agreement between the governments

Design Summary	Performance Indicators/Targets	Monitoring Mechanisms	Assumptions and Risks
Project information disseminated	Number of road shows and seminars held	Review by staff	
Activities			
Locate the reservoirs	Arrangements to make the reservoir functional in the shortest time possible	ADB review missions	Continued commitment of the GOP to provide all data/assistance for the study
Determine the most efficient ways to use the reservoirs		Consultants' periodic reports	
Estimate time and costs	Establishment of economic and financial rates of return		
Engage the governments to finalize the agreements	Finalization of agreements	As above	Adequate interest from governments and investors
Issue advertisements to solicit interest	Publishing of advertisements		
Conduct road shows and seminars	Holding of road shows		
Inputs			
Consulting services	International consulting services for 15 person-months	ADB review missions, periodic reports, review meetings	Capable consultants
Costs	Estimated total cost \$825,000 equivalent, including \$135,000 in local currency		
Financing	ADB financing of \$700,000 and Government of Pakistan contribution of \$125,000		Availability of counterpart funds

COST ESTIMATES AND FINANCING PLAN
(\$ '000)

Item	Foreign Exchange	Local Currency	Total Cost
A. Asian Development Bank Financing^a			
1. Part A			
a. International Consultants			
i. Remuneration and Per Diem International Consultants	355	0	355
ii. International and Local Travel	50	10	60
iii. Reports and Communications	10	0	10
b. Miscellaneous Administration & Support Costs	20	0	20
c. Representative for Contract Negotiations	5	0	5
d. Contingencies	50	0	50
Subtotal (A1)	490	10	500
2. Part B			
Solicitation of Bids, Legal Fees, Seminars, Road Shows, etc.	200	0	200
Subtotal (A)	690	10	700
B. Government of Pakistan Financing			
1. Office Accommodation and Transport	0	75	75
2. Remuneration and Per Diem of Counterpart Staff	0	50	50
Subtotal (B)	0	125	125
Total	690	135	825

^a Financed by ADB's technical assistance funding program.
Source: Asian Development Bank estimates.

OUTLINE TERMS OF REFERENCE FOR CONSULTANTS

A. Part A: Gas Storage Study

1. The study will be conducted by an international consulting company, which will provide 12 person-months of services. It will carry out all investigations to estimate costs, feasibility, work over, new facilities, construction, and operation and maintenance for the Pakistan underground gas storage (UGS) project based on depleted hydrocarbon reservoirs.

1. Scope of Work under Stage 1

2. Endorsed by the Ministry of Petroleum and Natural Resources, the most suitable reservoirs will be selected and used for the Pakistan UGS. Field selection will depend on the pipeline route through Afghanistan (north or south) selected to build the pipeline. The consultant will do the following:

- (i) Review the reservoirs available, list all the reservoirs examined, and short-list them, ranking them according to suitability for UGS functionality, using as criteria containment, reservoir size, well productivity, and distance to project infrastructure.
- (ii) Investigate how existing and planned infrastructure can be best used in relation to UGS and market location.
- (iii) Define the magnitude and timing of the winter service gas load in the medium term to meet peak shaving and security requirements.
- (iv) Review the extent to which interruptible gas contracts may induce industrial fuel users to shift from gas to other fuels during supply interruptions and peak load season.
- (v) Report on the selection of reservoirs most suitable for UGS and examine the feasibility of connecting them to the project pipeline systems. Two or three of the most promising candidate fields will be compared. Alternatively, the potential and comparative advantages of developing two smaller reservoirs for gas storage may be investigated. The objective is to develop an optimum proposal for UGS.

2. Scope of Work under Stage 2

3. The consultant will prepare a feasibility report on conversion to UGS of the selected fields and estimate its cost. The feasibility study will cover (i) reservoir aspects, (ii) injection and/or extraction facilities, (iii) connections to the project and national gas transmission systems, (iv) environmental aspects of the reservoirs and their related facilities, (v) implementation schedule, and (vi) cost estimates.

a. Reservoir Aspects

4. The suitability of fields selected will be based on UGS functionality requirements, using analysis of geological, geophysical, and petro-physical data; well data; production and test data; existing reservoir reports; and field studies.

5. The reservoir aspects to be addressed include (i) reservoir geometry and size, (ii) containment and leakage risks, (iii) lithology and reservoir characterization, (iv) porosity, (v) permeability, (vi) fluid contacts, (vii) compartmentalization, (viii) gas initially in place, (ix) well

productivity, (x) historic reservoir performance, (xi) reservoir pressure development, and (xii) material balance.

6. Containment is critical to determine the suitability of a depleted gas field for UGS. Containment is the reservoir's ability to store and handle gas with little loss or harm to public health and safety and the environment. Although the gas fields have a proven retention capability, their long- term containment integrity for UGS will have to be critically reviewed.

7. For each selected reservoir the study will establish a likely optimum configuration for UGS duty based on defined UGS functionality, including number and type of wells (horizontal and/or vertical or tubing diameter); amount of cushion gas required; maximum permissible pressure; and minimum operating pressure. Associated risks and uncertainties will be highlighted.

b. Injection and Extraction Facilities

8. The consultant will investigate how many existing wells are suitable for UGS. For new wells the optimum type (tubing diameter, horizontal and/or vertical) will be identified.

9. **Gas Compression into Storage.** A compressor station at the UGS will be derived and sized to compress gas from project pipeline pressure to storage injection pressure. The compressor station will be modular so that its throughput can be increased in line with gas off-take from the project.

10. **Gas Conditioning Out of Storage.** Gas extracted from storage will be saturated with water and possible heavier hydrocarbons under UGS reservoir conditions. It will also need to have its pressure reduced suitably for pipeline operation and conditioned to depress the water and hydrocarbon dew points and reduce impurities. Any requirement for gas compression from storage into the transmission system will be assessed.

11. **Gas Metering.** Gas to storage will be subject to fiscal metering at the off-take from the project and at the output points from storage, either into the Pakistan gas distribution system or back into the project for onward transmission to India, or both.

12. Gas consumption associated with UGS operation will also be metered for internal accounting purposes.

c. Ancillary Systems

13. UGS will be supported by its own operating infrastructure and will be connected to the control center for the project pipeline, the Sui control center, and the center to be developed to meet Indian gas demand.

d. Connection of the Gas Transmission System

14. UGS will be connected to the project pipeline on its alignment along the selected route with important cities that are in reasonably close through spur lines. The spur line will be sized to transport gas at the maximum flow rate determined for input into storage.

15. The Sui Southern Gas Company has a hydraulic model of the Sui southern and the northern gas pipeline network in Pipeline Studio's bureau package program, TGNET. The gas

company will make the updated model, including planned network developments up to 2020, available to the consultant. The consultant will use the model to assess its capacity to transport output gas flows from UGS to the Pakistan gas market. An optimum solution for UGS output gas connections to the existing network will be derived and sized with all de-bottlenecking, facilities, reversal of flow, etc.

16. Depending on the characteristics of the Pakistan gas distribution system and its enhancements, the study will look into the possibility of reconnecting output gas to India. Therefore, the spur line will be sized for the maximum outflow of gas from storage.

e. System Construction

17. The consultant will assess the engineering and equipment requirements to accommodate required injection and withdrawal rates. The consultant will assess these rates for the selected reservoirs.

3. Project Management

18. Proper project management is imperative for efficient construction and operation of the Pakistan UGS. The international consultant will develop a detailed project implementation schedule, estimate costs, and identify bid packages for the entire system. The work schedule will be of level-1 ($\pm 30\%$) network type and be in sufficient detail to permit monitoring of individual activities. The overall cost estimate will have an accuracy of $\pm 30\%$. From his or her design, the international consultant will tabulate material and construction costs for the following facilities:

- (i) construction costs—wells (worked over and new), compressor stations, gas conditioning plant, meter stations, pipelines, control system, and other facilities as required; and
- (ii) operating costs—labor, transportation, maintenance and spare parts, fuel gas, insurance, and management costs.

4. Environmental Analysis

19. The consultant will undertake the following:

- (i) Identify and assess environmental issues associated with the natural gas storage reservoirs.
- (ii) Prepare an environmental impact assessment (EIA) and summary EIA or initial environmental examination (IEE) and summary IEE report based on ADB's 2003 *Environmental Assessment Guidelines* as appropriate.

5. Economic Analysis

20. The consultant will undertake the following:

- (i) Estimate the financial capital and operating costs and carry out least-cost, viability, and distributional analysis of the project, including sensitivity analysis according to ADB's *Guidelines for the Economic Analysis of Projects* using a net present value approach based on a discounted cash-flow analysis to assess the comparative economic advantage of the project.

- (ii) Undertake economic benefit-cost analysis to confirm the overall viability of the project in terms of economic internal rates of return as per ADB's *Guidelines for the Economic Analysis of Projects*.
- (iii) Assess the uncertainties and risks facing the project, and carry out sensitivity analyses to check its viability under adverse conditions.
- (iv) Evaluate the project's direct and indirect environmental impacts and carry out an economic analysis of these impacts in terms of net present value and internal rates of return in accordance with ADB's *Handbook on Economic Evaluation of Environmental Impacts*.

6. Financial Analysis

21. The international consultant will undertake the following:

- (i) Prepare detailed project design cost estimates in ADB format based on 2004 prices expressed in foreign exchange, including appropriate provisions for physical contingency, price escalation, and interest during construction.
- (ii) Assess the financial feasibility and performance of the project, prepare appropriate financial statements in accordance with ADB's *Guidelines for the Preparation and Presentation of Financial Analysis*, and undertake benefit-cost analysis to compute the financial internal rate of return for individual investment components.
- (iii) Undertake sensitivity analyses for the financial evaluation of all components, considering key factors that could affect their viability.

7. Project Viability

22. After completing the financial and economic analyses, the international consultant will analyze all the collected information and in-country observations and recommend ways to make the project viable, considering (i) cost competitiveness of gas released from storage with alternative sources of standby fuel or feedstock (diesel, high fuel oil, etc); and (ii) interruptible contracts.

8. Individual Consultant's Services

23. An individual technical consultant with wide experience in the natural gas industry—including appraisal, development, financing, and implementation of large integrated gas projects—is required for 3 person-months on an intermittent basis to assist in TA monitoring and implementation. The consultant's broad terms of reference follow:

- (i) Review the study carried out on medium-term gas supply and demand balances; average and peak demand, taking into account coincidence factors; and average and peak supply capability. Assess gas storage requirements to remedy possible supply interruptions.
- (ii) Review the main gas supply concerns of the gas-importing countries and other industry participants under the project.
- (iii) Based on gas supply and security concerns, review the technical and economic aspects of options to meet projected demand, including UGS and other demand management measures.
- (iv) Monitor the flow of information and documents between the TA consultants and ADB to ensure completeness of data, timely implementation, work optimization,

and possible fragmentation of responsibilities that might result in delays and added costs.

- (v) Review and monitor the risks inherent in implementing such large projects and identify possible means for risk mitigation.
- (vi) Review the areas of ownership, operational arrangements, and financing for the various parts of the integrated gas project.
- (vii) Coordinate the work among all stakeholders and ADB, including the three governments and their various agencies.
- (viii) Review and comment on all reports and recommendations of the TA consultant for technical validity, accuracy, and completeness.

B. Part B: Advisory Services

24. The lawyers will undertake the following tasks:

- (i) Help finalize the model host government agreement, model gas sale and purchase agreement, and transportation agreement in consultation with the governments.
- (ii) Assist in and advise on preparation and finalization of all associated documents required to form the consortium.
- (iii) Help the steering committee and governments dialogue and negotiate with the private companies selected to be part of the consortium.