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Technical report: The Premises Development Study on a Gas Trunkline Loop over Middle East Countries*

Prepared by Chiyoda Corporation in cooperation with
United Nations Industrial Development Organization

Based on the work of Experts from Chiyoda Corporation

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Industrial Cooperation and Management Services Branch

V.94-25319

CONTENTS

EXECUTIVE SUMMARY

- Experts of UNIDO and CHIYODA have jointly completed the present report entitled: "Premises Development Study on a Gas TRUNKLINE LOOP over Middle East Countries", which represents the preparatory PHASE I of a large-scale multinational project intended to benefit the natural gas producing countries of the Middle East region: Iran, Oman, Qatar, Saudi Arabia, Syria and the U.A.E., as well as the gas consuming countries of the region: Jordan and Turkey, and also Japan, and Far East Asian and European countries.

- The basic concept underlying the project is the loop-route design of the gas collection/distribution system which will provide access to multiple sources of gas existing all over the region, and assure in this way a higher security/stability of long-term gas supply to consumers. Under such premise it can be expected that the Middle East region will become one of the two largest exporters of gas to Europe, Japan and Asian countries, while the other largest group will be composed of countries of the Former Soviet Union.

- Throughout the interviews conducted by the experts of the study team with representatives of Governments and institutions/companies of the Middle East region it was felt that the concept of the project is welcome, whereby it has been accepted in principle that there is an inherent need for taking into account co-operation with existing and committed LNG plants as well as other pipelines under consideration, such as: from Turkmenistan to Turkey, from Iran to India, from Qatar to Pakistan and from Oman to India. It was mutually understood that these plants and pipelines would also benefit from co-operation with the TRUNKLINE LOOP through providing higher security/stability and long-term back-up of gas supply to importing countries.

- The TRUNKLINE LOOP passes through 8 Middle East countries as shown in Fig. 1 "THE LOOP MAP". It will evidently be possible in the future to connect Iraq and Kuwait to the LOOP by spur pipelines.

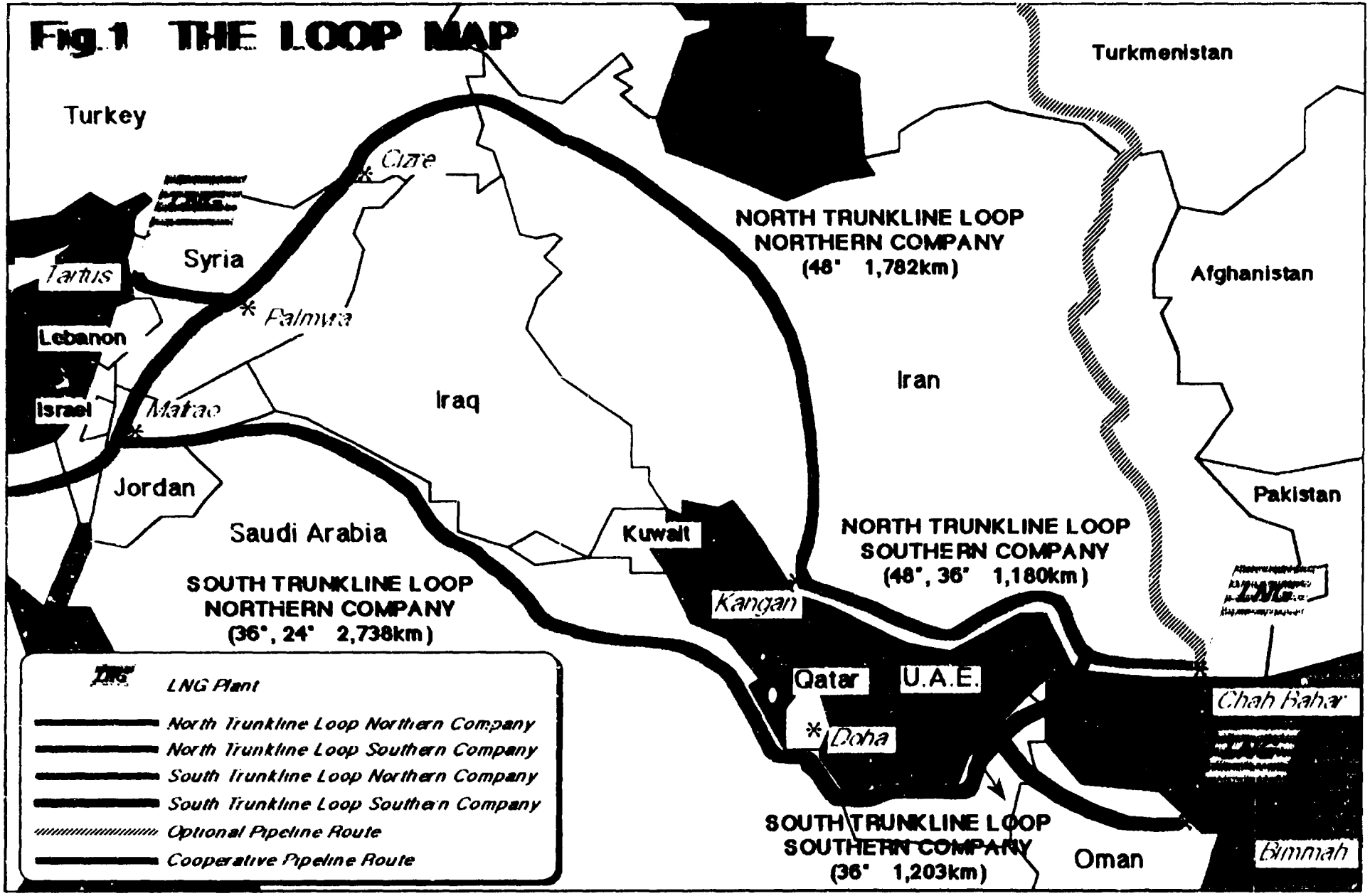


Fig.1 THE LOOP MAP
Turkey
Ceyhan
Tartus
Syria
Palmyra
Lebanon
Israel
Haifa
Iraq
Jordan
Saudi Arabia
Kuwait
Iran
Turkmenistan
Afghanistan
Pakistan
NORTH TRUNKLINE LOOP
NORTHERN COMPANY
(48" 1,782km)
NORTH TRUNKLINE LOOP
SOUTHERN COMPANY
(48", 36" 1,180km)
SOUTH TRUNKLINE LOOP
NORTHERN COMPANY
(36", 24" 2,738km)
SOUTH TRUNKLINE LOOP
SOUTHERN COMPANY
(36" 1,203km)
Kangan
Qatar
U.A.E.
Doha
Oman
Chah Bahar
Bimmah
LNG Plant
North Trunkline Loop Northern Company
North Trunkline Loop Southern Company
South Trunkline Loop Northern Company
South Trunkline Loop Southern Company
Optional Pipeline Route
Cooperative Pipeline Route

The proposed route of the TRUNKLINE LOOP has been surveyed and selected on the basis of a geological and geographical report prepared by Ove Arup & Partners (U.K.) and then discussed in each Middle East country. No technical problems have become evident.

- For the mechanical engineering design of the TRUNKLINE pipe diameters of 48" (full size) and 36" (half size) have been chosen and shall be applied to meet optimal flow rate requirements of gas transmission through appropriately selected Segments of the LOOP. Based on currently available technology the design pressure of the pipes shall be 148 bar A to attain maximum throughput wherever and whenever needed.

- The key techno-economic parameters applied as premises of the STUDY and presumed for the PROJECT are:

  PROJECT Life : 50 years
  Technical: 100 years for the pipeline, and 50 years for the LNG plants.

  Financing : Soft Loan conditions
  3 per cent interest rate, 10 years grace period, 40 years repayment of the loan.

- The demand for gas to be transmitted through the LOOP for export to Europe and Japan/Asia, as well as to countries of the Middle East region that are not endowed with sources of natural gas, has been summarized as follows:

	Year of 2010		2020	
To Europe	15	BCMY	23	BCMY
	(10.5	MMTY)	(16.0	MMTY)
To Japan/Asia	28.7	BCMY	43.1	BCMY
	(20	MMTY)	(30	MMTY)
To Regional Countries	13.9	BCMY	22.4	BCMY
	(9.7	MMTY)	(15.6	MMTY)

	Year of 2010		2020	
including:				
- Jordan	–		8.5	BCMY
- Turkey	13.9	BCMY	13.9	BCMY

- The outline of the TRUNKLINE LOOP and its Segments, as well as construction and gas transmission costs defined by the STUDY are:

	Pipe-Size	Length (Km)	Const. Cost (Billion US$)	Completion (year)	Transmission Cost (US$/MMBTU)
NORTH TRUNKLINE LOOP					
- Southern Segment*	48"	1,180	1.91	2010	0.18
- Northern Segment	48"	1,782	3.17	2010	0.30
SOUTH TRUNKLINE LOOP					
- Southern Segment*	36"	1,203	1.43	2010	0.27
- Northern Segment**	36"	2,738	3.46	2020	0.57
Total		6,903	9.97		0.30 (wt avg.)

Note* Includes 50% length of the mechanical connection under the Gulf of Oman south to the Strait of Hormuz (36", 345 Km).

** Includes 24" branch pipeline from Palmyra to Tartus (210 km).

The cost of transmission through the SOUTH TRUNKLINE LOOP - Northern Segment (from near Doha, Qatar, to near Cizre, Turkey) is higher than the economically acceptable limit for exporting the gas to Europe through an extension of the LOOP from a point in Turkey. It is necessary to seriously consider a shortcut of the gas transmission route to the planned North African Pipeline by connecting the off-take from the TRUNKLINE LOOP at a point of the SOUTH TRUNKLINE LOOP in Jordan.

The gas transmission cost by using a pipe diameter of 36" (half size) instead of 48" (full size) is higher by approximately 20 per cent. It appears necessary, therefore, to investigate possibilities of increasing the demand for gas in Europe and Japan/Asia that would justify a full utilization of the throughput capacity of a 48" diameter pipeline.

- The economic effect of applying a partial soft loan financing arrangement also for the establishment of LNG plants for export of gas to Japan has been investigated, contrary to the presently usual EXIM Bank loan conditions applied for the total capital requirement. The aim of considerations was to reduce the gas liquefaction costs, and thus to compensate partly for the surcharge which becomes due for transmission of the gas through the TRUNKLINE LOOP to the liquefaction plants.

  It has been found that financing of approximately 50 per cent of the investment capital requirements under soft loan conditions would suffice for proving the feasibility of such scenario which henceforth should be pursued.

  A further option worth taking into consideration proposes a higher than 50 per cent coverage of the total investment cost of the LNG plant by financing arrangement under soft loan conditions to compensate the entire gas transmission surcharge for the TRUNKLINE LOOP service.

  In particular, the effect of such option should favourably be considered because of the evident benefit of attaining higher security/stability and long-term assurance of gas supply warranted by the establishment and operation of the TRUNKLINE LOOP PROJECT.

  Another benefit deriving from the PROJECT is of cost-saving nature. The TRUNKLINE LOOP may be regarded as replacement of the need for increasing the LNG emergency stockpile in Japan. It would physically substitute a stockpile and thus save investment in such otherwise necessary storage facility.

- Additional gas supplies from Turkmenistan to the South-East end of the TRUNKLINE LOOP, as an optional arrangement, would reinforce in the future the attainment of higher security/stability and long-term availability of gas resulting from the PROJECT.

This scenario should also be pursued as a separate programme for implementation after the year 2020.

- The following corporate structure of the PROJECT and operating modalities of the TRUNKLINE LOOP have been assumed:

  - four (4) Sub-regional TRUNKLINE LOOP Joint-venture companies for investment and operation of each Segment of the LOOP shall be established by interested parties of the gas producing and consuming countries;

  - one (1) Central Joint-venture company shall be established by the afore-mentioned four Joint-venture companies for overall co-ordination of the natural gas collection, distribution and export business, and the technical services required.

- The Sub-regional TRUNKLINE LOOP Joint-venture companies shall define the cost of transmitting the gas through their respective Segments for the gas producers and consumers (eg. represented by gas exporting or importing companies). The pertinent commercial transactions shall preferably be based on long-term contracts.

- The Sub-regional Joint-venture companies are expected to act as service enterprises and shall pursue an economic policy of "cost plus transmission surcharge" (in principle of non-profit nature) while being otherwise supported by the soft loan financing arrangements of the gas producing and consumer countries. To the contrary, each gas exporting company dealing with producers of the gas and LNG as well as arranging for shipment or further transmission by pipeline to the market shall be expected to operate as profit centres.

- The proposed PHASE II IMPLEMENTATION STUDY will concentrate on the development of gas export projects for attaining full capacity utilization of the TRUNKLINE LOOP and will elaborate a financing plan with particular attention to arrangements to be made for implementation of the PROJECT under soft loan terms.

Moreover, the STUDY will comprise preparatory work on agreements to be reached among the concerned countries, as well as essential engineering design work necessary for expediting the implementation of Segments of the PROJECT.

It is assumed to take 18 months of work of a multidisciplinary study team of experts, whereas the cost, presumably amounting to several million dollars, shall be covered by a multinational financing effort.

1. INTRODUCTION

The United Nations Industrial Development Organization (UNIDO) and CHIYODA Corporation of Japan (CHIYODA) have jointly taken the initiative of studying the techno-economic aspects of a multinational effort to develop a project on the establishment of a **Gas TRUNKLINE LOOP over Middle East Countries**, (the PROJECT). Preparatory work has been undertaken within provisions of a Trust Fund Agreement between UNIDO and CHIYODA.

The concept of the PROJECT was first promoted by Mr. K. Nagata, Sr. Coordinator of CHIYODA, at the 6th Annual Arab Press Service (APS) Conference on "Middle East Strategy to the Year 2005", convened in Nicosia on 29 September 1992.

The Gas TRUNKLINE LOOP would have an approximate length of 7,000 kilometers and lead through Saudi Arabia, the United Arab Emirates, through the Gulf of Oman South to the Strait of Hormuz, Iran, Turkey, Syria and Jordan. Gas would thus be distributed over the region for the benefit of each of the Middle East countries participating in the PROJECT. It would also be charged into separate branches attached to the TRUNKLINE LOOP for transmitting the gas to the pipeline network of Europe, and into two branches respectively, through Iran and Oman to LNG plants serving as bases mainly for export to Japan and Asian countries of the Far East. Eventually, 23 and 43 billion cubic meters per year (BCMY) of gas could pass through the corresponding branches to Europe and to Japan and Asian countries, respectively.

The preliminary estimated overall cost of the trunkline system would approximately amount to US$ 10 billion and should preferably be funded by soft loans from international financing institutions such as World Bank, EBRD, EIB, ADB, etc., and gas consumers of Europe and Japan, as well as from gas producers of the Middle East countries. The target time of completion of the system would be post 2010, in due consideration of the assumption that Europe would need to

diversify their gas resources further by increasing supplies from the Middle East, and Japan would shift the majority share of their demand for natural gas from current sources (some of which will by the year 2010 already have been spent out) to sources of the Middle East region.

It can be expected, however, that some parts of the TRUNKLINE LOOP can be constructed earlier, such as the lines: from Qatar to Oman, and from Kangan in Iran to South Iran, as well as revamping of the IGAT pipeline in response to prior needs of each sub-region and their economic and development related requirements, similar to construction of consecutive sections of highways. Therefore, it is essential to establish a Master Plan in advance, under mutual understanding among and coordination between Middle East countries so that those earlier constructed sections would consistently tally with the overall final system. The process of reaching a mutual understanding regarding investments and future joint operation of the system by Middle East countries is expected to contribute extensively to the enhancement of industrial and economic development of the entire Middle East region.

In pursuance of the above concept UNIDO and CHIYODA jointly undertook in February 1993 to conduct the "Premises Development Study on a Gas TRUNKLINE LOOP over Middle East Countries" as PHASE I of the PROJECT.

The proposed concept has been appreciated in the countries concerned. A number of preliminary meetings between CHIYODA and candidates for cooperation were held as brain storming sessions which resulted in modifications of the initial conceptual basis of the STUDY and options to be investigated, and provided preliminary commitments for cooperation.

On 12 December 1992, CHIYODA and ENI/SNAM concurred to cooperate in the manner that ENI/SNAM shall represent the European interests and policies and make finally available to CHIYODA the

related European study, namely "Prospective Du Gas Naturel En Afrique du Nord, Version Finale, October 1993" prepared by Observatoire Méditerranéen De l'Energie, as an input to this STUDY and to make it an integral part thereof in form of an ANNEX.

After having positively evaluated the potential merits and viability in principle of the proposed ca. ten billion dollar PROJECT, UNIDO has expressed its readiness to pursue the international coordination of the necessary preparatory work towards the establishment of the PROJECT, and to assist in the collection of basic technical and economic data, execution of pertinent supplementary studies, formulation of agreements, etc.

2. OBJECTIVES AND TARGETS

2.1 Objectives

This STUDY aims at:

i) Strengthening the cooperation amongst Middle East countries, Europe and Japan through the PROJECT which is expected to lead to mutually beneficial utilization of gas resources and favour long-term export commitments:

- promote industrial development of each country of the region participating in the PROJECT through easier, diversified and secured access to natural gas for any purposes, mainly as a means of energy supply through electric power generation and combustion heat for chemical, metallurgical, food processing, and other industries, wherever technically opportune and economically justified;

- benefit the gas producing countries of the Middle East region, directly through income generated by the TRUNKLINE service, and indirectly through providing an increased crude oil export potential owing to possible further replacement of domestic oil consumption by gas;

- provide higher security, more stable and longer lasting supply to gas importing countries. This effect will be attained by the TRUNKLINE LOOP system through linking manifold gas supply resources of the Middle East region with outlets to Europe by pipeline and liquefaction, and to Japan by liquefaction, outside of the Gulf area. Especially, the proposed system which combines abundant resources of gas can also be considered as substitution of increasing the LNG emergency stockpile (storage inventory) in Japan. Countries of the two large gas importing regions, i.e. the European and East Asian countries, would thus be connected to prospective and reliable gas resources of the Gulf area;

- improve the environmental conditions caused by decreased CO_2, SO_x and NO_x emissions over the Middle East countries as a result of replacement of oil burning by natural gas as source of energy;

ii) Developing the premises of the PROJECT as well as the first Master Plan of the PROJECT based on mutual understanding of the Middle East countries in order to proceed with the subsequent phase: the TRUNKLINE LOOP IMPLEMENTATION STUDY, and to provide concepts for the immediate future with the aim of undertaking the construction of some gas pipelines in the area in advance, whenever possible.

2.2 Targets

The STUDY on the TRUNKLINE LOOP over Middle East Countries has been assumed to produce the following outputs:

- Preliminary Master Plan showing the geographical pipeline route, gas production/consumption and export plans, gas transmission diagrams with pressure ratings, pipeline size, location of compressor stations, details of branch pipelines to Europe, and to Iran/Oman for exporting the gas to Japan.

- Preliminary cost estimates of investment and operation.

- Economic analyses of various options under most favourable techno-economic and financing conditions.

- Conceptual plan for elaboration of PHASE II IMPLEMENTATION STUDY, and for reaching pertinent agreements with countries and entities expected to participate in the PROJECT.

3. DISCUSSION OF CONCEPTS

As compared to the initial concept the basis and lay-out of the STUDY have been adjusted or changed throughout the preparatory work on this report.

3.1 Summary Conclusions of Interviews

During interviews with the concerned high level government officials in each of the Middle East countries, their strategies, preferences and plans for the development of their gas fields and related gas collection/distribution systems have been found more advanced than expected. It has been the most important and challenging task to find a way of harmonizing and matching the programmes and projects, undertaken by each individual country, with the proposed overall new TRUNKLINE LOOP system. However, it has also been necessary to partially disregard some of those that did not fit into the concept of the overall system.

- The most difficult issue is how to systemize between unexpected but likely huge requirements of Turkey and uncertainties regarding means of transportation and transmission routes of the gas to Europe.

- Historical conservatism regarding gas transactions between Turkey and Iran is understood. However, the preliminary evaluation of the situation indicates that Turkey should preferably import gas from Iran through the LOOP together with transmission of gas from Iran to Europe, taking into consideration the geographical advantage of such transmission and the higher security resulting from the proposed multinational supporting PROJECT as compared to Turkey's independent gas import plan.

- The originally proposed strategy regarding the concept of constructing one single branch of the LOOP for exporting the gas to Japan and Asian countries has been changed in reflection of

some political preferences of Southern LOOP countries such as Qatar, the U.A.E., and Oman. These countries would favour a second independent branch from the Southern LOOP at the side of the Gulf of Oman, with a liquefaction plant adjacent to a possible SHELL/Japanese Consortium plant, for common use of off-plot facilities and the jetty.

In this case, the segment of the LOOP through the Gulf of Oman south to the Strait of Hormuz would become a mechanical connection closing the LOOP between its Northern and Southern Segments.

- Iran and UNIDO/CHIYODA would agree to establish an additional pipeline from Turkmenistan to Chah Bahar, Iran, onshore over a desert route on Iranian territory. This would constitute an advantageous and efficient strategy to increase gas availability and enhance the security of supply. In this STUDY however, only a brief model concept is presented for consideration as an optional proposition.

- Both Turkey and Syria expressed interest in constructing a LNG plant for export to Europe. Tentatively the location of the LNG plant in Syria had been considered in this STUDY, because the length of the branch from the TRUNKLINE LOOP in Syria is shorter. Appropriate options should be considered during elaboration of PHASE II of the STUDY since the requirements of European countries are at present not certain as regards the means of gas transmission (pipeline or LNG) and location of off-take points at the destination.

- UNIDO/CHIYODA could not arrange to date for an opportunity to interview high level officials of the Saudi Arabian Government. Therefore, its strategies, preferences and plans, other than those known from journals and technical publications, are not reflected in this STUDY.

- Certain countries expressed their interest in receiving an income for the right of way for transmission of gas on their territory. However, charges for the right of way for pipeline construction and land acquisition for compressor stations are assumed to be nil in due consideration of the beneficial nature of the PROJECT to the national economy of each country participating in the PROJECT.

- Certain countries expressed their concerns in connection with their existing and planned possible future LNG plants, but understand the benefit of connecting them to the LOOP. Their LNG plants could continue production even after the countries' own natural gas reserves (usually of a life of 20-30 years) would be spent out. Thereafter the LNG plants could be supplied from the LOOP to the extent of future gas demand of any magnitude.

- Most of the countries accepted the multinational venture concept for the company structure of the PROJECT. However, the opinion of some of them regarding plant operation varies. Viable and mutually acceptable modalities need still to be worked out.

- Iran indicated its difficulty on legal grounds. Multinational ventures in the field of energy related sectors are prohibited under the current law. This problem needs to be solved for further development of the PROJECT, including the possibility of utilizing the "Free Zone" concept of Qeshm Island.

3.2 Cooperative Pipeline Plan

- The STUDY takes into account the cooperation of the TRUNKLINE LOOP PROJECT with the North African Pipeline Plan which has been proposed by ENI in 1991 at a joint meeting with representatives of Maghreb countries. Since then the concept of the pipeline has been studied by the Observatoire Méditerranéen De l'Energie (representing a group of companies of the Northern and Southern Mediterranean region). Mutual understanding is

presumed that the North African lines will be connected from a point of the TRUNKLINE LOOP in Jordan to Egypt through Israel, onshore their territories, at least as a mechanical tie-up for increasing the flexibility of operation and enhancing the security and long-term availability of gas supply to Europe.

- During the preparatory work on the STUDY, several other pipeline plans that could be connected with the TRUNKLINE LOOP have become known and considered as follows:

  a. Turkmenistan through Turkey
     by BOTAS

  b. Qatar to Pakistan
     by Crescent Petroleum Corporation

  c. Oman to India
     by Oman Oil Company

  d. Iran through Pakistan to India
     by Oil India Limited

  All of these lines have been presumed as potential future cooperative linkages with the TRUNKLINE LOOP and are considered as not competing with the PROJECT. UNIDO/CHIYODA did not pursue those possible cooperation plans in this STUDY since they are still rather of conceptual nature or in a preliminary stage of investigation.

3.3 Other Aspects

- Japan, the largest LNG importer, has recently been debating the need for increasing its emergency stockpile of natural gas (storage inventory) which now constitutes a hold-up of only 24 days, while the crude oil stockpile has reached 142 days in April 1993. It should also be noted that the storage of LNG is by far more expensive than that of crude oil.

The above-mentioned fact favourably supports the establishment of the LOOP, which constitutes an active support system by means of double-directional supply pipelines, that in case of shut-off or break-down of gas flow at any points would assure continuity of transmission. The LOOP represents a multisource supply potential and assures a higher supply security without a necessity of routing the gas through the Strait of Hormuz, and could thus be considered as substitution for the otherwise necessary increase of the LNG stockpile in Japan.

- Traditionally, the technical life of LNG plants is being assumed 20-25 years as standard. However, some of the existing plants constructed in the 1960s and early 1970s have already been operated for more than 20 years. Recently, discussions have started on how to extend the life of LNG plants, e.g. at the workshop of the 11th LNG Conference, Kuala Lumpur in 1992. An extension of their technical life-time up to 50 years is considered a most likely achievable target at this stage of industrial development, but presupposes a reasonable level of the estimated maintenance cost.

4. STUDY TEAM

CHIYODA and UNIDO have jointly conducted the STUDY in cooperation with their external contributors included in the Task Force Team as shown in Figure 4.1.

CHIYODA professionals have mainly conducted the interviews with senior government officials of the Middle East countries and have proposed the technical contents of the STUDY, while UNIDO has co-ordinated the entire work on the STUDY and contributed its share to the economic analysis of the PROJECT.

ENI of Italy has provided advice to CHIYODA and UNIDO, in its capacity as representative of the European countries regarding their demand for gas, and has engaged in discussions with European companies and the European Economic Community (EEC) on their possible cooperation with the planned North African Pipeline.

SNAMPROGETTI, Italy has assisted CHIYODA in the technical design of the TRUNKLINE LOOP.

The STUDY PROGRAMME SCHEDULE pursued by the STUDY TEAM is attached as Figure 4.2.

Figure 4.1 Task Force Team for the Study

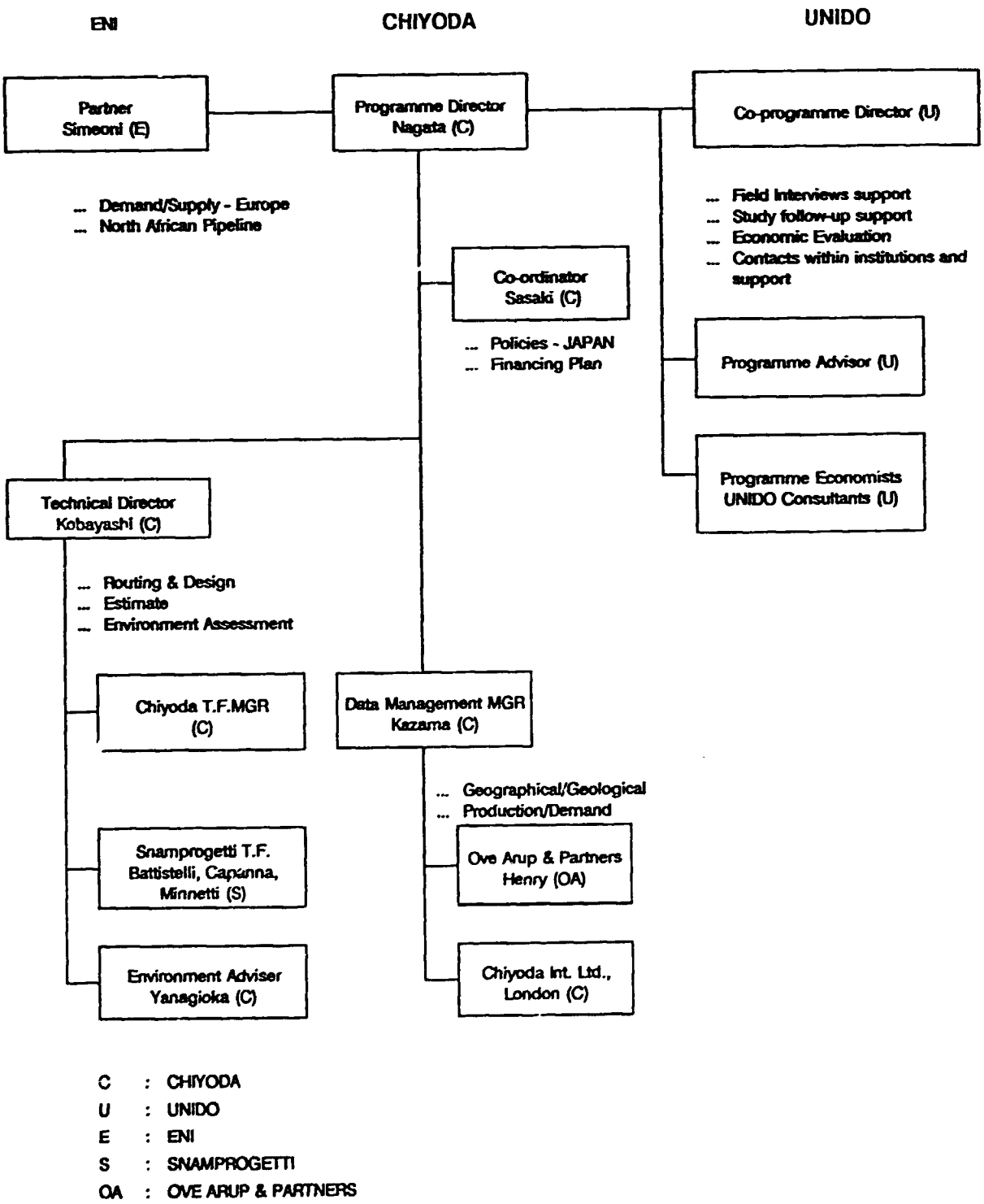
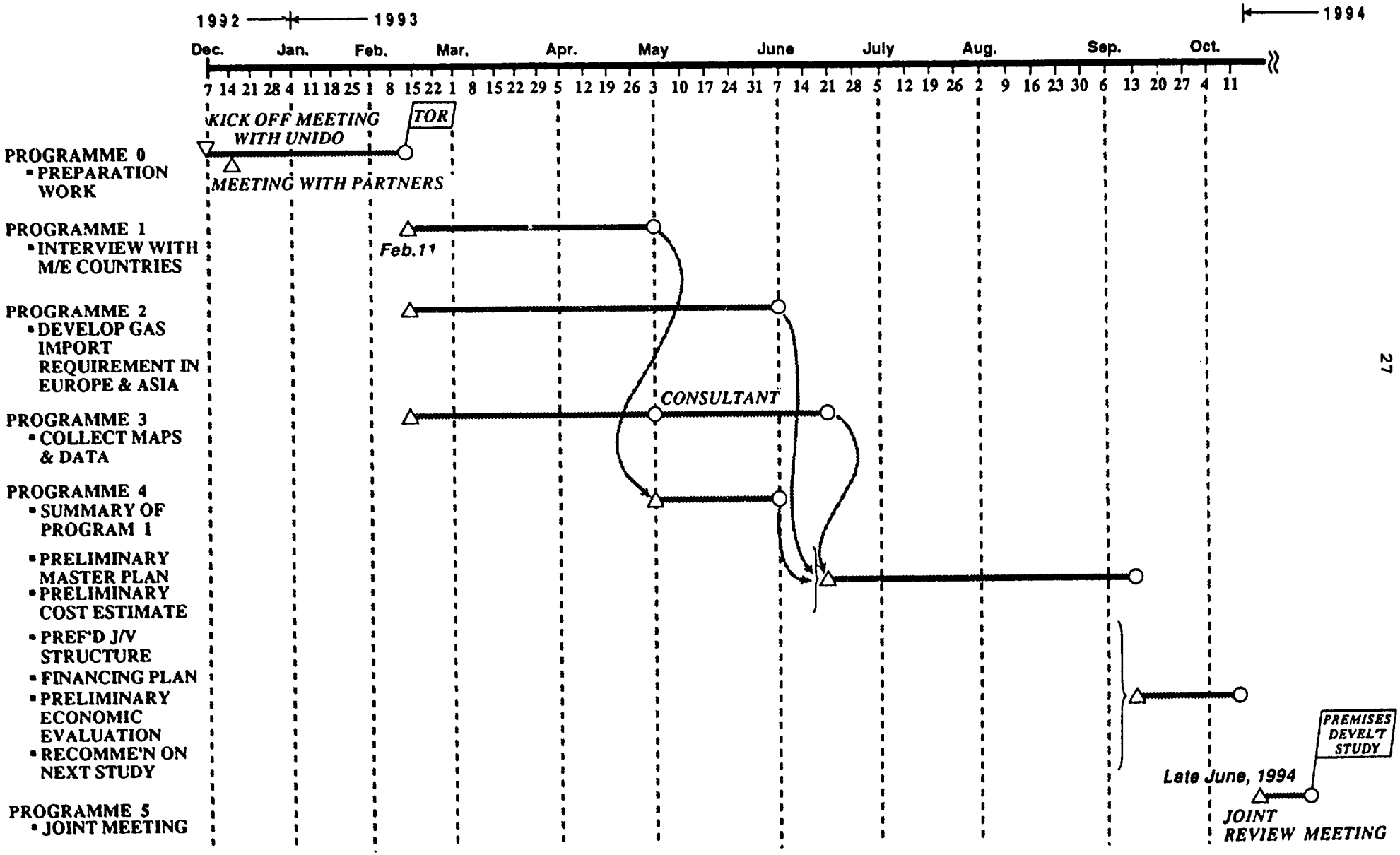


Fig. 4.2 STUDY PROGRAMME SCHEDULE



5. STUDY BASIS AND OPTIONS

5.1 Study Basis

5.1.1 Strategy and Concept

The basic concept and strategy for the establishment of the Gas TRUNKLINE LOOP over Middle East Countries have originated firstly from the idea that the LOOP over Middle East Countries promotes mutually beneficial interdependence. It supports industrial development of each country, in particular, and of the entire region, in general, because pipeline gas transmission is of very real time nature with no simple alternative as is the case with pipeline oil transportation and shipment. It also promotes peace among the participating countries because of its social and macro-economic effects and integrates possible interests of gas markets of Europe and Japan.

- Europe may need the gas from the Middle East region which offers additional diversified sources of supply, whereby the LOOP represents a remarkable potential.

- Japan may replace its current major Asian gas sources of supply by those of the Middle East countries in the years 2010 - 2020, due to the declining output of the Asian gas reserves.

- Both Europe and Japan could take advantage of the much increased security of gas supplies provided by the connection to manifold gas resources and through the loop-design of the collection/distribution system.

The route of the LOOP is assumed to lead from Turkey through Iran, offshore under the Gulf of Oman, through the United Arab Emirates, near Qatar, Saudi Arabia, Jordan, Syria and back to Turkey. However, Iraq and Kuwait are assumed to use the lines to and from the LOOP in the future.

Three separate branches shall be connected to the TRUNKLINE LOOP. One branch shall lead from Palmyra to Tartus in Syria for export to Europe by LNG. An option for connecting a branch to the LOOP in Turkey for the same purpose shall be studied in PHASE II IMPLEMENTATION STUDY. Among the other two eastward directed branches for export of LNG to Japan and Asian countries, one shall lead from near Kuh-e Mobarak of the LOOP in the southeastern part of Iran to Chah Bahar in Iran, where a LNG plant is to be constructed. The other branch shall extend from the LOOP near Abu Dhabi in the U.A.E. to Bimmah in Oman, where another LNG plant shall be constructed.

However, branches to Europe by pipelines other than the North African Pipeline have not been defined in this STUDY, but tentatively assumed to lead through Turkey or Azerbaijan (along with the IGAT I pipeline).

Domestic demand and supply within each country shall be a part of the service of the LOOP. This requirement, however, is disregarded for the system design of the present STUDY.

The total length of the TRUNKLINE LOOP and the three extension branches, as shown in Figure 5.1, is estimated at approximately 7,000 kilometers. The length of the main TRUNKLINE LOOP is approximately 5,800 km (comprising the length of the connecting lines in Oman and Iran inclusive of the off-shore line under the Gulf of Oman of ca. 345 km), whereas the length of the branch from Palmyra to Tartus, the branch from near Kuh-e Mobarak to Chah Bahar, and the branch from near Abu Dhabi to Bimmah is approximately 210 km., 300 km., and 590 km., respectively. (The total length of these branches is 1,100 km).

The TRUNKLINE LOOP is designed to be operated in bilateral directions. The capacities of the various Segments of the TRUNKLINE LOOP have been defined, and the number and location as well as power requirements of compressor stations have been optimized is this STUDY.

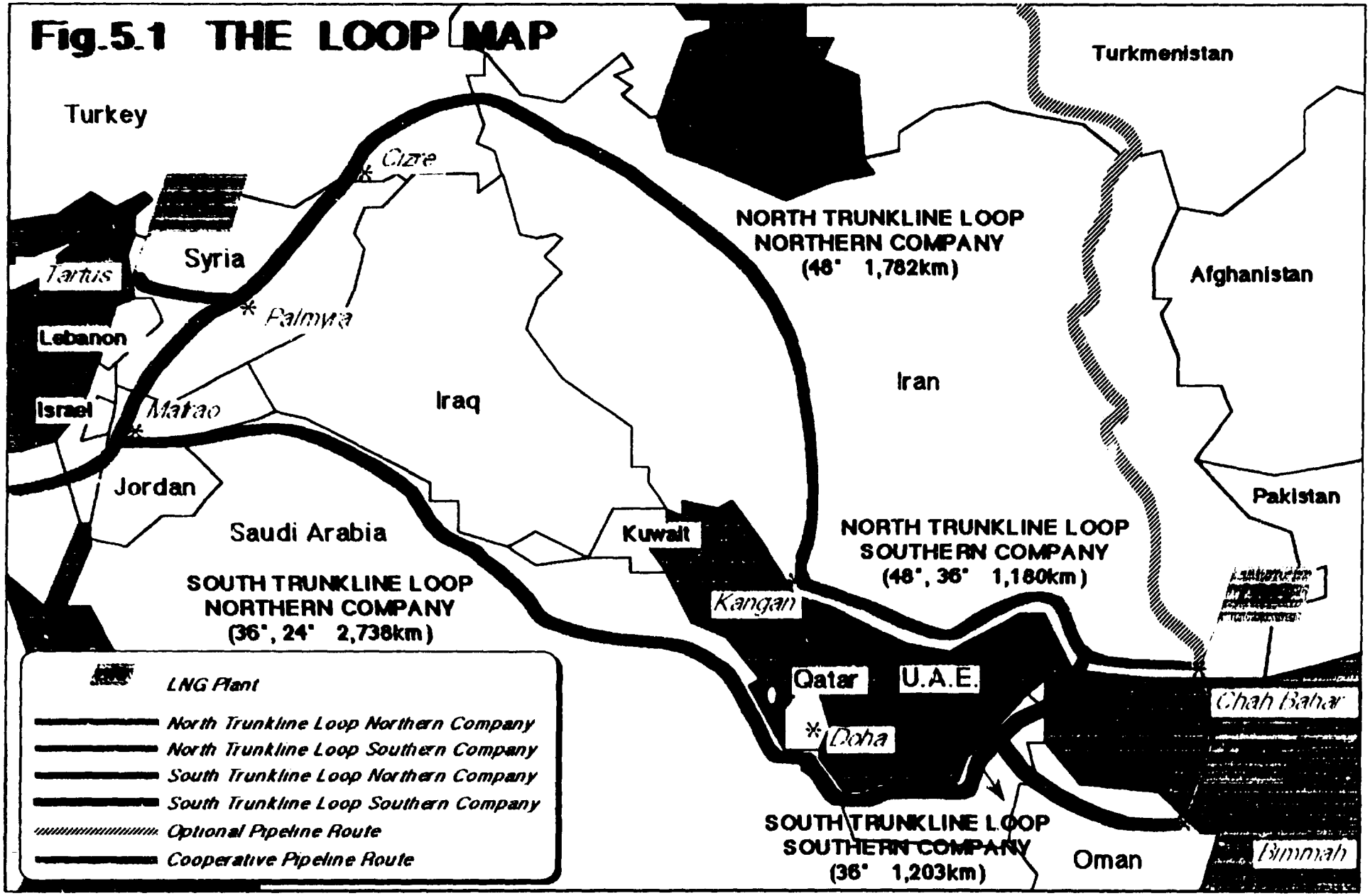


Fig.5.1 THE LOOP MAP
Turkmenistan
Turkey
Cizre
NORTH TRUNKLINE LOOP
NORTHERN COMPANY
(48° 1,782km)
Syria
Tartus
Afghanistan
Palmyra
Lebanon
Iran
Israel
Mafraq
Iraq
Jordan
Pakistan
Saudi Arabia
Kuwait
NORTH TRUNKLINE LOOP
SOUTHERN COMPANY
(48°, 36° 1,180km)
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Bimmah
LNG Plant
North Trunkline Loop Northern Company
North Trunkline Loop Southern Company
South Trunkline Loop Northern Company
South Trunkline Loop Southern Company
Optional Pipeline Route
Cooperative Pipeline Route

During the course of interviews with high level government officials of most of the Middle East countries involved, such as: Iran, Oman, the U.A.E., Qatar, Jordan, Syria and Turkey, and by taking into account the results of an overall geological and geographical survey along the route of the LOOP, the following concept and strategy has been developed and defined:

a) A single 48" API 5L/X70 pipeline (Design pressure : 148 bar A) is assumed as full size of the LOOP, while considering that this is the presently possible largest sizing and highest rating under the current technology and code/regulation available based on actual world-wide experiences; and a 36" API 5L/X70 pipeline (Design pressure : 148 bar A) is assumed as half size of the LOOP where preferable and reasonable, in due consideration of the possibility to duplicate it in the future, when necessary.

b) Together with the above-mentioned pipeline sizing philosophy, it is proposed that the construction schedule of Stage 2010 (Completion in the year 2010) and of Stage 2020 (Completion in the year 2020) shall reflect the expected development of the market demand for the gas.

c) The foregoing two paragraphs imply that design of the LOOP would be somewhat hardware oriented, whereas the requirements of the market would need to be partially adjusted or sacrificed.

d) The proposed route excludes Iraq and Kuwait, and the preferred favourable route of the TRUNKLINE LOOP shall definitely lead through Iran, Turkey, Syria, Jordan, Saudi Arabia and the U.A.E. Such route would: (1) be of benefit to countries deficient in natural gas resources or having a small production only, such as Turkey, Syria and Jordan, (2) offer an easier and better cooperation with the planned North African Gas Pipeline, which aims at stability of energy supplies to the Mediterranean countries, (3) broaden the option for exporting gas to Europe, and (4) be more convenient for connecting branch pipelines from Iraq and Kuwait to the LOOP from the viewpoint of system design.

e) Cooperation with existing and/or planned pipelines of each country shall be fully taken into account, especially during the period between Stage 2010 and Stage 2020. However, their details shall be defined in the PHASE II IMPLEMENTATION STUDY.

f) The route needed for connecting the northern and southern Segments of the TRUNKLINE has been proposed with a view to assuring high supply security. It is proposed to lead the connecting pipeline through the Gulf of Oman south to the Strait of Hormuz on the continental shelf.

g) The routes of existing oil and gas pipelines such as IGAT 1 & 2, IGAT 2 to Tabriz, and the TAP line are fully recognized and taken into account as far as possible.

h) Cooperation of the TRUNKLINE LOOP PROJECT with the planned North African Gas Pipeline (under study by the Observatoire Méditerranéen De l'Energie) has been considered. The tentative solution proposed at this stage is to establish a mechanical connection for mutual flexibility of operation and security of gas supplies. It should preferably be completed in the beginning of the 21st century, providing a possibility of pipeline gas transmission from the LOOP to the western part of Europe by using the surplus throughput capacity of the North African Pipeline.

i) Cooperation with other multinational gas pipelines that are being planned, such as the pipelines from Turkmenistan to Turkey, from Iran through Pakistan to India, from Oman to India, and from Qatar to Pakistan, would be possible and beneficial. Such options will, however, further be considered in the PHASE II IMPLEMENTATION STUDY.

j) Further branches for transmission of gas to Europe, other than the branch from Syria for LNG export and the connection from the LOOP to the European market through a pipeline, would be considered. However the location of these additional branches and assignment of connecting points are left open in this STUDY for further discussion.

k) The overall TRUNKLINE LOOP PROJECT life is tentatively assumed to extend over 100 years for design purposes, in due consideration of the abundance of gas reserves in the entire region.

5.1.2 System Design

a) Countries producing gas for export, such as Iran and Qatar/U.A.E. are assumed to supply the gas to the LOOP at no ceiling quantity or on an "as required basis" because of their huge reserves of gas. Consequently for design purposes it was not necessary to take into account the gas production and supply to the LOOP from the U.A.E.

b) In reflection of the gas reserves of Iran and Qatar/U.A.E., which have an exiting operating plant and committed export capacity in total amounting to 10 MMTY of LNG, Iran is assumed to supply its gas to the LOOP through the Southern Segment of the North Gas TRUNKLINE LOOP to Chah Bahar in quantities satisfying two third (2/3) of the expected off-take of Japan and Asian countries.

Qatar/U.A.E. is assumed to supply their gas to the LOOP in quantities satisfying one third (1/3) of the expected off-take of Japan and Asian countries through the Southern Segment of the South Gas TRUNKLINE LOOP (GCC side of the LOOP) to Bimmah.

c) The connecting points of branches for transmission of the gas by pipeline to Europe are assumed at a certain location on the LOOP between near Bu'in in Iran and near Cizre in Turkey, while the connecting point of the branch pipeline for gas supply to Europe (by LNG from a liquefaction plant located at Tartus) is proposed at Palmyra in Syria with a capacity of 8.0 BCMY.

d) The connection between the North Gas TRUNKLINE LOOP and the South Gas TRUNKLINE LOOP, outside the Strait of Hormuz, is to be constructed as a mechanical link for obtaining flexibility of operation and security of gas supply to consumers.

e) Iran is assumed to supply its gas to the LOOP for off-take by Europe in the year 2010 through the Northern Segment of the North Gas TRUNKLINE LOOP to a certain connecting point at near Cizre in Turkey. Iran is assumed to supply also additional gas to the LOOP for satisfying a part of Turkey's demand in the year 2010, while further assuming that Turkey may start to import gas from gas fields that may possibly jointly be developed by Turkey and Syria along their border, or by LNG that would satisfy the demand of Turkey until the year 2010.

f) Iran and Qatar/U.A.E. are assumed to supply gas to the LOOP for off-take of Europe, both through the Northern Segment of the North Gas TRUNKLINE and Northern Segment of the South Gas TRUNKLINE, respectively to certain points in the Mediterranean seaside countries in the year 2020. Iran is assumed to supply gas to the LOOP also for Turkey's share of demand, and Qatar/U.A.E. is expected to supply gas for Jordan's share of demand in the year 2020.

g) Syria has abundant gas reserves which suffice to satisfy her domestic demand for gas as forecast till the year 2010. Therefore, the supply of gas from the LOOP to Syria has not been taken into account for design purposes.

h) A progressive Construction Schedule has been assumed as follows:

Completion by the year 2010

- Kangan to Chah Bahar	(Full size 48")
- Kangan to near Cizre	(Full size 48")
- Near Doha to Bimmah	(Half size 36")

Completion by the year 2020

- Near Doha to near Cizre	(Half size 36")
- Palmyra to Tartus	(Size 24")
- Trans Gulf of Oman line	(Half size 36")

i) For details of gas flow sequences, elevation and distances of Segments, Sections and Branches of the LOOP, reference be made to Figure 5.2 and 5.3. However, the balance of gas input and output relating to the domestic consumption of each country has been disregarded for the design purposes of the LOOP.

5.1.3 Basic Data

a) Gas Composition

For design purposes the gas composition within the LOOP is assumed to comply with that from Qatar offshore sources, as follows:

Composition	Mol %
N2	3.70
C1	90.34
C2	5.88
C3	0.08
	100.00

Fig. 5.2 OUTLINE OF NORTH GAS TRUNKLINE LOOP

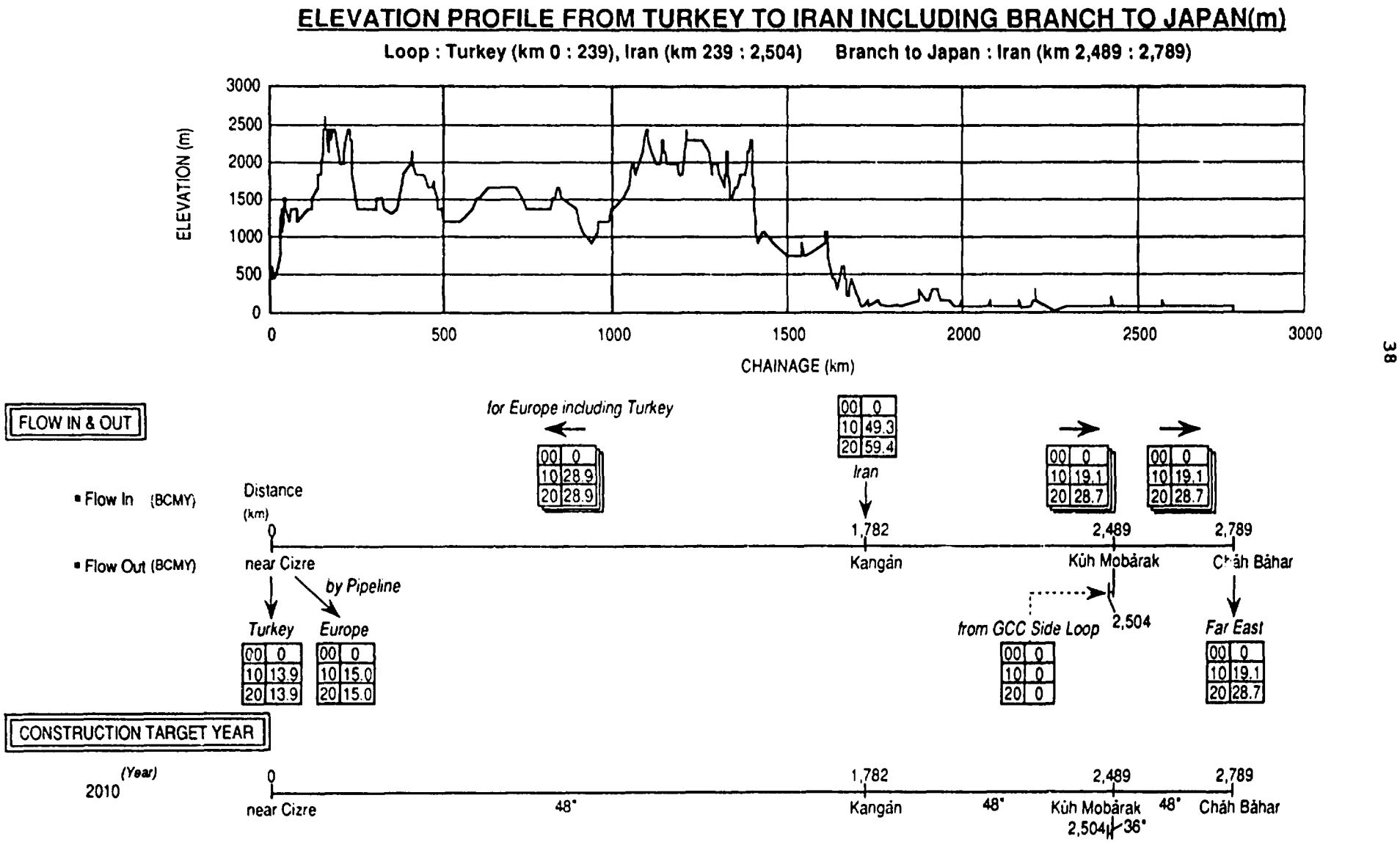


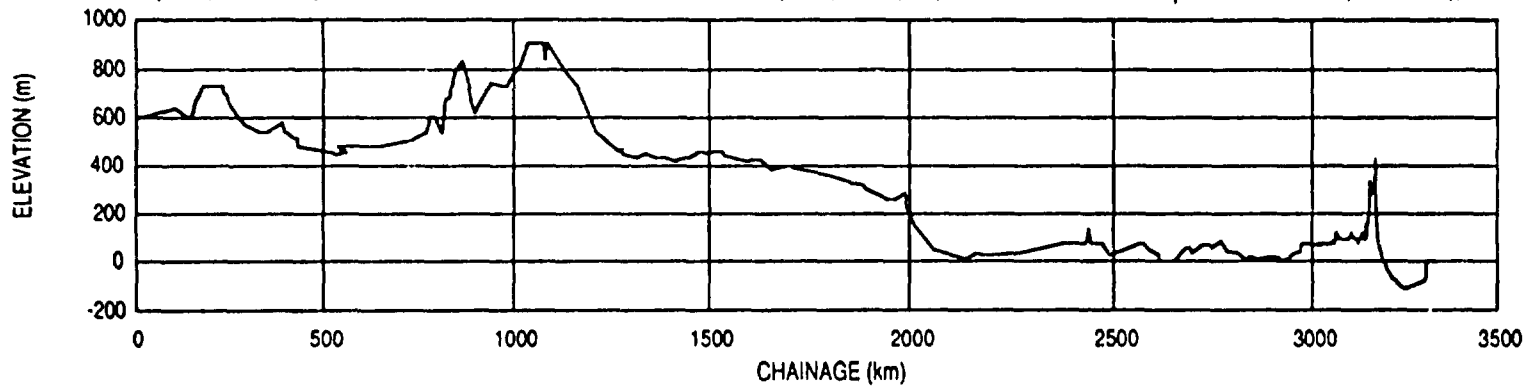
Fig. 5.3 OUTLINE OF SOUTH GAS TRUNKLINE LOOP : GCC SIDE LOOP

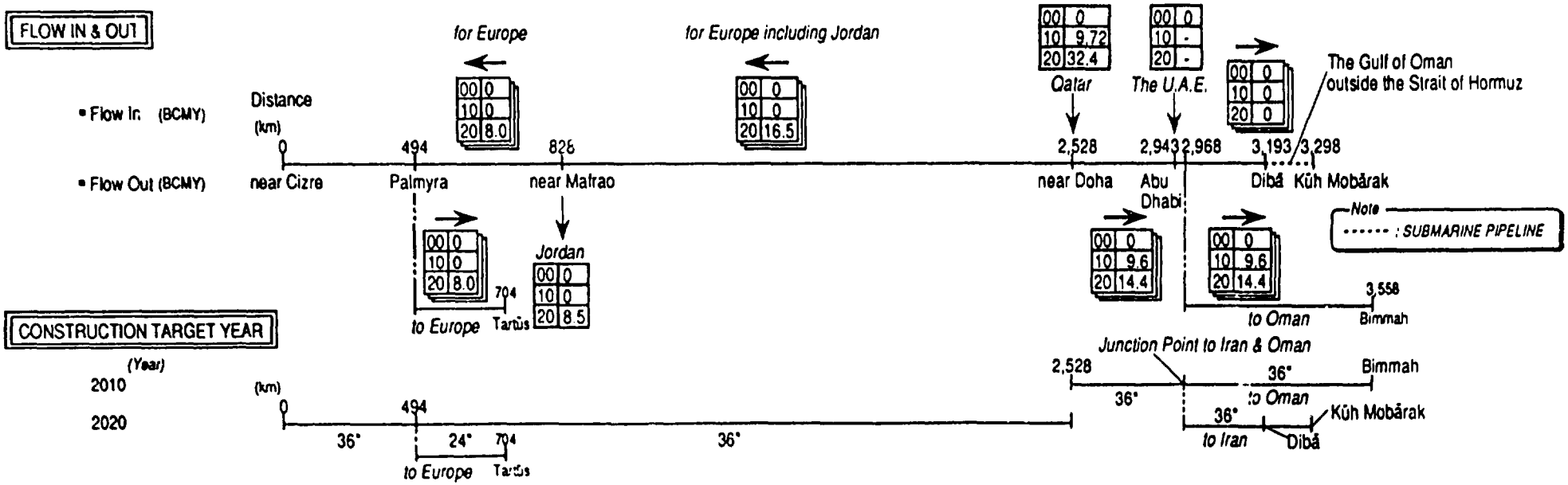
ELEVATION PROFILE FROM TURKEY TO IRAN THROUGH SYRIA, JORDAN, SAUDI ARABIA, THE U.A.E. AND THE GULF OF OMAN OUTSIDE THE STRAIT OF HORMUZ (m)

Loop : Turkey (km 0 : 30), Syria (km 30 : 812), Jordan (km 812 : 1,018), Saudi Arabia (km 1,018 : 2,633), The U.A.E. (km 2,633 : 3,193), The Gulf of Oman outside the Strait of Hormuz (km 3,193 : 3,298)

Branch to Europe : Syria (km 0 : 210)

Branch to Japan : The U.A.E. (km 0 : 120), Oman (km 120 : 590)





- The permissible content of H_2S gas is assumed to be less than 7.5 ppm (w%).
- Residual water content is assumed to be less than 25 ppm (w%).
- CO_2 content is assumed to be less than 25 ppm (w%).

b) Flow Rates

North TRUNKLINE LOOP

i) Kangan (Iran) - Cizre (Turkey) Northern Segment

- 28.9 BCMY from the year 2010
- 28.9 BCMY from the year 2020

ii) Kangan (Iran) - Chah Bahar (Iran) Southern Segment

- 19.1 BCMY from the year 2010
- 28.7 BCMY from the year 2020

South TRUNKLINE LOOP

i) Doha (Qatar) - Mafrao (Jordan) Section of Northern Segment

- 0.0 BCMY from the year 2010
- 16.5 BCMY from the year 2020

ii) Mafrao (Jordan) - Palmyra (Syria) Section of Northern Segment

- 0.0 BCMY from the year 2010
- 8.0 BCMY from the year 2020

iii) Palmyra (Syria) - Cizre (Turkey) Section of Northern Segment

- 0.0 BCMY from the year 2010
- 0.0 BCMY from the year 2020

iv) Palmyra (Syria) - Tartus (Syria) Branch of Northern Segment

- 0.0 BCMY from the year 2010
- 8.0 BCMY from the year 2020

v) Doha (Qatar) - Bimmah (Oman) Southern Segment including Branch

- 9.6 BCMY from the year 2010
- 14.4 BCMY from the year 2020

vi) Abu Dhabi (the U.A.E.) - Kuh-e Mobarak (Iran) offshore Segment
- 0.0 BCMY (mechanical connection)

c) Load Factor

The load factor of the TRUNKLINE LOOP is fixed at 8000 hr/year.

5.1.4 Other Study Basis

For further basic data and assumptions relating to the STUDY reference be made to Chapters 6, 7, 8, 11, 12, 13, 14 and 15.

5.2 Options

The following optional cases have been studied to obtain or justify best economic results of the TRUNKLINE LOOP PROJECT.

■ Option 1

Economic analysis alternatively to use loans from EXIM banks of Europe and Japan instead of soft loans.

- **Option 2**

  Gas transmission costs per MMBTU to be defined (calculated) as average cost (flat rate) over the entire LOOP and its branches.

- **Option 3**

  Additional gas supply from Turkmenistan to Chah Bahar, Iran, (LNG Terminal) for export to Japan and Asian countries.

- **Option 4**

  Economic analysis inclusive of export marketing facilities, such as: LNG plants and ships (LNG tankers).

- **Option 5**

  Economic analysis of investment in the construction of the LOOP in comparison with the cost of increasing the LNG emergency stockpile (storage inventory) in Japan.

6. PRODUCTION FORECAST

Table 6.1 shows the forecast of gas production of the Middle East countries considered by the STUDY, which are: Jordan, Syria, Turkey, Iran, the U.A.E., Oman, Qatar and Saudi Arabia. The forecasts of gas production of Syria and Iran in Table 6.1 have become known through the interviews with relevant high level government officials of the concerned countries. Gas production of Jordan and Turkey are small and hence have not been taken into account. Figures for other countries have been quoted from the report: "Natural Gas in the Middle East, Actual Status and Future prospects, March 1993" by Observatoire Méditerranéen De l'Energie. The forecasts for the year 2020 except of Iran and Qatar are extrapolated figures.

Any of the currently available gas trend forecasts are understood as those linked with the domestic demand of the given countries and their current export potential. Therefore, the related figures do not specify the maximum ceiling of their gas production. If gas suppliers like Iran and Qatar/U.A.E. and gas consumers would later reach export agreements on larger quantities, any surplus quantities beyond those recorded here are understood to be possible.

Table 6.1 Forecast of Gas Production (BCMY)

	2000		2010		2020	
	Pessi-mistic	Opti-mistic	Pessi-mistic	Opti-mistic	Pessi-mistic	Opti-mistic
Jordan	-	-	-	-	-	-
Syria*1	4.02	4.02	8.76	8.76	19.1	19.1
Turkey	-	-	-	-	-	-
Iran*1*2	120.0	160.0	200.0	264.0	255.0	374.0
The U.A.E.*3	44.5	45.9	55.0	58.0	68.0	73.3
Oman*4	13.0	15.0	18.5	21.5	26.3	30.8
Qatar*5	39.5	43.5	40.0	46.5	40.5	46.5
Saudi Arabia	67.0	69.4	82.0	88.0	100.4	111.6
Total:	**288.02**	**337.82**	**404.26**	**486.76**	**509.0**	**661.8**

Pessimistic = minimum forecast
Optimistic = maximum forecast

*1) Gas production forecast revealed at interview

*2) Iran's production figures include the gas export volumes to countries of the former Soviet Union which will be 6, 84 and 134 BCMY in the years 2000, 2010 and 2020, respectively.

3) The U.A.E.'s production figures include the LNG export volumes which will be 8.2, 8.2 and 8.2 BCMY in the years 2000, 2010 and 2020, respectively.

*4) Oman's production figures include the gas export volumes which will be 7.2, 9.5 and 9.5 BCMY in the years 2000, 2010 and 2020, respectively.

*5) Qatar's production figures include the gas export volumes which will be 34.1, 34.95 and 33.4 BCMY in the years 2000, 2010 and 2020, respectively.

7. DEMAND FORECAST

7.1 Middle East

The forecast of gas demand of the Middle East countries which are Jordan, Syria, Turkey, Iran, the U.A.E., Oman, Qatar and Saudi Arabia have been summarized. The forecasts of gas demand of Jordan, Turkey and Iran have become known through the interviews with relevant high level Government officials. Figures for other countries have been quoted from the report: "Natural Gas in the Middle East, Actual Status and Future prospects, March 1993" by Observatoire Méditerranéen De l'Energie.

The forecasts for the year 2020 except Jordan and Qatar are extrapolated figures. For PHASE II IMPLEMENTATION STUDY all figures will be essentially those to be provided by each Government, and will jointly be analyzed, because they represent key issues for establishing a most suitable system design of the TRUNKLINE LOOP.

Table 7.1 Forecast of Gas Demand of the Middle East (BCMY)

	2000		2010		2020	
	Pessi-mistic	Opti-mistic	Pessi-mistic	Opti-mistic	Pessi-mistic	Opti-mistic
Jordan	-	-	5.66	5.66	8.50	8.50
Syria	9.0	10.0	13.0	16.0	18.8	25.6
Turkey*1	16.9	17.3	27.5	31.9	44.7	58.8
Iran	54.0	67.0	90.0	120.0	150.0	214.9
The U.A.E.	36.9	40.1	67.8	72.2	124.6	130.0
Oman	6.0	6.6	11.0	12.0	20.2	21.8
Qatar	7.4	7.4	8.6	8.6	10.1	10.1
Saudi Arabia	53.0	57.0	77.0	83.0	111.9	120.9
Total	183.2	205.4	300.56	349.36	488.8	590.6

*1) Imports of Turkey are composed of:

5 to 6 BCMY in 1993 from countries of the former Soviet Union.
2 BCMY in 1993 from Algeria (LNG)
5 BCMY in 2000 from Turkmenistan
10 BCMY in 2010 from Turkmenistan

7.2 European Countries

ENI provided the demand of Europe for gas importation from the LOOP as follows:

Table 7.2 (a) Demand of Europe (Unit: Billion Cubic Meter per year)

	1991	1992	2000	2010	2020
Western Europe	298.0	317.4	415.0	455.0	495.0
Eastern Europe (incl. ex-Yugoslavia)	79.4	68.1	85.0	116.0	143.0
Total	377.4	385.5	500.0	571.0	638.0

Table 7.2 (b) Supply to Europe (Unit: Billion Cubic Meter per year)

	1991	1992	2000	2010	2020
Pipeline					
Western Europe	200.0	217.2	250.0	249.0	255.0
Eastern Europe	38.2	34.1	38.0	42.0	44.0
Russia & Turkmenistan	104.2	99.1	135.0	175.0	210.0
Maghreb	16.2	14.9	33.0	35.0	41.0
Middle East	0.0	0.0	0.0	0.0	0.0
Nigeria, and Other African Countries	0.0	0.0	0.0	0.0	0.0
Total	358.6	365.3	456.0	501.0	550.0

	1991	1992	2000	2010	2020
LNG					
Western Europe	0.0	0.0	0.0	0.0	0.0
Eastern Europe	0.0	0.0	0.0	0.0	0.0
Russia & Turkmenistan	0.0	0.0	0.0	0.0	0.0
Maghreb	18.8	20.2	32.0	35.0	39.0
Middle East	0.0	0.0	7.0	10.0	12.0
Nigeria, and Other African Countries	0.0	0.0	5.0	10.0	14.0
Total	18.8	20.2	44.0	55.0	65.0
Total Supply of Pipeline Gas and LNG (BCMY)	377.4	385.5	500.0	556.0	615.0
Balance to be supplied from the LOOP (BCMY)	0	0	0.0	15.0	23.0

7.3 Japan and Asian Countries

The Japanese Government officially presented the forecast of demand for natural gas as elaborated in October 1990 by its Advisory Committee for Energy: 54.9 BCMY in 1991, 66.5 BCMY in 2000 and 81.8 BCMY in 2010. However, the forecast does not analyze the decline of the currently ongoing LNG supply to Japan and it is also a continuously updated programme presenting short/medium term developments. It is reissued every year to take into consideration possible changes of the political climate, environmental issues, and economic conditions.

Therefore, the following forecast compiled by commercial sectors (made by Mr. Yokose, Mitsubishi Corporation and presented to the First Annual Middle East Petroleum and Gas Conference at Dubai in February, 1993) has been used for this STUDY.

Table 7.3 (a) Demand Forecast (MITSUBISHI) (Unit: BCMY)

Year	1991	2000	2010	2020	
Japan	54.0	73.3	100.6	138.1	*1)

His forecast for Korea and Taiwan has also been taken into account:

Year	1991	2000	2010	2020	
Korea *2)	4.0	11.5	21.6	40.4	*1)
Taiwan	2.2	10.1	21.6	40.4	*1)

Another set of figures presenting the demand projection for Thailand based on preliminary forecasts of PTT has also been considered.

Year	1991	2000		2010	2020	
Thailand	0	7.2		11.6	21.6	*1)
Total (BCMY) (Japan including Asian countries)	60.2	102.0	*3)	155.4	240.5	

Table 7.3 (b) Supply Forecast (Unit: BCMY)

Year	1991	2000	2010	2020
Pipeline				
Thailand	6.8	9.4	9.4	9.4
Total	6.8	9.4	9.4	9.4
LNG				
Alaska	1.3	1.3	1.3	1.3
Australia	5.6	10.1	18.7	18.7
Brunei	7.3	7.3	7.3	7.3
Indonesia	32.0	38.6	26.4	26.4
Malaysia	10.1	21.6	28.7	28.7
Abu Dhabi	3.6	7.2	7.2	7.2

Year	1991	2000	2010	2020
Qatar (In Site)	-	8.6	21.6	21.6
Oman (In Site)	-	4.3	4.3	4.3
Sakhalin	-	8.6	8.6	8.6
Natuna	-	-	-	-
Alaska (North Slope)	-	-	-	-
Turkmenistan	-	-	-	-
East Siberia	-	-	-	-
Papua New Guinea	-	-	-	-
Yemen (In Site)	-	-	-	-
Iran (In Site)	-	-	-	-
Total	59.9	107.6	124.1	124.1
Total Supply of Pipeline Gas and LNG (BCMY)	66.7	117.0	133.5	133.5
Supply from the LOOP (BCMY)	0	0	28.7	43.1

Note: *1) extrapolated figure

*2) Korean Government's forecast is 13.7 BCMY in the year 2000 and 20.1 BCMY in the year 2006.

*3) Mr. Yokose's forecast tallies with that of the World Gas Intelligence (WGI) for the year 2000, but it seems to be much higher than that expected for the year 2010.

Demand Forecast (WGI)

	2000		2005	
	LOW	HIGH	LOW	HIGH
Japan	72	76	80	89
Korea	11	13	15	17
Taiwan	7	8	9	10
Total	90	97	104	116

8. ANALYSIS OF GAS PRODUCTION AND DEMAND BALANCE

The current gas production and import, and gas demand, as well as future gas production and import, and export demand from the LOOP have been summarized as shown in Table 8.1.

Gas production for export has been assumed on an "as required basis" due to the existence of huge gas reserves in Iran and Qatar, and also taking into account the possibility of introducing additional quantities of gas to the LOOP from Turkmenistan and Yemen.

Gas production projects for export purposes have not been considered by this STUDY. It is supposed, however, that investment in gas field development projects and related facilities will be conducted jointly by the gas producing and gas consuming countries as separate (individual) gas export projects apart from the TRUNKLINE LOOP PROJECT, however, linked with the LOOP PROJECT, while investment in gas production projects for domestic use are assumed to be undertaken by each country concerned itself.

In this manner the demand of the gas consuming countries could be satisfied under the concept presented in this STUDY. There should however be interaction of the various necessary investment projects to assure that the timing of establishment (construction) of the LOOP would tally with the investment schedules of the gas field development/gas production projects, and with the implementation of the export market related facilities (transmission and connecting pipelines, LNG plants, shipment facilities and terminals, etc.)

Table 8.1 - Gas Production - Demand (BCMY)

	Current		2000		2010			2020		
	Production and Import	Demand	Production and Import■	Demand	Production and Import■	Demand	Demand for the LOOP	Production and Import■	Demand	Demand for the LOOP
Europe	251.3	P 365.3 L 20.2	283.0	P 456.0 L 44.0	291.0	P 501.0 L 55.0	P 15.0 L 0.0	299.0	P 550.0 L 65.0	P 15.0 L 8.0
Japan and Asia	60.2	P 6.8 L 60.2	117.3	P 9.4 L 102.1	133.8	P 9.4 L 155.3	L 28.7	133.8	P 9.4 L 240.5	L 43.1
Japan	54.0	L 54.0	92.2	L 73.3	84.7	L 100.6		84.7	L 138.1	
Korea	4.0	L 4.0	7.2	L 11.5	10.6	L 21.6		10.6	L 40.4	
Taiwan	2.2	L 2.2	5.4	L 10.1	8.3	L 21.6		8.3	L 40.4	
Thailand	6.8	P 6.8 L --	9.4	P 9.4 L 7.2	9.4	P 9.4 L 11.5		9.4	P 9.4 L 21.6	
Uncertain	--	--	4.2	--	20.8	--	--	20.8	--	--
Middle East	182.85	102.56	343.8	205.4	500.0	349.4	13.9	684.6	590.6	22.4
Iran	64.0	* 25.7	160.0+	* 67.0	264.0+	* 120.0	--	374.0+	214.9	--
Qatar	10.13	9.30	43.5+	7.4	46.5+	8.6	--	46.5+	10.1	--
The U.A.E.	32.94	22.99	45.9+	40.1	58.0+	72.2	--	73.3+	130.0	--
Oman	6.72	3.50	15.0+	6.6	21.5+	12.0	--	30.8+	21.8	--
Saudi Arabia	64.70	32.0	69.4+	57.0	88.0+	83.0	n.a.	111.6+	120.9	n.a.
Syria	4.0	4.0	10.0+	10.0	22.0+	16.0	--	48.4+	25.6	--
Jordan	0.36	0.36	--	--	--	5.7	--	--	8.5	8.5
Turkey	--	5.21	--	17.3	--	31.9	13.9	--	58.8	13.9

Note:
- P : Through Pipeline
- L : By LNG
- \+ : Possibly to produce more
- * : Does not include gas injection
- ■ : "Import" includes onnly on-going, imports and facilities under construction, committed and most probable.
- n.a. : Data not available

9. TRUNKLINE ROUTING

9.1 General

Figure 9.1 shows the proposed Gas TRUNKLINE LOOP route drawn on a satellite map over the Middle East countries including crossing of the Gulf of Oman south to the Strait of Hormuz.

The pipeline route described here is based on a detailed desk study carried out by specialists who had access to available geological and geotechnical information. The result of their study confirms that the proposed route corridor can be considered feasible. However, an exact site survey with on-site reconnaissance along the route will need to be conducted in PHASE 2 IMPLEMENTATION STUDY for further refinement of the routing.

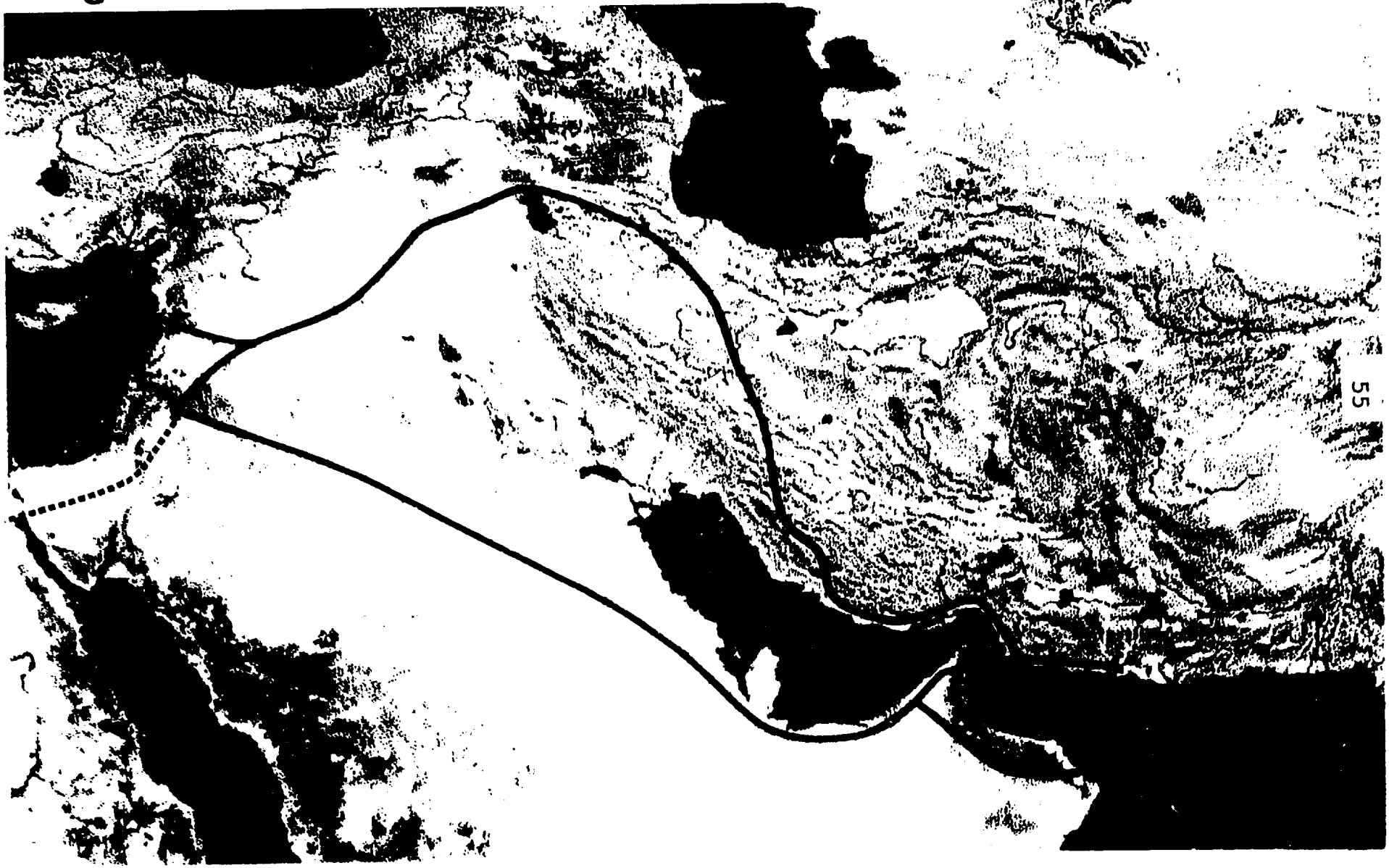
The Gas TRUNKLINE LOOP considered in the present study mainly consists of:

- Onshore TRUNKLINE with a total length of approximately 6,800 km which runs through Iran, Turkey as the North TRUNKLINE LOOP and from Oman, the U.A.E., Qatar, Saudi Arabia, Jordan, Syria and Turkey as the South TRUNKLINE LOOP.

  The junction points of the TRUNKLINE LOOP between the Northern part of the LOOP and the Southern part of the LOOP are located both at Cizre in Turkey and Kuh-e Mobarak in Iran.

- The Offshore TRUNKLINE section with a total length of approximately 105 km and maximum water depth of 110 m which crosses the Gulf of Oman south to the Strait of Hormuz and connects the northern and southern parts of the TRUNKLINE, thus closing the LOOP.

Fig. 9.1 PROPOSED GAS TRUNKLINE LOOP ROUTE



The overall geographical and geological desk study of the route corridor of the entire gas TRUNKLINE LOOP has been carried out by Ove Arup & Partners (UK). The results of their work have been taken into account in this report.

9.2 Onshore Segment of the TRUNKLINE

9.2.1 General Outline

The following general explanations can be given regarding the 6,800 kms of the proposed land route of the TRUNKLINE:

a) 3,400 kms (50%) are in excavable deposits. The balance will require ripping or controlled blasting to enable excavation.

b) 1,200 kms (18%) of the route lead through areas of high groundwater levels.

c) 600 kms (9%) are in corrosive environments.

d) 1,600 kms (23%) of the route lead through seismically active areas with potentially high risk of seismic damage.

Table 9.1 displays the summary of land characteristics by country and distance.

Table 9.1 Summary of Onshore Route Characteristics

		Total Length		Jordan	Syria	Turkey	Iran	Saudi Arabia	The U.A.E.	Oman
		Km	%	Km	Km	Km	Km	Km	Km	Km
Route Length		6,797	100	206	992	269	2,565	1,615	750	400
■ Rock	- Hard	471	6.9	154	133	70	99	5	0	10
	- Soft	3,228	47.5	17	788	176	861	949	127	310
■ Soil		3,098	45.6	35	71	23	1,605	661	623	80

(*) The Gulf of Oman Crossing: 105 Km. The total TRUNKLINE length including offshore crossing is 6,902 Km

9.2.2 Detailed Descriptions of the Routes

a) Turkey (km 30 to km 269; equivalent to km 0 to km 239 of the North TRUNKLINE LOOP)
(km 0 to km 30 of the South TRUNKLINE LOOP)

Two pipeline routes have been studied in the area of the border between Turkey and Iran. The more flat and shorter (southern) course has been selected. The TRUNKLINE route in Turkey starts in the southeastern part of the country at the Syrian border and proceeds to the northeast through rugged, mountainous terrain, south of Lake Van for 190 km before turning east to cross the frontier with Iran at km 269. The route crosses a wide variety of sedimentary, igneous and metamorphic rock types. The position of the route up to km 140 leads through a zone of moderate exposure to risk of earthquake damage. Beyond this point the route lies entirely within the zone of heavy exposure to risk of earthquake damage. The risks owing to seismicity are compounded by steep slopes of the hilly terrain, which are characteristic for this region.

The first 50 km of the route lies between 500 and 600 m above sea level and exhibits moderate slopes. From km 150 the route leads over a mountainous region with steep slopes and an average elevation of approximately 2000 m above sea level, rising to a maximum elevation of 2500 m above sea level. The approach to and descent from the high sections between 2000 and 2500 m are very steep.

The basalt and metamorphic rocks are likely to require blasting. The heavy exposure to earthquake damage and steep slopes will require design measures to cope with potential pipeline ruptures.

b) Syria (km 0 to km 782; equivalent to km 30 km to km 812 of the South TRUNKLINE LOOP)
(km 0 to km 210; of the branch in Syria from Palmyra to Tartus)

The TRUNKLINE route starts at km 0 at the border with Turkey, in the northeastern part of Syria, and follows in general a southwest direction through Syria. The route crosses extensive plains of primary soft rock and soil sequence and exits at km 782 in the southwest of Syria at the border with Jordan. The route runs from km 0 at the border with Turkey through Jubissa to Palmyra along an existing 16" gas pipeline and from Palmyra to the east of Damascus along an existing 18" gas pipeline.

The crossing of the River Euphrates flood plain encounters high water levels.

The branch from the TRUNKLINE in Syria starts from Palmyra and leads through Homs to Tartus along an existing 16" gas pipeline.

c) Jordan (km 0 to km 206; equivalent to km 812 to km 1,018 of the South TRUNKLINE LOOP from Cizre)

The route of the South TRUNKLINE LOOP runs for 16 km towards the south from the Syrian border to near Mafrao, northeast of Amman. Up to km 8 the route runs on a level plateau surface on extensive lava sheets which flowed from vents to the northwest towards Syria. From there up to km 16 the terrain is generally gently rolling to a level monotonous limestone plateau.

Thereafter, the route of the South TRUNKLINE LOOP leads along the existing TAP line (Trans-Arabian Pipeline) up to km 206 from near Mafrao to the border with Saudi Arabia. The route of the South TRUNKLINE LOOP is distant from the Rift valley fault zone and leads through an almost no-risk zone of the stable Arabian Plate.

d) Saudi Arabia (km 0 to km 1615; equivalent to km 1018 to km 2633 of the South TRUNKLINE LOOP)

The initial 1285 km of the TRUNKLINE from the Jordanian border follow a virtually straight southeastward direction across the Arabian Desert along the existing Trans-Arabian Pipeline to the coast near Dhahran. The route then proceeds close to the Gulf coast, cutting across the base of the Qatar Peninsula, to the border of the United Arab Emirates at km 1615. There is an existing TAP line road, and the remaining 330 kms near the Gulf coast are served by a good road network, therefore access for construction is very good. The most resistant rock units encountered will be cherts, duricrusts and some types of limestones. The existing TAP line is predominantly buried, which may provide guidance for assessing the ease of excavation.

Slopes over this section of the TRUNKLINE will generally be flat to gentle, and there is little or no exposure to risk of earthquake damage, since the entire route leads through the stable Arabian Plate area.

The section of the route near the Gulf coast encounters substantial lengths of sabkha and aeolian or windblown sands. Sabkha have high water levels and represent very corrosive soil conditions. In aeolian sands there is a risk of unconsolidated sands and of later exposure of the pipe to erosion by wind-blown sands.

e) The United Arab Emirates (km 0 to km 560; equivalent to km 2633 to km 3193 of the South TRUNKLINE LOOP),
and (km 0 to km 190 of the branch to Oman)

The TRUNKLINE LOOP

The proposed route corridor follows close to the coastal line of the Gulf from km 0 to km 350. It moves gradually inland towards a pass through the low but rugged Oman Mountains from km 520 to

km 540 and then descends gradually down a valley to Diba al Gurfah on the narrow coastal plain facing the Gulf of Oman south to the Strait of Hormuz.

The coastal section of the route is flat and is situated at or near sea level. The level of the traverse through the Oman Mountains remains below 500 m although the pass is narrow and twisting.

As the route runs northeastward to cross the Oman Mountains it moves into the zone of category 3 of moderate exposure to risk of earthquake damage.

The majority of the route leads close to the Gulf Coast and will experience high water levels and corrosive saline soils or loose, mobile sand.

Near to and in the Oman Mountains infrequent flash flooding of wadi channels will occur thus potentially causing erosion and temporary buoyancy.

Branch of the South TRUNKLINE LOOP to Oman

The initial 50 km of the route, starting from the branching off point close to Abu Dhabi, follows the road to Buraymi and an existing water pipeline.

The southern border of the range of Oman Mountains is reached after approximately 190 km. The first 180 kms of the proposed route is situated between 100 and 300 m above sea level and passes over very low slopes. In this section sand dunes predominate up to at least km 120, while alluvial gravel may be frequently found when approaching the mountains. Thereafter the route crosses a rocky plateaux up to the border between the U.A.E. and Oman.

f) Oman (km 0 to km 400; equivalent to km 190 to km 590 of the TRUNKLINE branch in Oman)

The proposed route of the branch line to the Bimmah Terminal, located on the coast of the Gulf of Oman has a total length of 590 km including its section in the U.A.E. The pipeline follows in general a southeast direction towards the Oman Mountains.

The route follows the borderline of the Oman mountains, running towards the town of Sur. The Bimmah Terminal, located some 20 km northwest of Sur, is reached by following the road along the coast.

Along the border of the Oman Mountains area the proposed route crosses rocky plateaus up to approximately km 260 and reaches a maximum elevation of 900 m above sea level. From km 260 the route descends to Sur and then to the Bimmah Terminal generally with moderate shape and mostly in sandy-gravelly terrains.

g) Iran (km 0 to km 2250; equivalent to km 239 to km 2489 of the North TRUNKLINE LOOP), (km 0 to km 300; of the branch in Iran) and (km 0 to km 15; equivalent to km 2489 to km 2504 of the North TRUNKLINE LOOP) at Kuh-e Mobarak

The pipeline leads through Iran from km 0 in the northwest of the country at the border between Turkey and Iran to km 2550 at Chah Bahar in the southern part of Iran. The pipeline route proceeds adjacent to the existing IGAT buried gas pipeline from km 500 to km 1280, passes Kangan at km 1543 and intercepts the connection of the TRUNKLINE LOOP crossing the Gulf of Oman south to the Strait of Hormuz at km 2250.

The majority of the proposed route within Iran follows relatively flat or gently sloping ground by leading through major valley floors and the coastal plain. However, some notable exceptions occur. Steep slopes are significantly encountered between the Turkish

border and km 30 and from km 780 to km 1280 in the area of the Zagros mountains. Altitudes range between 1000 m to 2500 m from the Turkish border to km 1480 where the route descends to the northern coastal plain of the Gulf and where it remains at or near to sea level.

The entire length of the proposed pipeline within Iran falls into zones of category 3 and 4 of risk of seismic damage. The areas of heavy exposure to risk of seismic damage occur between km 0 to km 480 and km 1260 to km 2230. The remainder of the route is moderately exposed to risk of seismic damage. Significantly faulted areas along the route are encountered between km 280 to km 730 and within the Zagros fold and fault belt at km 980 to km 1330. Areas of high water levels potentially prone to cause liquefaction occur on the lacustrine plain of Lake Uraniya and on marine deposits of the Gulf coast in the heavy risk zones.

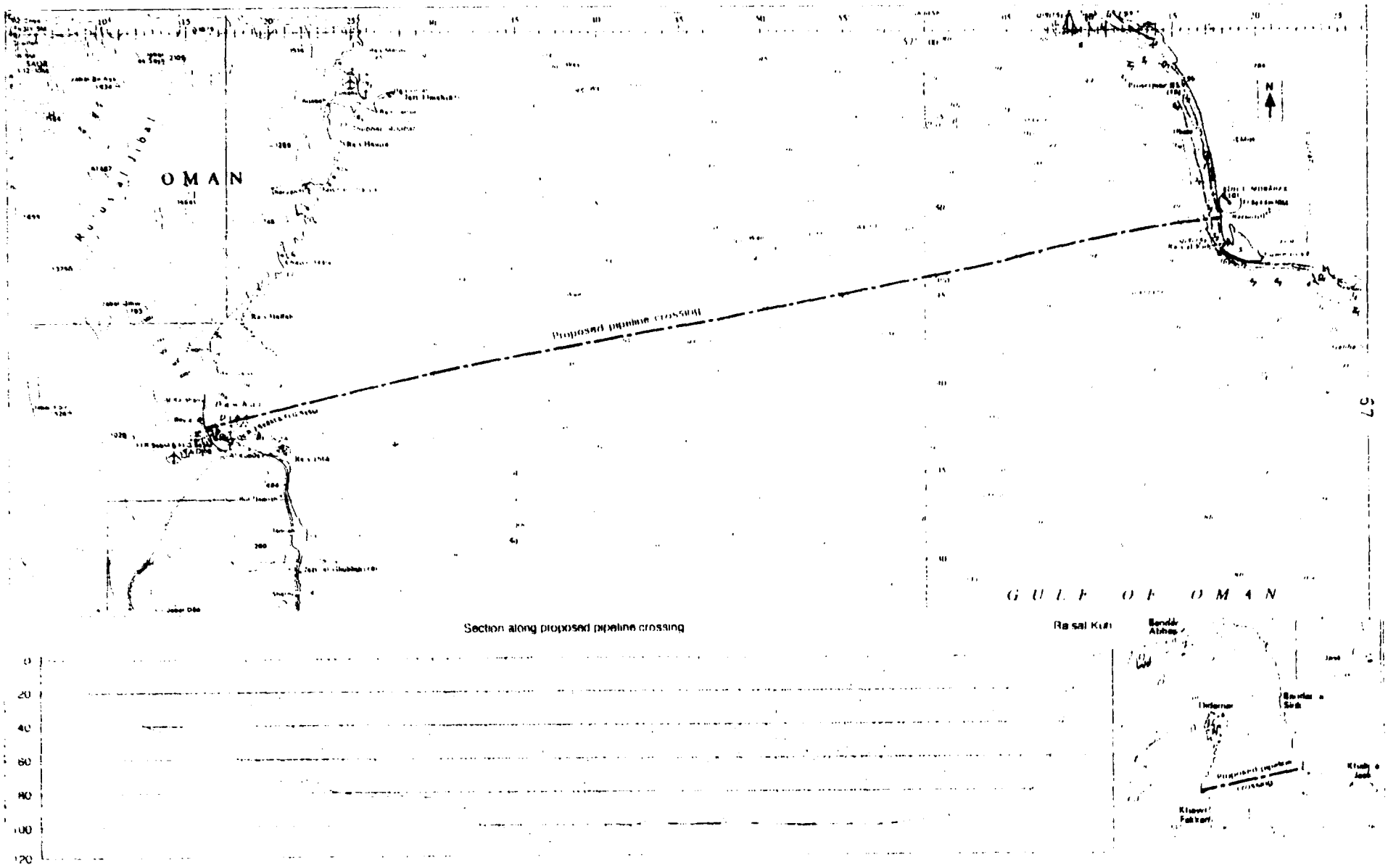
9.3 Offshore Section of the TRUNKLINE

Figure 9.2 shows the proposed 105 km offshore route across the Gulf of Oman south to the Strait of Hormuz which reaches a maximum depth of 110 m. For this section the proposed routing has been carried out based on available nautical charts including mete-oceanic and geological data. Actual sea floor topography is likely to be more complex than indicated in the nautical charts, but the proposed route is worthy of further detailed investigation. More detailed data relevant to bathometry, seabed geomorphology and metro-oceanography shall be obtained during PHASE II IMPLEMENTATION STUDY.

On that basis a suitable corridor for the pipeline will be defined which must take into account the avoidance of the following difficulties that are likely to be encountered when constructing the pipeline under the Gulf of Oman for connecting the TRUNKLINE LOOP between the U.A.E. facing towards the Gulf of Oman and South-East Iran.

- sudden slope variations
- uneven areas
- outcrops of rock
- shipping and fishing areas

Fig.9.2 PROPOSED OFFSHORE ROUTE UNDER THE GULF OF OMAN SOUTH TO THE STRAIT OF HORMUZ



10. TRUNKLINE DESIGN AND RATING

SNAMPROGETTI has carried out the basic trunkline design and rating. The results of their work have been incorporated in this report.

10.1 Design Criteria

The STUDY has been prepared on the basis of the following main design criteria:

a) The Trunkline system shall be designed for steady-state flow conditions.

b) Intelligent pigs (internal pipe wall testing devices) shall be operated between the compressor stations, by applying available experience with pig launching operations in pipelines having a space between two pigging stations over 500 km.

c) The main line valves will be located along the line according to ANSI B. 31.8 Code in order to minimize the dispersion of the gas to the environment in case of accidental damage of the pipeline.

d) The maximum operating working pressure has been fixed 4% lower than the design pressure in order to avoid interferences between the maximum operating pressure and the compressor discharge pressure alarms and shut-down. The compressor station discharge pressure shut down is set at the design pressure according to ANSI B31.8 code.

e) The pressure of the gas supplied to the TRUNKLINE LOOP has been fixed at 95 bar A, either for the Kangan Gas Source in Iran and the North Field Gas Source in Qatar. In any case, different values of the supply pressure shall not affect the TRUNKLINE configuration.

f) The arrival pressures have been fixed at:

- 90 bar A at Cizre
- 80 bar A at the LNG plant.

g) The design temperature of the TRUNKLINE LOOP has been fixed at 50°C as summer condition taking into consideration the balance between the energy necessary to cool the gas at the compressor station discharge and the energy necessary for gas transportation.

h) For hydraulic calculations, the roughness of the pipeline has been fixed at 15 microns considering that the line pipe is internally painted forming a protective coating of epoxy resin of ca. 60 - 70 microns thickness.

i) The optimum design configuration has been obtained by minimizing the actualized transport cost index *.

Note) * : Actualized Transport Cost Index
The main significant index for selecting the best economical solution is the actualized transport cost index (ATC) which is calculated as a ratio between the actualized value of all yearly cost disbursements (both for investment and operating cost) and the actualized annual flow rates.

j) The TRUNKLINE LOOP wall thicknesses have been evaluated according to ANSI B 31.8 Code (onshore) and DNV 1981 Code (offshore).

For the onshore pipeline 8% and 5% of total length has been assumed as class location 2 and class location 3, respectively based on pipeline installation experience in the Middle East area.

10.2 Design Code

The pipeline design has been carried out according to the following Codes:

- ANSI B 31.8: Gas Transmission & Distribution Pipeline Systems.
- DNV 1981 : Rules for Submarine Pipeline Systems.
- DNV 1976 : Rules for the Design, Construction and Inspection of Submarine Pipelines and Risers.

10.3 Wall Thickness Definition

10.3.1 Onshore Pipeline

According to ANSI B 31.8 Code, the pipeline wall thickness has been defined considering the following design factors:

0.72 for class location 1
0.6 for class location 2
0.5 for class location 3

The above class location factors express the ratio of the population density index to the route of the pipeline crossing the area under consideration. Class location 1 corresponds to waste lands, deserts, rugged mountains, farm land; class location 2 corresponds to fringe areas around cities and towns or industrial areas; and class location 3 refers to areas designated for residential or commercial purposes.

a) 48" size pipe

- 27 mm as per ANSI B.31.8 class location 1
- 31.8 mm as per ANSI B.31.8 class location 2
- 37.5 mm as per ANSI B.31.8 class location 3

ANSI B31.8 requires post welding heat treatment of the welding

joint for pipes which exceed 1"1/4 of wall thickness. Therefore the pipeline sections of 37.5 mm wall thickness, whose total length is assumed 140 km of the entire TRUNKLINE route, will need to receive the post welding heat treatment. Pipe material analysis and the welding procedures shall be investigated and defined during PHASE II IMPLEMENTATION STUDY.

b) 36" size pipe

- 20.6 mm as per ANSI B31.8 class location 1
- 23.8 mm as per ANSI B31.8 class location 2
- 28.6 mm as per ANSI B31.8 class location 3

c) 24" size pipe

- 14.3 mm as per ANSI B31.8 class location 1
- 15.9 mm as per ANSI B31.8 class location 2
- 19.1 mm as per ANSI B31.8 class location 3

10.3.2 Offshore Pipeline

According to DNV 1981 Code, due to the different safety factors to be adopted for the internal pressure containment, respectively 0.72 for the zone 1*1 and 0.5 for the zone 2*2, two pipe wall thicknesses have been selected:

- 22.2 mm along the whole pipeline route
- 28.6 mm in the shore approach areas.

*1) Zone 1: By Zone 1 is meant the part of the seabed located more than a certain distance away from any platform or building, normally to be taken as 500 m.

*2) Zone 2: By Zone 2 is meant the part of the seabed located close to any platform or building, and normally to be taken as a distance of 500 m.

The 22.2 mm wall thickness has to be considered as a minimum value and could be increased during future engineering phases, once the sea bottom morphology is known to take into account possible over-stress of the pipe when resting on the sea floor.

The pipeline wall thickness will vary along the length of the TRUNKLINE LOOP according to its optimization coming from operating and collapse pressure/conditions.

However, for practical reasons a standardization procedure shall be implemented so as to reduce the number of recommended sizes to a couple of commercially suitable sizes and thus solve the problem of variation of wall thicknesses of the same pipeline.

Stability against environmental loads is achieved through concrete coating. The minimum concrete thickness (density 2350 Kg/m3), to guarantee the negative buoyancy, is 60 mm.

The value may be increased along the pipeline route in order to take into consideration the effective data on waves and currents.

In the shore approach areas, the pipeline shall be trenched to resist the hydrodynamic forces and to reach an adequate safety level.

10.4 Design Optimization

10.4.1 Optimization Procedure

The objective of the design calculation is to define the optimum flow rates in connection with most suitable compressor configurations in terms of their numbers, locations and power requirements for each of the following four TRUNKLINE Segments, for the purpose of minimizing the actualized transport cost index.

- North TRUNKLINE LOOP, Northern Segment
  from Kangan in Iran to near Cizre in Turkey
- North TRUNKLINE LOOP, Southern Segment
  from Kangan in Iran including its branch to Chah Bahar in Iran.
- South TRUNKLINE LOOP, Southern Segment
  from near Doha in Qatar including its branch to Bimmah in Oman.
- South TRUNKLINE LOOP, Northern Segment
  from near Doha in Qatar to near Cizre in Turkey.
- Branch of the South TRUNKLINE LOOP in Syria from Palmyra to Tartus

"OTGAS", SNAMPROGETTI'S computer programme, has been utilized and Figure 10.1 shows the optimization procedure for the above four TRUNKLINE Segments.

10.4.2 Results of the Optimization

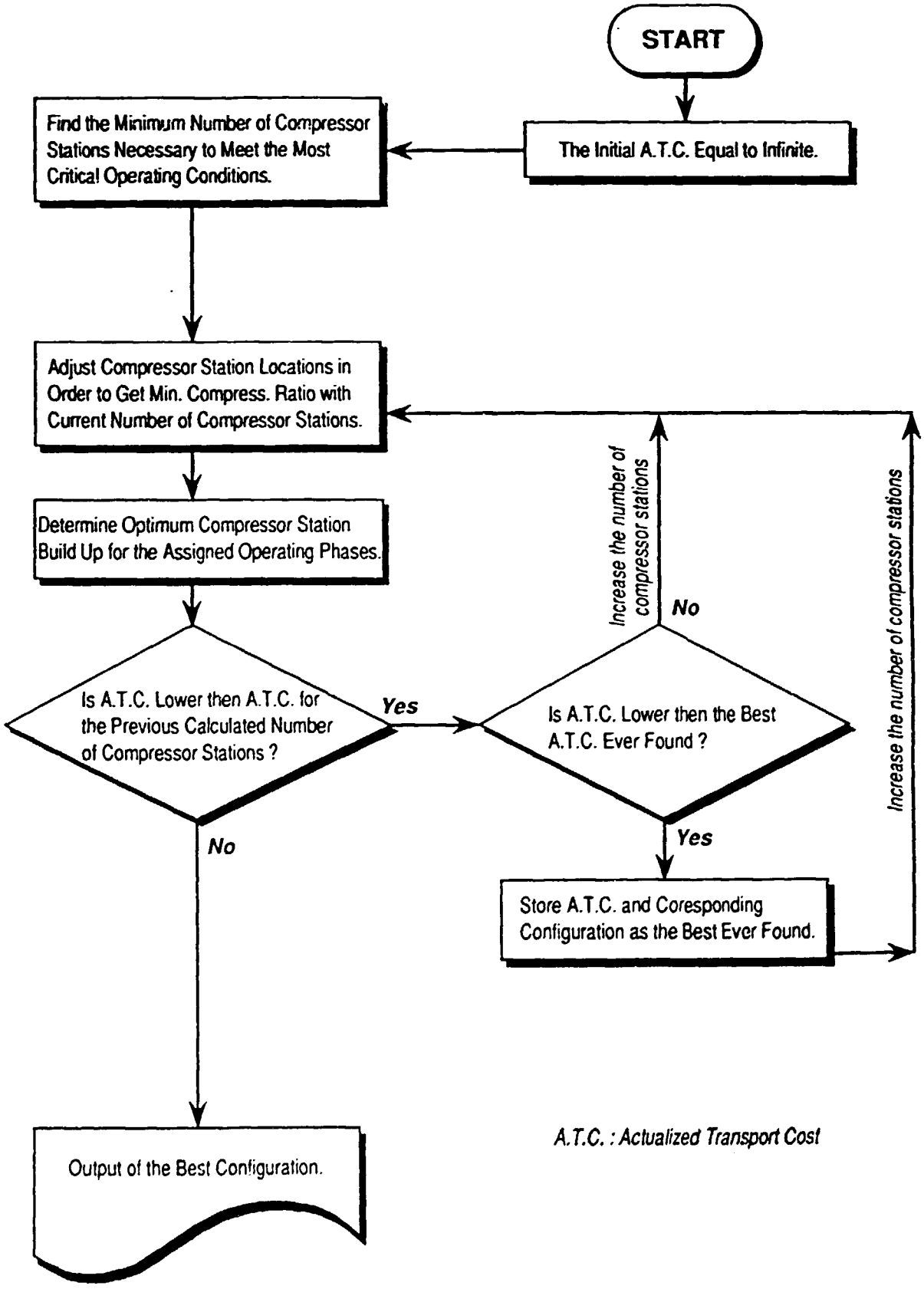
1) North TRUNKLINE LOOP

a) Kangan - Cizre (North TRUNKLINE LOOP, Northern Segment)

The flow rate determined for the transmission of gas through the 48" line of this Segment is 28.9 BCMY (15.0 BCMY for export to Europe and 13.9 for Turkey) in the year 2010 as well as the year 2020. 9 compressor stations are required for 28.9 BCMY. Figure 10.2 shows the block diagram of the pipeline configuration as one example of the calculated results. Compressor stations are installed every 150-220 km, and the position of the stations has been indicated as km Post (KP) on the pipeline diagram.

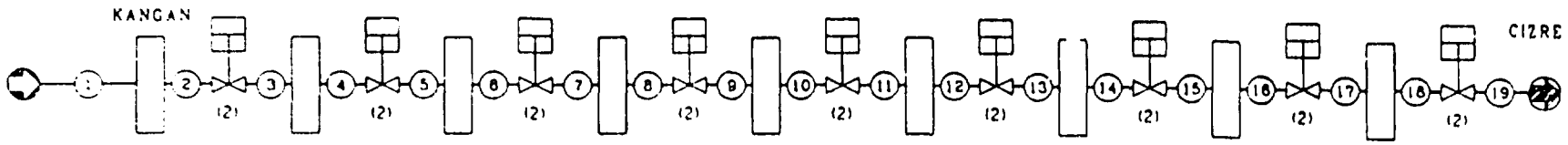
It is also possible to position the new compressor station in the area of the existing IGAT's compressor stations. This shall be determined by site survey to be conducted in PHASE II IMPLEMENTATION STUDY.

Fig. 10.1 OPTIMIZATION ANALYSIS METHOD "OTGAS" CODE FLOW CHART



A.T.C. : Actualized Transport Cost

Fig. 10.2 PREMISES DEVELOPMENT STUDY ON GAS TRUNKLINE LOOP OVER MIDDLE EAST COUNTRIES
NORTH GAS TRUNKLINE LOOP: KANGAN - CIZRE SECTION
ALTERNATIVE 1: FLOW RATE OF 28.9 BCMY (16 BCMY TO EC AND 13,9BCMY TO TURKEY)
OPTIMUM COMPRESSION STATION LOCATION



C S KP	0.0	154	312	500	685	895	1086	1295	1514	1782
ESTIMATED INST. POWER KW ISO	114000	91000	91000	91000	91000	91000	91000	91000	91000	
DISCHARGE AIR COOLER	YES	YES	YES	YES	YES	YES	YES	YES	YES	
YEAR OF OPERATION	2010	2010	2010	2010	2010	2010	2010	2010	2010	
FUEL CONS Stm³/h	20000	16000	16000	16000	16000	16000	16000	16000	15000	

OUTSIDE DIAMETER	48"
STEEL GRADE	API 5L X70
WALL THICKNESS	27 mm (1)
DESIGN PRESSURE	148 bar a
DESIGN TEMPERATURE	50 °C

STREAM / OPERATING DATA	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑰	⑱	⑲
FLOW RATE BCMY at 15 °C and 1.013 bar a	29.8	29.7	29.7	29.6	29.6	29.5	29.5	29.4	29.4	29.3	29.3	29.2	29.2	29.1	29.1	29	29	28.9	28.9
PRESSURE bar a	95	142.5	102.1	142.5	96.6	136	97.1	135.7	96.5	135.4	102.1	142.5	102.1	142.5	101.8	142.5	102.1	141.4	90
TEMPERATURE °C	50	50	36.5	50	34.8	50	35.5	50	35.5	50	36.4	50	35.6	50	35	50	35	50	31.5

NOTES

(1) 27 mm WALL THICKNESS ACCORDING TO ANSI B 31.8 CODE CLASS LOCATION 1. 8% AND 5% OF TOTAL LENGTH OF CLASS LOCATION 2 (WALL THICKNESS 31.8 mm) AND 3 (WALL THICKNESS 37.5 mm) RESPECTIVELY HAVE BEEN CONSIDERED.

(2) MAIN LINE VALVES REMOTE CONTROLLED, WILL BE LOCATED ALONG THE LINE ACCORDING TO ANSI B 31.8 CODE.

b) Kangan - Chah Bahar (North TRUNKLINE LOOP, Southern Segment)

The flow rate determined for the transmission of gas through the 48" line of this Segment is 19.1 BCMY from the year 2010, and two more stations are required to transmit 28.7 BCMY starting from the year 2020.

A compressor station just at Kuh-e Mobarak needs to be installed in order to send the gas from the North TRUNKLINE LOOP to the South TRUNKLINE LOOP through the offshore 36" line under the Gulf of Oman to Bimmah in Oman for back-up purposes. The estimated flow rate to transport a sufficient quantity of gas over 330 km from Kuh-e Mobarak to the junction point at Bimmah in South TRUNKLINE LOOP is 12.3 BCMY.

The location and timing of installing the compressor stations on this Segment are as follows: (KP-0 corresponds to the Kangan location).

- Starting from the year 2010, three compressor stations shall be in operation (KP 0, 175 and 558).

- Starting from the year 2020, two more compressor stations (KP 371 and 706) will be necessary. KP 706 is at Kuh-e Mobarak.

2) <u>South TRUNKLINE LOOP</u>

a) Near Doha - Cizre (South TRUNKLINE LOOP, Northern Segment)

The flow rate determined for the transmission of gas through the 36" line of this Segment is 16.5 BCMY (8.5 BCMY to Jordan and 8.0 BCMY to Europe through the branch in Syria) in the

year 2020. 12 compressor stations are required from near Doha to Palmyra in Syria, which is the junction point at the TRUNKLINE LOOP of the branch in Syria.

b) Palmyra - Tartus (South TRUNKLINE LOOP, Branch of Northern Segment)

The flow rate determined for the transmission of gas through the 24" line of this Branch is 8.0 BCMY from the year 2020. In this branch 2 compressor stations need to be installed; one at Palmyra and the other at an intermediate point.

c) Near Doha - Bimmah (South TRUNKLINE LOOP, Southern Segment including Branch)

The flow rate determined for the transmission of gas through the 36" line of this Segment and Branch is 9.6 BCMY from the year 2010 requiring 3 compressor stations, and two more stations to transmit 14.4 BCMY from the year 2020.

A compressor station at KP 440 (the junction point to Bimmah in South TRUNKLINE LOOP) needs to be installed in order to transport the gas from the South TRUNKLINE LOOP to the North TRUNKLINE LOOP through the 36" offshore line (under the Gulf of Oman) for back-up purposes (KP-0 corresponds to the near Doha location).

The location and timing of installing the compressor stations on this Segment and Branch are as follows:

- Starting from the year 2010 three compressor stations shall be in operation (KP 0, 220 and 440). KP 440 is the junction point to Bimmah in the South TRUNKLINE LOOP.

- Starting from the year 2020 two more compressor stations (KP 640 and KP 840) will be necessary.

The estimated flow rate to transport a sufficient quantity of gas over 330 km from the junction point at Bimmah in the South TRUNKLINE LOOP to Kuh-e Mobarak in the North TRUNKLINE LOOP will be 12.3 BCMY, identically as stated above for the North TRUNKLINE LOOP.

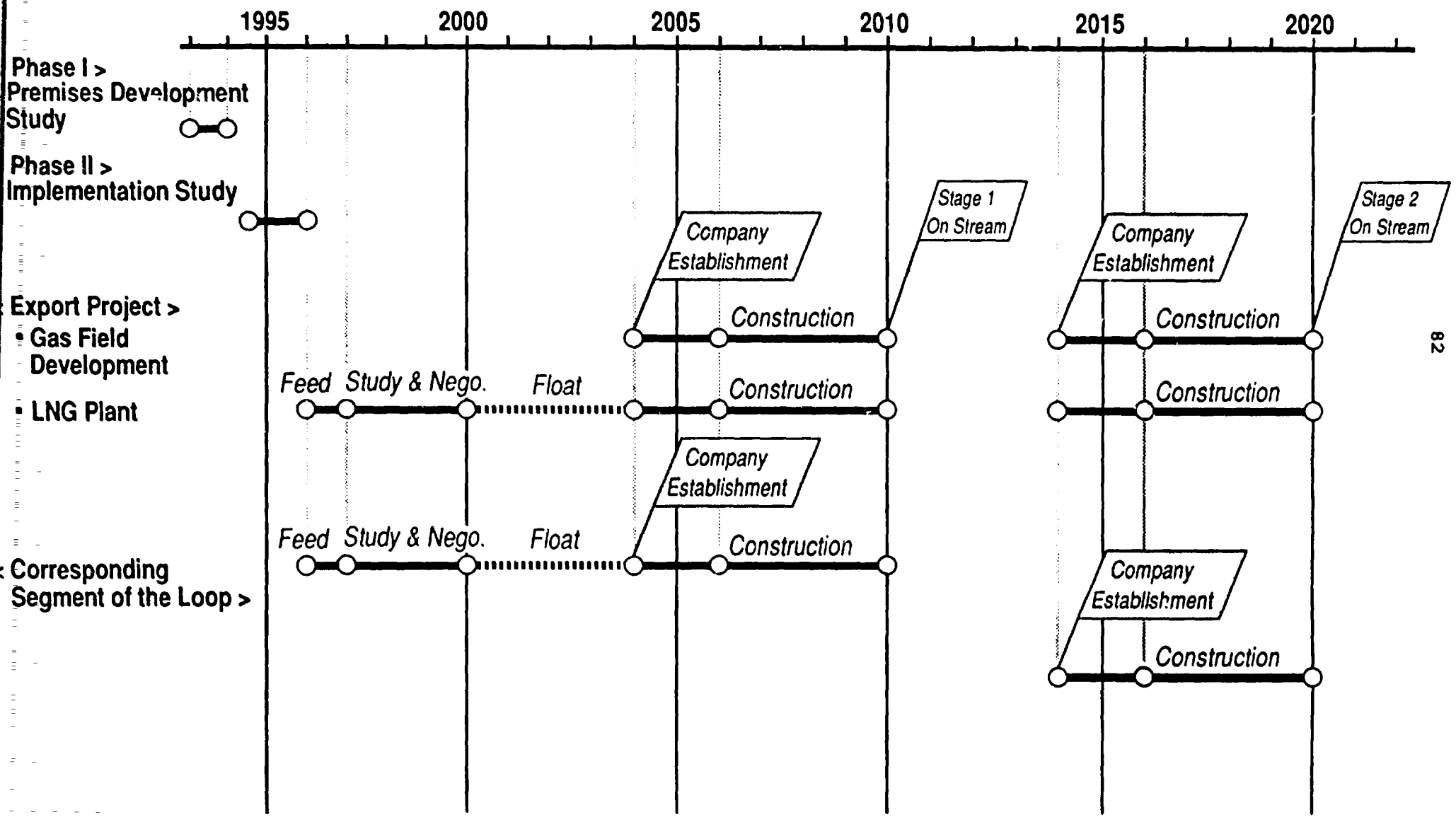
11. PROJECT TIMETABLE

The overall timetable of the PROJECT from the present time to the year 2020 until the completion of the LOOP together with the gas exporting facilities at the end of the branches are outlined and displayed in Figure 11.1.

For accommodating possible adjustments a period of four years appears necessary for Stage 2010 to allow for flexibility of the planned onstream dates of the system.

The key target of the implementation schedule is to synchronize the timing of putting the multi-purpose TRUNKLINE LOOP into operation, with the timing of the gas export projects implemented by other sectors. The sequence of timing shall also take into consideration a necessary "warming-up time period" needed for the development of the gas export projects. To this end a flexibility of four years appears reasonable and justifiable, and is hoped to provide sufficient time to prepare and co-ordinate the challenging tasks to be taken up at both ends, or will allow earlier completion of implementation of the TRUNKLINE LOOP, if possible.

Fig. 11.1 PROJECT TIME TABLE



12. COST ESTIMATE

The overall budget of the PROJECT and investment costs of the pipeline and compressor stations have been estimated on the basis of recent Middle East pipeline construction data and presently prevailing market cost indices as taken from SNAMPROGETTI'S internal statistical data. The investment and operation cost estimates described hereinafter are based on present-time cost value.

The estimates include the supply of all materials to the site, the engineering services and the construction activities in the Middle East for the establishment of the TRUNKLINE LOOP, and its branches in Syria, Iran and Oman.

12.1 Estimated Cost Items

12.1.1 Investment

i) Onshore Pipeline

The following costs have been estimated:

- material supply; (line-pipe & coatings, other pipeline materials)
- construction cost (extra costing conditions are applied for different types of soil and different countries);
- engineering services and contingencies;
- emergency shut-down valve stations along the entire pipeline;
- pig launcher and receiver stations being installed at compressor stations;

- cost effects due to class locations 2 & 3 with 8 % and 5 % of total length, respectively;

- precommissioning and commissioning costs of start-up operations and training costs;

ii) Offshore Pipeline

- material supply;
- transportation & installation cost;
- engineering services and contingencies.

iii) Compressor Stations

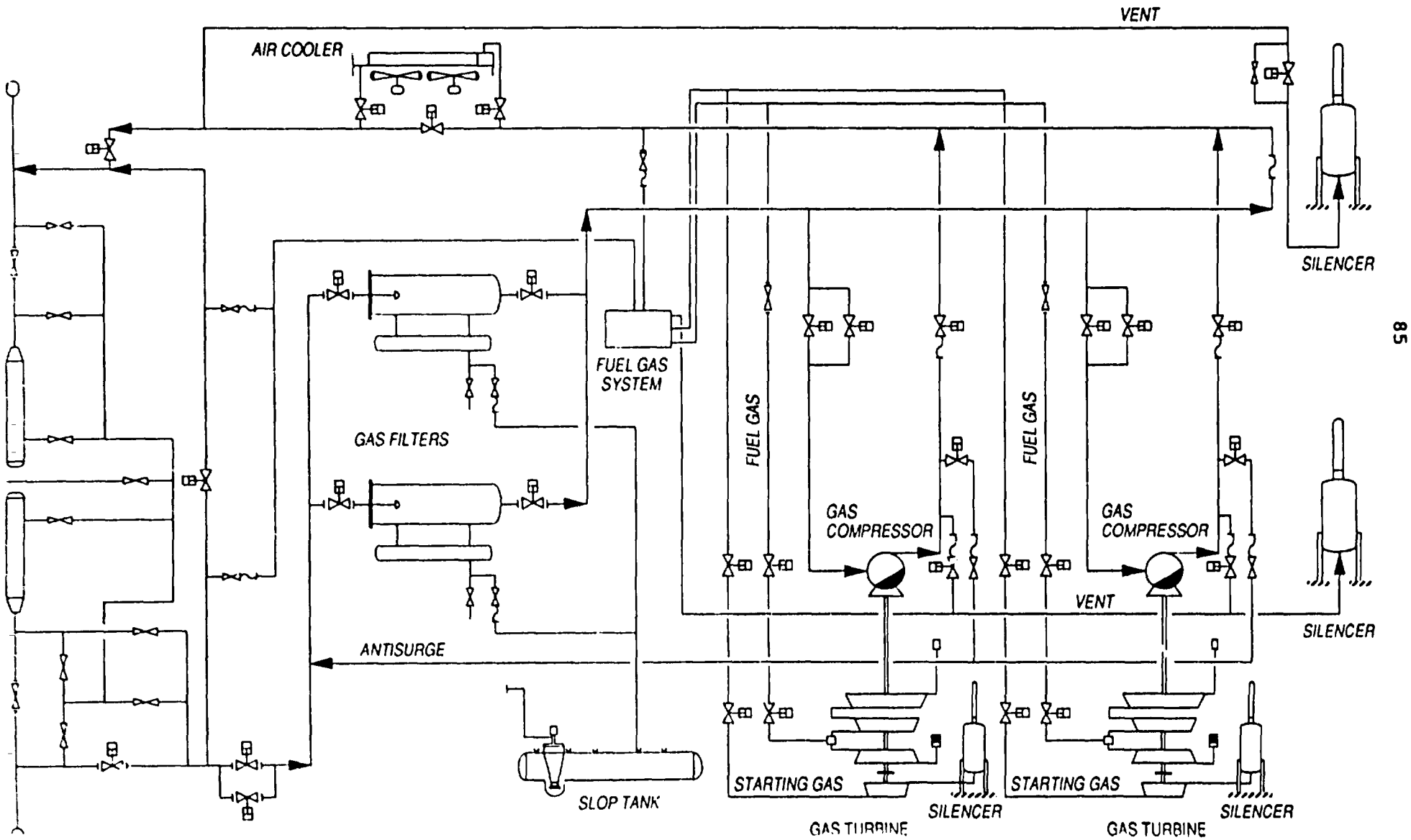
Figure 12.1 shows a schematic drawing of a typical compressor station. For all the stations the costs of the compressors, gas turbines, all auxiliary piping, air coolers, vessels and equipment, station control system and the compressor station buildings have been estimated. The cost of vendor's assistance in commissioning and start-ups, as well as spare parts for the compressor stations has been taken as 3 % of the total compressor station costs.

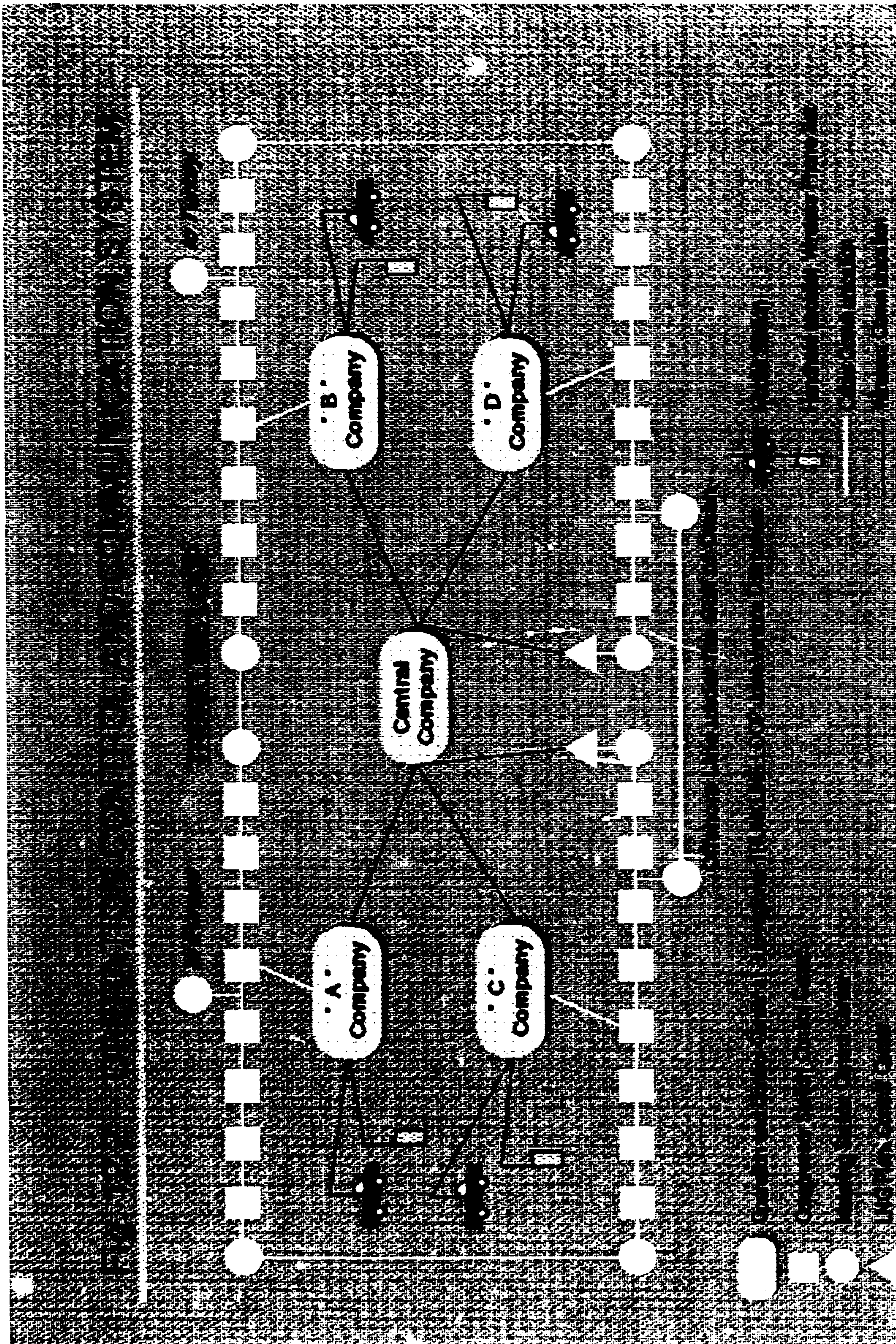
iv) SCADA (Supervisory Control and Data Acquisition) and Communication System

Figure 12.2 shows a schematic drawing of an expected SCADA and communication system. The SCADA dispatching centres shall be installed in the offices of the Sub-regional TRUNKLINE LOOP Joint-venture companies. A main control centre for the entire LOOP that directs the Sub-regional companies shall be installed in the head-office of the central company for the entire TRUNKLINE LOOP PROJECT.

The following cost has been estimated for the establishment of the SCADA and communication system:

Fig. 12.1 TYPICAL GAS COMPRESSOR STATION




" B " Company
" D " Company
Central Company
" A " Company
" C " Company

- SCADA and Communication Equipment Cost of each Sub-regional TRUNKLINE LOOP Joint-venture company, as well as of the central company of the entire PROJECT;

- Cost of Communication Materials;

- Construction costs of SCADA Centre Buildings of each Sub-regional TRUNKLINE LOOP Joint-venture company, as well as of the central company of the entire PROJECT.

12.1.2 Operation and Maintenance Cost

The following operation and maintenance costs have been estimated:

- The annual cost of operation and maintenance activities for the pipeline and compressor stations, which include the salaries of operators and maintenance personnel of the compressor stations and of the personnel on the pipeline whose function will be to check the operation of valve stations, remote terminal units and the cathodic protection system, as well as expenses for recurrent annual procurement of usual spare parts, and indirect costs, etc. are also included and have been assumed as 0.8 % of the total pipeline investment cost, and 2 % of the total compressor station investment costs, respectively.

  Here, the number of operators and maintenance persons are estimated as follows;

  - 3 operators on 4 shifts duty at one SCADA dispatching centre to be installed in each Sub-regional TRUNKLINE LOOP Joint-venture company.

  - 2 operators on 4 shifts duty at each compressor station.

  - 2 maintenance personnel on 4 shifts duty for each compressor station at each SCADA dispatching centre.

- **2 pipeline workers on 4 shifts duty for every 200 km distance of the TRUNKLINE.**

The fuel gas cost of the compressor stations operation has been assumed as 0.30 US$/MMBTU.

12.2 Total Cost

Table 12.1 shows the total investment and operation cost per year for each Sub-regional TRUNKLINE LOOP Joint-venture company. The cost of the 36" line from near Abu Dhabi to Kuh-e Mobarak in Iran under the Gulf of Oman for back-up purpose leading to the LNG plants is assumed to be shared by the North TRUNKLINE LOOP Southern company and the South TRUNKLINE LOOP Southern company. The cost of a central company to be established by the year 2020 in a third country to direct and co-ordinate the work of all Sub-regional TRUNKLINE LOOP Joint-venture companies is assumed to be shared by all the Sub-regional TRUNKLINE LOOP Joint-venture companies. The total investment cost of the Middle East TRUNKLINE LOOP, and its branches in Syria, Iran and Oman will amount to approximately 9.97 Billion US$, which consists of the cost 5.53 Billion US$ for stage 2010 (Completion by the year 2010) and for Stage 2020 of 4.44 Billion US$ (Completion by the year 2020).

Table 12.1 Total Investment and Operation and Maintenance Costs

a) Year 2010

Company	Investment Cost (Billion US$)	Operation and Maintenance Cost (Million US$/Year)
North TRUNKLINE LOOP Northern Company	3.16	54.5
North TRUNKLINE LOOP Southern Company	1.36	17.4
South TRUNKLINE LOOP Southern Company	1.01	14.3
Sub-Total	5.53	86.2

b) Year 2020

North TRUNKLINE LOOP Northern Company	0.0	54.5
North TRUNKLINE LOOP Southern Company	0.54	30.6
South TRUNKLINE LOOP Northern Company	3.45	60.6
South TRUNKLINE LOOP Southern Company	0.41	23.2
Central Company	0.04	2.2
Sub-Total	4.44	171.1
Grand Total	9.97	

Table 12.2 shows the breakdown of total investment by target years of implementation.

Table 12.2 Breakdown of Total Investment

	Pipeline			Compressor Station & Others (MMUS$)
	Line-pipe & Material (MMUS$)	Construction (MMUS$)	Engineering Services (MMUS$)	
a) Year 2010				
North TRUNKLINE LOOP, Northern Company	1,086	676	171	1,232
North TRUNKLINE LOOP, Southern Company	614	368	97	283
South TRUNKLINE LOOP, Southern Company	471	213	74	254
Sub-Total	2,171	1,257	342	1,769
b) Year 2020				
North TRUNKLINE LOOP, Northern Company	0	0	0	0
North TRUNKLINE LOOP, Southern Company	79	25	12	422
South TRUNKLINE LOOP, Northern Company	1,220	650	192	1,383
South TRUNKLINE LOOP, Southern Company	79	25	12	293
Central Company	0	0	0	40
Sub-Total	1,378	700	216	2,138
Grand Total	3,549	1,957	558	3,907

Table 12.3 shows the outline of the TRUNKLINE LOOP system of each Sub-regional TRUNKLINE LOOP Joint-venture project company.

Table 12.3 TRUNKLINE System Outline of Each Sub-Regional Project Company

Project Company	Country	Pipeline						Compressor Station			
		Diameter (")		Length (km)		Pipe Weight (x 10^3 ton)		Number		Req. Power (MW)	
		Year		Year		Year		Year		Year	
		2010	2020	2010	2020	2010	2020	2010	2020	2010	2020
NLNC*	Iran, Turkey	48	-	1,782	-	1,457	-	9	-	842	-
NLSC*	Iran	48	36	1,007	173	823	81	3	2	153	325
SLNC*	Saudi Arabia, Jordan, Syria, Turkey	-	36 & 24	-	2,738	-	1,225	-	14	-	728
SLSC*	Saudi Arabia, the U.A.E., Oman	36	-	1,030	173	481	81	3	2	97	168
Total				3,819	3,084	2,761	1,387	15	18	1,092	1,221
Grand Total				6,903		4,148		33		2,313	

Note) * NLNC refers to the North TRUNKLINE LOOP Northern Company
NLSC refers to the North TRUNKLINE LOOP Southern Company
SLNC refers to the South TRUNKLINE LOOP Northern Company
SLSC refers to the South TRUNKLINE LOOP Southern Company

13. PROPOSED PROJECT COMPANIES

- For the establishment and co-ordination of operation of the TRUNKLINE LOOP in the year 2010, three Sub-regional TRUNKLINE LOOP Joint-venture companies should be established as follows:

  — North TRUNKLINE LOOP, Northern Sub-regional company for the Segment of the pipeline from Kangan, Iran to near Cizre, Turkey; Joint-venture between Iran, Turkey and Europe.

  — North TRUNKLINE LOOP, Southern Sub-regional company for the Segment of the pipeline from Kangan, Iran to Chah Bahar, Iran: Joint-venture between Iran and Japan together with Asian gas consuming countries.

  — South TRUNKLINE LOOP, Southern Sub-regional company for the Segment of the pipeline from near Doha, Qatar to Bimmah, Oman; Joint-venture between Qatar, the U.A.E., Oman, and Japan together with Asian gas consuming countries.

- For completing the establishment and full operation of the TRUNKLINE LOOP and its branches in the year 2020, one additional Sub-regional TRUNKLINE LOOP Joint-venture company should be established.

  — South TRUNKLINE LOOP, Northern Sub-regional company; Joint-venture between Qatar, Syria and Jordan (possibly with participation of Saudi Arabia), and some European countries.

  At that time also one central company should be established to co-ordinate the pipeline operation of the four Sub-regional TRUNKLINE LOOP Joint-venture companies.

- Each Sub-regional TRUNKLINE LOOP Joint-venture company shall be registered and located in the country which is the majority gas supplier to the TRUNKLINE LOOP.

The Central co-ordinating company shall be registered and located in another country that shall mutually be agreed among the parties to the PROJECT.

- The equity contribution of each Sub-regional TRUNKLINE LOOP Joint-venture company shall be 20% of the total capital investment cost of its Segment of the TRUNKLINE, i.e. an amount sufficient to cover the company operation costs before initial commercial operation and reserves for contingencies other than those needed for pipeline construction.

- The equity portion of each of the Sub-regional TRUNKLINE LOOP Joint-venture companies shall in principle be shared by 50:50 per cent between gas supplying countries and gas consuming countries involved. Financing for the establishment of the central company shall be equally shared among the Sub-regional TRUNKLINE LOOP Joint-venture companies.

- The Sub-regional TRUNKLINE LOOP Joint-venture companies shall define the cost of transmitting the gas through their respective Segments for the gas producers and consumers (eg. represented by gas importing or exporting companies). The pertinent commercial transactions shall preferably be based on long-term contracts.

- The Sub-regional Joint-venture companies are expected to pursue an economic policy of "cost plus transmission surcharge" (in principle of non-profit nature) while being otherwise supported by the soft loan financing arrangements of the gas producing and consuming countries. To the contrary, each gas exporting company dealing with producers of the gas and LNG as well as arranging for shipment or further transmission by pipeline to the market shall be expected to operate as profit centres.

- **Companies of other countries could also participate in the TRUNKLINE LOOP Joint-venture companies mentioned above under agreements to be reached among the countries concerned.**

14. FINANCING PLAN

- The investment capital necessary for construction of the TRUNKLINE LOOP and its branches shall be supported predominantly by soft loans from international financing institutions and the national financing institutions of the gas producing and consuming countries, but except those of Turkey, Syria and Jordan.

- Terms of financing shall be favourable to achieve low cost gas transaction (sales) prices, through low interest rates, long periods of repayment, and appropriately long grace periods in order to cope with the unavoidable low income during early years of operation.

  The assumed targets of soft loan conditions are: 3% interest rate, 10 years grace, and 40 years repayment.

- On the basis of the conclusions of the present STUDY contacts shall be established and pursued and mutual preliminary commitments should be reached with international financing institutions and the national financing institutions of the gas producing and consuming countries during the work on the PHASE II IMPLEMENTATION STUDY.

15. ECONOMIC ANALYSIS

15.1 Criteria and Basic Data for the Economic Analysis

- **Gas Price**

  a. **Feed Gas Price**
     — **Optional for each supplier**

  b. **Selling Gas Price at any point of the TRUNKLINE LOOP**
     — **Feed gas price plus pipeline gas transmission cost**

  c. **Fuel Gas Cost for compressor station at any point of the TRUNKLINE LOOP**
     — **30¢/MMBTU**

- **Pipeline Investment and Operation Costs (See Table 12.1)**

- **The Right of Way for pipeline routing and land cost for compressor stations is provided free of charge by the respective countries.**

- **Basis of Financing**
  — **Soft Loan for construction cost of the TRUNKLINE and its branches at an interest rate to be 3% per annum, 10 years grace after start up, and 40 years period of repayment.**

- **Equity Contribution**
  — **20% of the total capital investment cost, i.e. an amount sufficient to cover the company operation cost before initial commercial operation and reserves for contingency other than those needed for pipeline construction.**

- **Operators**

— Expatriate	100,000 US$ per person
Regional	20,000 US$ per person

- **Maintenance Cost**
  - — **Pipeline: estimated/assumed at 0.8% of the total investment cost per annum.**
    Compressor Stations: estimated/assumed at 2% of the total investment cost per annum.

- **Project Life**
  - — **Economic 50 years**
    (Technical 100 years)

- **Taxes**
  - — **All national/local taxes and duties to be exempted**

- **Escalation**
  - — **not to be assumed**

- **Internal rate of return on equity**
  - — **15%**

15.2 Analysis of Base Case

The transmission cost of the gas through the Segments of the TRUNKLINE operated by the four Sub-regional Joint-venture companies has been calculated in accordance with the foregoing criteria. The following results have been obtained.

Company	Distance (km)	From/To	Transmission Cost US$ per MMBTU
North TRUNKLINE LOOP Northern Company	1,782	Kangan to Cizre	0.30
North TRUNKLINE LOOP Southern Company	1,180	Kangan to Chah Bahar	0.18
South TRUNKLINE LOOP Northern Company	2,738	Near Doha to Cizre	0.57
South TRUNKLINE LOOP Southern Company	1,203	Near Doha to Bimmah	0.27

The above figures give to understand that the transmission costs (surcharge on gas price) of the gas through the North TRUNKLINE LOOP, Northern Segment for export to Europe is 0.30 US$/MMBTU, while the transmission through the South TRUNKLINE LOOP, Northern Segment is 0.57 US$/MMBTU. Whereas, the transmission costs through the North TRUNKLINE LOOP, Southern Segment for export to Japan is 0.18 US$/MMBTU, and through the South TRUNKLINE LOOP, Southern Segment is 0.27 US$/MMBTU.

The surcharge of the gas transmission cost for the export to Japan (0.18 US$ per MMBTU) through the North TRUNKLINE LOOP, Southern Segment and (0.27 US$ per MMBTU) through the South TRUNKLINE LOOP, Southern Segment, caused by using the TRUNKLINE LOOP system, could be compensated by a new challenging concept, such as: application of the soft loan coverage for the establishment of the LNG plants to the extent needed for compensating the entire surcharge requirement, as well as considering a longer project life of the LNG plants.

The gas transmission costs for export to Europe through the North TRUNKLINE LOOP, Northern Segment (0.30 US$/MMBTU) could be acceptable by the European market, while considering that the current gas arrival price at the European point of entry from the Former Soviet Union and from Algeria amounts to approx. 3.0 US$/MMBTU. However, transmission of gas through the South TRUNKLINE LOOP, Northern Segment, at a cost of 0.57 US$/MMBTU would be difficult to justify economically for transmission by pipeline through Turkey to Europe.

To the contrary, transmission of gas as LNG from Tartus, Syria, to Europe may economically be viable while taking into account that the price level of LNG on the European market is different (usually higher) as compared to that of pipeline gas. This difference reflects also the inherent advantage of LNG because of its suitability for geographical peak-shaving.

Moreover, for decreasing the cost of gas transmission to Europe through the South TRUNKLINE LOOP, Northern Segment, it appears recommendable, therefore, to foresee a shortcut of the gas flow from a certain take-off point on the TRUNKLINE LOOP to be located in Jordan for directing the gas to the planned North African Pipeline.

Through pursuance of these measures it could be possible to maintain even the current LNG/CIF Japan import price basis of approximately 4 US$ per MMBTU.

It should be realized in this connection that the transmission cost of gas through a pipeline of half size of the TRUNKLINE LOOP (i.e. 36" instead of 48" diameter) is higher by 20 per cent. If the export capacities of the South TRUNKLINE LOOP to Europe and Japan/Asia are increased and a 48" line instead of 36" line would be used for both Segments, the transmission cost becomes approximately 0.46 US$/MMBTU for the South TRUNKLINE LOOP, Northern Segment, and 0.18 US$/MMBTU for the South TRUNKLINE LOOP, Southern Segment. It is therefore recommendable to further investigate in detail the increase of the export capacities of the South TRUNKLINE to Europe and Japan/Asia, and consider it in the PHASE II IMPLEMENTATION STUDY by taking into account an up-dated overall gas export plan.

16. CONVERTIBLE CURRENCY REVENUE AND STRATEGICAL BENEFITS

16.1 Revenue in monetary terms

Income in monetary terms by operation of the TRUNKLINE LOOP companies have been calculated for each company as shown in Table 16.1 below.

Table 16.1 Convertible Currency Revenue * (Base Case in MM US$)

Company/Op. Year	1	2 ~10	11	12 ~50
North TRUNKLINE LOOP Northern Company	193	322	322	322
North TRUNKLINE LOOP Southern Company	74	124	161	186
South TRUNKLINE LOOP Northern Company	210	350	350	350
South TRUNKLINE LOOP Southern Company	58	97	126	145

*) Operation at 60% load is assumed during the first year after start-up of the pipeline.

Table 16.1 has been calculated under the assumption that all gas consumer countries (without exceptions for Turkey, Syria and Jordan) pay for the transmission cost in convertible currencies.

A further break down of the amount to reflect the share of each particular country cannot be made at this stage since it largely depends upon their spirit of equality, share of equity participation, share of supplies, and other individual cost components.

In addition to the income in monetary terms generated by operations of the TRUNKLINE LOOP companies, a huge amount of income originating from gas production and LNG plants will be associated. However, all income components of such commercial nature have not been calculated because this STUDY does not deal with these subjects.

The possibility of accepting payments from some countries in local currencies may be considered if mutually beneficial to the region.

16.2 Strategical and Prospective Benefits

The countries, sub-regions and the region as a whole involved in the PROJECT are expected to benefit from the operation of the TRUNKLINE LOOP and its branches as outlined below:

Region

- The mutually agreed interdependence of countries of the region through their connection to a single real-time based system would favourably increase, and thus promote regional peace and further strengthen their economic ties.

- Mutual understanding would be reached among neighbouring countries and would positively influence the cooperation within the entire region, both ways: through assistance in exporting gas from land-locked countries, such as Turkmenistan, and through cooperation in supplying the gas to Pakistan and India by branch pipelines connected with the TRUNKLINE LOOP.

- The establishment of the TRUNKLINE LOOP system would enhance the development of both energy intensive industries (plants requiring considerable combustion heat inputs), such as: cement and chemical process plants, metallurgical industries, and of high-quality-fuel demanding industries, such as: ceramics, tiles,

electronic components, and food processing industries, within and outside the region, and would thus also encourage the development of satellite power generation facilities.

- The increased use of gas as a cleaner source of energy by replacing the use of oil for the same purpose which produces less emissions of CO_2, SO_x and NO_x would also contribute to improving the environment of the countries concerned.

Gas producing countries

- The promotion of new gas field development Projects would be enhanced because the LOOP itself creates a market for new medium/small gas fields. It should be noted that there is an obvious difficulty in gas field development caused by lack of interest of potential local companies or foreign partners to undertake jointly such development, unless local markets or distribution systems are available.

- Because of advantages provided by the LOOP system which constitutes a manifold for collecting the gas from a multiplicity of sources all over the region, long-term commitments required for gas export projects would become possible, and thus facilitate the promotion of such projects and smoothen their implementation.

- The foregoing features of the TRUNKLINE LOOP PROJECT could be expected to contribute to further stability of long-term national economic plans through offering an assured income based on mutually agreed long term commitments.

- A further increased efficiency of the pipeline network of each country could be achieved through integration of the TRUNKLINE LOOP system with existing and planned domestic pipelines. In this way the LOOP should be considered a major development effort like a master plan which combines sources of supply for better utilization of energy resources of the region, and satisfies the ever-increasing demand for exports.

- **Income directly generated by the TRUNKLINE LOOP operation and related indispensable services, and indirectly produced income through increased crude oil export potential owing to possible further replacement of domestic oil consumption by gas.**

Gas consuming countries of the region

- **Stable and low-price energy supplies (much lower than oil prices) could be expected to largely improve the economy of industries of the countries concerned.**

- **Through increased use of gas, oil consumption in the participating countries would be reduced. Consequently, saving of oil consumption could contribute to saving of convertible currencies in these countries.**

Europe and Japan and other gas consuming countries

- **Both Europe and Japan would benefit from the much diversified gas supply potential provided by the TRUNKLINE LOOP PROJECT under existing favourable conditions regarding its large capacity, long prospective time of operation (more than 100 years) and higher security of supplies all over the future.**

- **Europe could benefit from obtaining competitive gas supplies over very efficient routes and connecting points both by pipeline and LNG, other than the currently used routes and sources of import from the Former Soviet Union and Maghreb countries.**

- **Japan would benefit from diversifying in the future her sources of supplies by increasing imports from countries of the Middle East region which have a larger long-term supply perspective than the declining outputs of the Asian countries, and would also gain from highly secured gas imports made possible by the TRUNKLINE LOOP system which will compensate to a considerable extent the need for increasing the country's LNG emergency stockpile (storage inventory).**

17. ANALYSIS OF OPTIONS

17.1 Results

■ Option 1

The transmission costs, taking into account the less favourable loan conditions of EXIM Banks of Europe and/or Japan, have been calculated in order to demonstrate the necessity of obtaining soft loans for the implementation of the TRUNKLINE LOOP PROJECT.

Certain currently prevailing EXIM conditions applied for the computations are: 6.45 per cent interest rate, 10 years repayment, no grace.

	Option 1 EXIM basis US$/MMBTU	Base Case Soft Loan basis US$/MMBTU
North TRUNKLINE LOOP Northern Company	0.54	0.30
North TRUNKLINE LOOP Southern Company	0.32	0.18
South TRUNKLINE LOOP Northern Company	0.99	0.57
South TRUNKLINE LOOP Southern Company	0.48	0.27

The result clearly indicates that undertaking of the TRUNKLINE LOOP PROJECT would not be feasible unless loans on soft conditions become available.

■ Option 2

By taking into consideration the fundamental feature of the PROJECT which by its very nature is expected to be of mutual benefit to all the participating parties (countries, companies), the

concept of an average identical transmission cost (flat rate) over the entire TRUNKLINE LOOP has been investigated.

The result indicates a weighted average cost amounting to 0.30 US$/MMBTU, which might represent a sustainable surcharge on the gas price for exports to Europe. However, Japan and Asian countries will presumably not accept a higher (additional) transmission cost, since transmission costs of the North TRUNKLINE LOOP, Southern Segment and the South TRUNKLINE LOOP, Southern Segment represent already a kind of surcharge in the case of a possible LNG project whose plant would be located adjacent to a gas field, and thus trade off the higher security of supply provided by the LOOP.

- Option 3

This option deals with the additional gas supply pipeline from Yerbent in Turkmenistan to Chah Bahar, Iran (LNG terminal on the Branch of the North TRUNKLINE LOOP for the export of gas to Japan and Asian countries). Reference be made to the attached Satellite Picture Map which shows the likely pipeline routing.

The total length of the proposed pipeline from Yerbent in Turkmenistan to Chah Bahar in Iran is approximately 1,710 km. The sections of the pipeline in Turkmenistan and Iran are 370 km and 1,340 km, respectively.

The principal constraint for construction of the pipeline is the heavy exposure of the route to seismic risk, which is 950 km within zone 3, and 760 km within zone 4. The length of the line exposed to high water levels and saline soils is 220 km and 380 km, respectively. Therefore, the affected length of the pipeline needs to be designed for protection against soil liquefaction (swamping). A detailed investigation of the route including a site survey will be further required and shall be included in PHASE II IMPLEMENTATION STUDY.

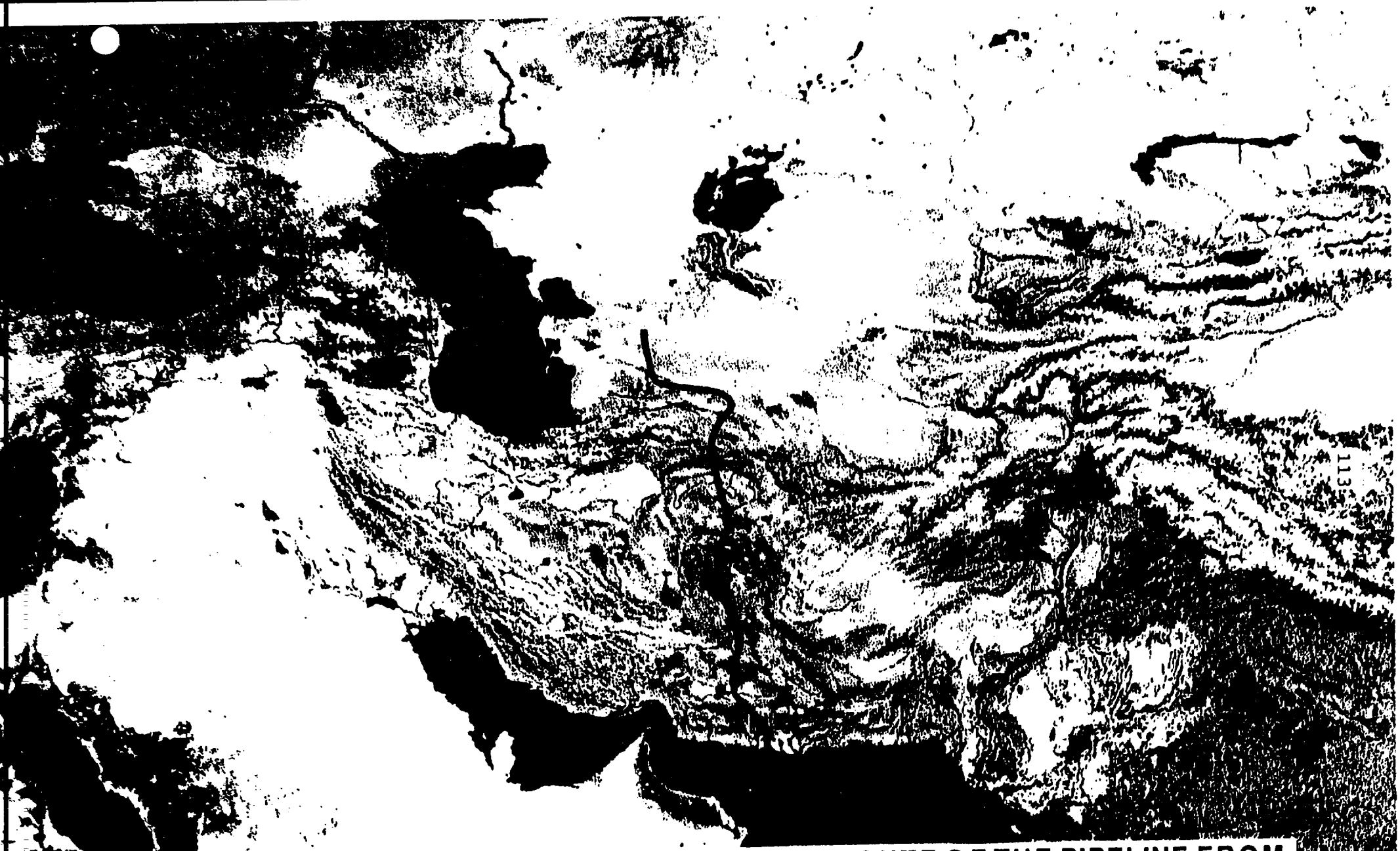


Fig. 17.1 SATELLITE MAP OF THE PROPOSED ROUTE OF THE PIPELINE FROM TURKMENISTAN TO IRAN

Design

A single 48" API 5L/X70 pipe (Design pressure : 148 bar A) is being assumed for this pipeline. It could transmit approximately 28.7 BCMY (20 MMTY LNG equivalent) of natural gas.

The total weight of the pipe would be about 1,400,000 tons, and 9 compressor stations are required.

Cost Estimate

Under the same conditions as assumed for the Base Case, the total cost of the pipeline from Turkmenistan would be the following:

Table 17.1 Total Investment Cost and Operation Cost

	Investment (Billion US$)	Operation (MM US$/Year)
Turkmenistan-Iran-Japan Pipeline	3.08	53.8

The breakdown of investment costs is presented in Table 17.2.

Table 17.2 Breakdown of Total Investment Cost

	Pipeline			Compressor Stations & Others (MM US$)
	Line-Pipe & Material (MM US$)	Construction (MM US$)	Engineering Services (MM US$)	
Turkmenistan-Iran-Japan Pipeline	1,045	643	165	1,230

Based on the above cost estimate and the same financial conditions as the Base Case, the transmission cost of natural gas from Turkmenistan to Chah Bahar would be US$ 0.30/MMBTU while assuming the same target of the expected IRR to equal 15 per cent.

This permits to state that the benefit of this option could lead to an extension of the operating life of the TRUNKLINE LOOP for another hundred years and to increase the export capacity of the entire system for Japan/Asia by up to 67 percent, whereby the involvement of Iran will very much be strengthened.

The transmission cost of this Segment is rather high. This option means that Turkmenistan should accept a lower gas selling price than those offered by the Gulf countries, or should reserve the possibility of constructing this Segment (branch) of the TRUNKLINE until gas market prices become favourable enough to support such project.

■ Option 4

Various options of gas prices have been calculated and combined with options of financing conditions for the establishment of LNG plants. The resulting options have been compared to check to what extent they would match the current LNG price if the surcharge for gas transmission through the TRUNKLINE LOOP is also taken into account. The ocean shipment costs would remain as currently charged (US$ 1.29/MMBTU: this figure was introduced in a symposium organized by Institute of Energy Economics, Japan on 15 May, 1992), while assuming the likely relatively short life of LNG ships.

Options of the gas price

1) US$0.30/MMBTU
2) US$0.60/MMBTU: however leaving fuel gas cost at US$0.30/MMBTU
3) US$0.90/MMBTU: however leaving fuel gas cost at US$0.30/MMBTU

Options of financing conditions for the establishment of the LNG plants

a) Soft loan, 50 years project life
b) EXIM loan, 20 years project life

are presented on Tables 17.3 (a) and (b).

TABLE 17.3 (a) OPTIONAL LNG CIF PRICE LOCO JAPAN (US$/MMBTU)
(20 MMTY LNG from Chah Bahar In Iran)

Option: Finance for LNG Plant		Option: Gas Selling Price to the LOOP (US$/MMBTU) 0.30	0.60	0.90	1.20
Soft Loan 100%	LOOP Transp. Cost	0.18	0.18	0.18	0.18
50 Years Project Life	Liquefaction	1.25	1.25	1.25	1.25
	Freight Charge	1.29	1.29	1.29	1.29
		3.02	3.32	3.62	3.92
Soft Loan 50%	LOOP Transp. Cost	0.18	0.18	0.18	0.18
EXIM Loan 50%	Liquefaction	1.63	1.63	1.63	1.63
50 Years Project Life	Freight Charge	1.29	1.29	1.29	1.29
		3.40	3.70	4.00	4.30
EXIM Loan 100%	LOOP Transp. Cost	0.18	0.18	0.18	0.18
20 Years Project Life	Liquefaction	2.12	2.12	2.12	2.12
	Freight Charge	1.29	1.29	1.29	1.29
		3.89	4.19	4.49	4.79

TABLE 17.3 (b) OPTIONAL LNG CIF PRICE LOCO JAPAN (US$/MMBTU)
(10 MMTY LNG from Bimmah in Oman)

Option: Finance for LNG Plant		Option: Gas Selling Price to the LOOP (US$/MMBTU) 0.30	0.60	0.90	1.20
Soft Loan 100%	LOOP Transp. Cost	0.27	0.27	0.27	0.27
50 Years Project Life	Liquefaction	1.36	1.36	1.36	1.36
	Freight Charge	1.29	1.29	1.29	1.29
		3.22	3.52	3.82	4.12
Soft Loan 50%	LOOP Transp. Cost	0.27	0.27	0.27	0.27
EXIM Loan 50%	Liquefaction	1.77	1.77	1.77	1.77
50 Years Project Life	Freight Charge	1.29	1.29	1.29	1.29
		3.63	3.93	4.23	4.53
EXIM Loan 100%	LOOP Transp. Cost	0.27	0.27	0.27	0.27
20 Years Project Life	Liquefaction	2.30	2.30	2.30	2.30
	Freight Charge	1.29	1.29	1.29	1.29
		4.16	4.46	4.76	5.06

Under the assumption that the current LNG CIF price in Japan is around US$ 4,00/MMBTU, only the optional gas price of US$ 0.30/MMBTU would be competitive in the case of EXIM loan conditions and a 10 years repayment term. Otherwise only the provision of soft loans would make the LNG options feasible.

It needs to be understood, however, that higher security of supplies assured through implementation of the TRUNKLINE LOOP PROJECT has its price which is justifiable also on economic grounds from the point of view of benefits derived by the importing countries. It remains, therefore, necessary also that for the establishment of LNG plants in the Middle East soft loan conditions should be provided.

Studies on this topic and discussions with current LNG suppliers as well as international and national financing institutions will be essential during the envisaged work on PHASE II IMPLEMENTATION STUDY.

- Option 5

Japan has taken up considerations on the increase of the LNG emergency stockpile as briefly described in Chapter 3 and elsewhere in this report.

Based on the consideration that the TRUNKLINE LOOP provides access to multiple sources of gas, the proposed LNG plants at safe locations and the LOOP design of the supply system could substitute the otherwise necessary increase of the Japanese emergency stockpile. The export potential of 30 MMTY LNG provided by this PROJECT could, therefore, supposedly be equivalent to a 30 MMT LNG emergency stockpile (storage inventory) in Japan, as presented below:

The equivalent emergency stockpile provided by this PROJECT: 30 MMT

divided by:

40 MMTY - LNG import of Japan (1992) plus

30 MMTY - quantities regularly available after completion of the PROJECT (2020)

equals: 0.429 year of stockpile or 156 days.

The comparison of investment and operating costs between those resulting from the establishment and operation of the LOOP, and the cost of establishment of an emergency stockpile in Japan of ca. 150 days capacity provides the following result:

	Investment Billion US$	Annual operating costs MM US$/Year
The TRUNKLINE LOOP PROJECT (Southern Segments of the North and South TRUNKLINE LOOP including the Branches to Bimmah and Chah Bahar)	3.32	53.60
150 days emergency stock pile in Japan	16.4* 1)	164* 2)

* 1) The cost of a tank and auxiliary facilities plus the cost of LNG of a volume (load) of 100,000 kilolitres is about 50 MM US$.

* 2) Interest for the capital needed to purchase the LNG represents the major share of the total annual operating cost (assumed: 5% interest on the value of the LNG only).

This result clearly shows that the TRUNKLINE LOOP concept provides a much more economical solution than the emergency stockpile in Japan, even if the volume of the equivalent emergency stockpile provided by the LOOP would amount to only half of the assumed imported quantity (75 days equivalent).

In this connection also an alternative strategy could, of course, be considered, e.g. to use exploited mining caverns as far as possible to increase the emergency stockpile in Japan. However, this would not reduce the operating costs presented in the above results of calculations.

18. PROJECT PREMISES TO BE FURTHER DEVELOPED

This STUDY aims at developing all the most essential aspects of project premises, and substantiating them as far as possible.

The STUDY has attained almost all of its presumed targets, and provides a well defined basis for undertaking the PHASE II IMPLEMENTATION STUDY.

The following remaining premises and conditions are considered essential and need to be elaborated and concluded under PHASE II IMPLEMENTATION STUDY:

- To obtain commitments of the countries participating in the PROJECT stipulating their demand for gas, inclusive of their schedules of gas supplies that will be required from the LOOP under their national plans and preferences regarding options of sources of supply.

  In this connection an integrated system taking into account domestic existing and planned pipelines in each country and the TRUNKLINE LOOP needs to be considered, evaluated and worked out.

  In particular the demand of non-gas-producing countries such as Turkey and Jordan should be favoured and some temporary new provisions should be considered in advance of the establishment of the TRUNKLINE LOOP.

- To define the required gas transmission capacities for export to Europe and the preferred mode of transportation, as well as to define the connecting point of the branch on the TRUNKLINE LOOP.

- To define details of expected LNG requirements of Japan and Asian countries.

- To develop a construction schedule for implementation of the entire TRUNKLINE LOOP PROJECT, and realistic phasing of establishment of its Segments in stages.

- To study and develop seriously the economic parameters of the LNG plants in order to confirm the design philosophy and investment/operation/maintenance costs of these plants, that would satisfy the condition of assuring their project life for 50 years.

- To study seriously as an option the completion of the South TRUNKLINE LOOP, Southern Segment by the year 2020, but assuming a full size diameter of 48" in order to attain better economic results.

- To discuss with relevant Government bodies and negotiate with international financing institutions and the national financing institutions of concerned countries for obtaining, at least, their preliminary commitments on possible financing arrangements under the presumed indispensable most favourable conditions for the TRUNKLINE LOOP PROJECT.

- To obtain preliminary commitments of concerned Middle East countries regarding favourable conditions of the Right of Way, concession rights, etc.

- To develop and decide upon the corporate structure of all the companies participating in the PROJECT, keeping in mind that the corporate structure suggested in this STUDY is of very preliminary conceptual nature.

- To study and develop potential gas export projects as complete design packages, comprising gas field development, construction of export marketing facilities, and market development, with the aim of assuring continuity of gas supply to the TRUNKLINE LOOP all over the future.

- **To adjust the optimization of the TRUNKLINE LOOP system, taking into account the most probable economic conditions, because the optimization of the system prepared in this STUDY has been based on slightly different conditions owing to time constraints that did not allow to make pertinent changes to the currently available software.**

19. CONCLUSIONS AND RECOMMENDATIONS

- The outcome of PHASE I of the PROJECT, the "PREMISES DEVELOPMENT STUDY ON A GAS TRUNKLINE LOOP OVER MIDDLE EAST COUNTRIES" is prospective and represents a viable concept from the technical and economic point of view, in keeping with the overall industrial development policies of the countries invited to participate in the PROJECT. All the countries of the Middle East region concerned expressed their interest during the interviews conducted by the study team.

  In pursuance of their willingness to support the PROJECT it is recommended, therefore, to continue the preparatory work by undertaking PHASE II "IMPLEMENTATION STUDY" as outlined in Chapter 20 of this report.

- Some premises have been left undefined for further elaboration as summarized in Chapter 18. However, the key issue of primary importance is to establish firm foundations that are indispensable to materialize the PROJECT and require continued efforts in promoting the interest in as well as acceleration of its implementation. To this end a reasonably balanced economic scheme needs to be worked out for defining the benefits to be shared under mutual agreement among countries of the Middle East Region, as well as the European countries and Japan, and countries of the EAST ASIAN region.

  The PHASE II "IMPLEMENTATION STUDY" should be conducted with participation of representatives of the countries concerned, under the umbrella of a UN organization. Involvement of other international organizations such as the World Bank (IBRD/IDA/IFC), EBRD, IEA, OPEC, etc., should also be considered.

- Another key issue of high priority to be taken up in order to streamline the implementation of all components of the PROJECT is to promote simultaneously the initiation of work towards execution of gas export projects which shall support at the same time full capacity utilization of the TRUNKLINE LOOP. Those projects should be studied and developed between commercially interested entities of the gas producing and consuming countries, and need to be coordinated with PHASE II "IMPLEMENTATION STUDY".

- The PHASE I "PREMISES DEVELOPMENT STUDY ON A GAS TRUNKLINE LOOP OVER MIDDLE EAST COUNTRIES" clearly indicates the necessity of making arrangements for financing under soft loan terms which constitute a prerequisite condition enabling to materialize the PROJECT. Such preferential terms should be considered as representing a kind of special incentive to the development of world energy resources.

  Furthermore, soft loan arrangements for financing the linked gas marketing facilities (LNG or pipeline) should be pursued to the extent needed to compensate for the gas transmission charge of the TRUNKLINE LOOP (i.e. to make provisions for soft loan terms covering at least 50% but possibly up to 100% of the investment cost of establishment of an LNG plant for export to Japan that would sufficiently balance out the gas transmission cost) of the LOOP and its branches. The higher security/stability and long-term assurance of gas supply to be achieved by using the LOOP should be considered as bonus.

- It is essential and recommendable to take into account a project life of 50 years for the linked LNG plant, and to the extent possible also a longer project life of linked ocean LNG tankers. The extended project life assumptions should favourably be considered in order to obtain better economic results of the entire LNG export system connected with the TRUNKLINE LOOP supported by the existence of huge reserves of natural gas in the region to which

access will be facilitated through combining multiple sources of supply into one common system owing to the pipeline-loop concept.

- It should be borne in mind that gas transmission by the TRUNKLINE LOOP is by far more economical than electric power transmission, (i.e. the cost of gas transmission is less than half of the cost of electric power transmission per unit of energy). Swapping and/or backing up of gas supply for power generation can be provided through linkage of satellite power stations with the TRUNKLINE LOOP system for the benefit the countries' power generation and distribution systems. In particular, this may be a key or critical issue for the Mediterranean borderline and neighbouring countries, comprising Turkey, Syria, Jordan, Israel, the new self-reliant Palestine territories and Egypt.

20. PROGRAMME OF PHASE II IMPLEMENTATION STUDY

PHASE II IMPLEMENTATION STUDY aims primarily at establishing a consistent and solid agreement on the Gas TRUNKLINE LOOP over the Middle East Countries comprising design, routing, and commitments to be made among the concerned countries and sectors of their national economies. Secondly, its purpose is to make preparations for expediting the implementation of construction projects of Segments of the TRUNKLINE.

The preliminary outline of the programme of PHASE II, and organization of the STUDY is presented in Figures 20.1 and 20.2 under sharing of inputs on 50:50 basis between Europe and Japan and under guidance provided by UNIDO.

The proposed programme will concentrate on the development of gas export projects with the aim of attaining full utilization of the throughput capacity of the TRUNKLINE LOOP. It will also include the preparation of a conceptual proposition of a plan for making the necessary financing arrangements, in particular with a view to the support needed through award of soft loan conditions. These two components of the programme constitute the issues of primary importance on which the success of the entire PROJECT depends.

In terms of time and costs it may take one year and a half and several million US$ to prepare the PHASE II IMPLEMENTATION STUDY, that can presumably start by mid 1994. UNIDO, ENI of Italy, and CHIYODA of Japan shall jointly pursue the matter in order to develop cooperation with interested partners of the private sector of European countries and Japan, as well as with other entities and Development Financing Institutions, such as the World Bank, EBRD, etc., and to obtain the necessary concurrence or approval of governments of the concerned countries for the implementation of the entire TRUNKLINE PROJECT and for the consecutive physical execution of its Segments and branches.

Fig. 20.1 PHASE II STUDY PROGRAMME

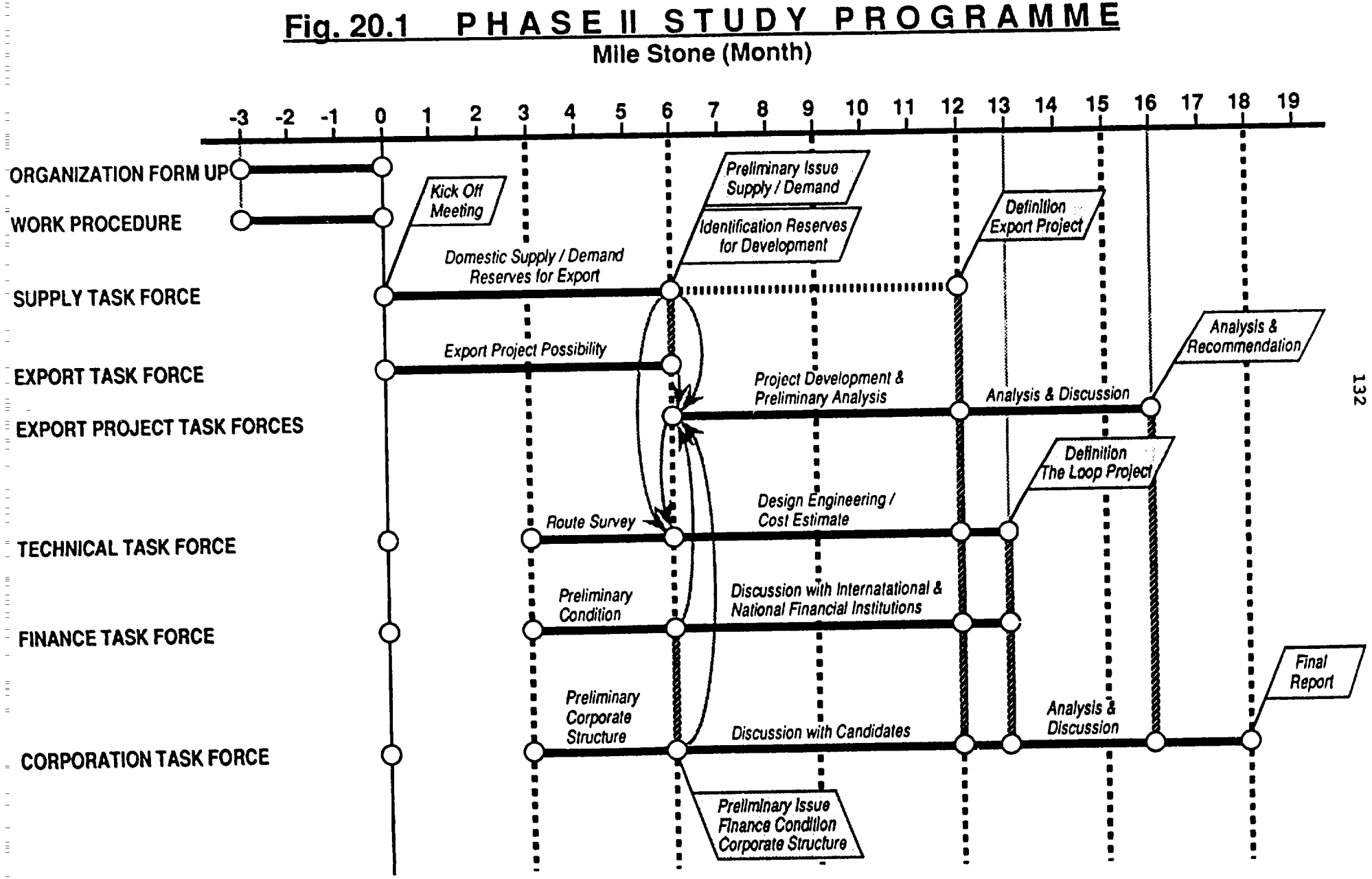
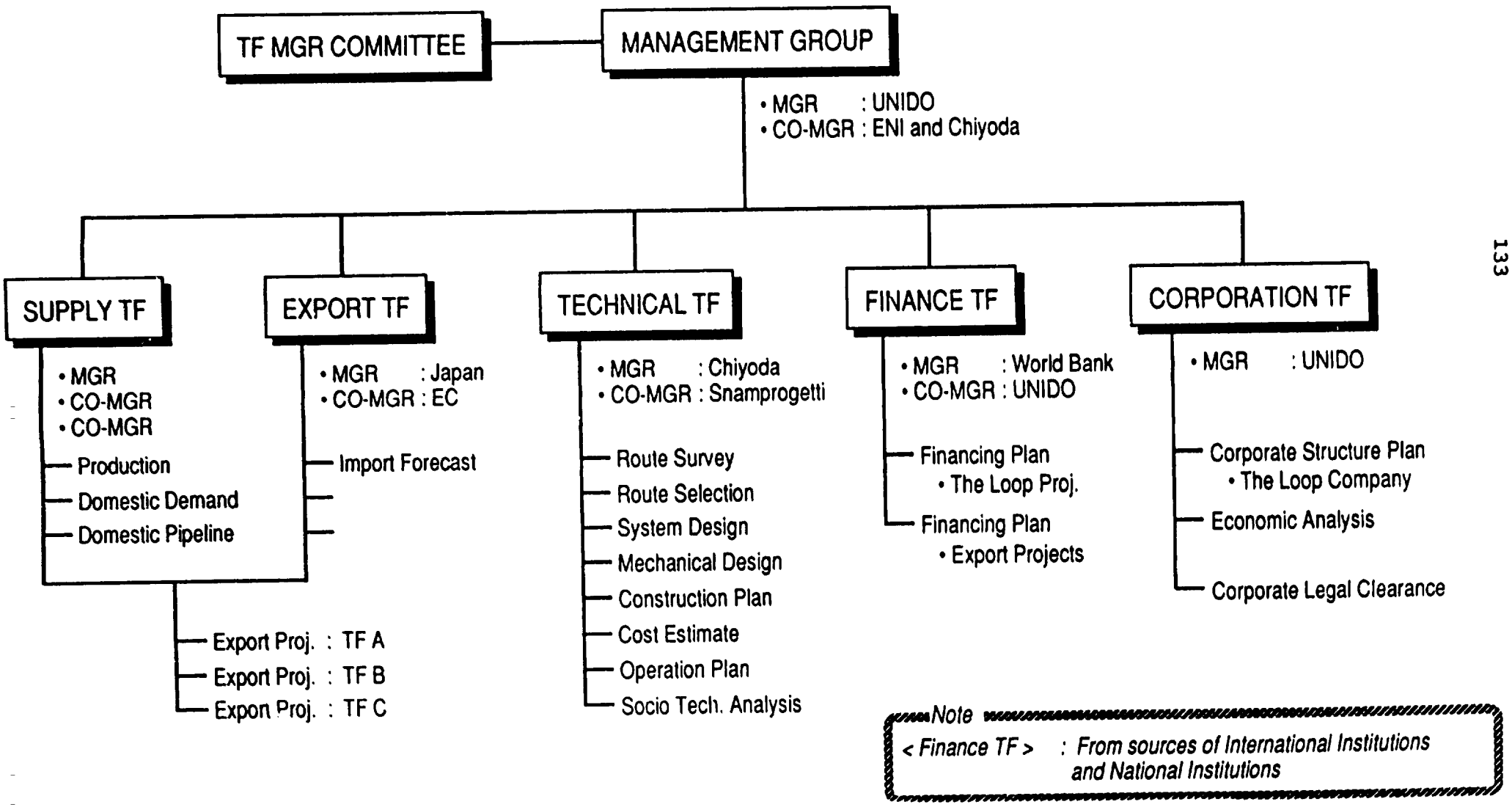


Fig. 20.2 PHASE II STUDY ORGANIZATION



APPENDIX I • **Prospectives du Gaz Naturel en Afrique du Nord, Oct. 1993**
By Observatoire Méditerranéen De l'Energie

APPENDIX II • **Middle East Gas Trunkline Loop Route Corridor Study, June 1993**
By Ove Arup & Partners

APPENDIX III • **Technical Version of Premises Development Study on Gas Trunkline Loop over Middle East Countries, Sept. 1993**
By Snamprogetti

APPENDIX IV • **Minutes of Meeting with Middle East Countries and Correspondences**

Note: The APPENDICES are available for perusal at UNIDO FMD/PF/IS