

# Annex 1

## Oil flow forecasts in the Caspian sea area

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# 1. Introduction

The Caspian sea region is an area of major strategic importance for countries importing primary energetic products:

- The region disposes of non-negligible reserves of oil and natural gas.
- Important quantities of oil and gas are transferred through the area.
- The region is divided into several independent states with different political orientations, that may incur risk of supplies for importing countries.

The geo-political environment of the area does not make easy the preparation of forecasts of international exchange of oil and gas, because many decisions still depend more upon political than economical reasons. For instance, the agreement between Turkey, Georgia and Azerbaijan regarding the construction of a new pipeline for oil transport from the Caspian sea to the Mediterranean sea through Turkey, avoiding Russia and Iran, even if the project is financially fragile (MEP, from Azerbaijan to Ceyhan).

This context contains important factors of uncertainty for the flow forecasts and the modes of transport from production site to the consumers. They have to be respected in form of various scenarios. The tasks concerning traffic have to take into consideration various influences on the policy in the region. Their definition includes great uncertainty. Going out from the fact that the area will remain oil exporter, these tasks will consider the following items:

- Demand from the importing countries and related locations (development of consumption of energetic products ).
- Prices on world level.
- Potential reserves of the Caspian region.
- Production capacity corresponding to the demand and to production costs.
- Mode of transport of this production to importing countries.
- Traffic of ports.
- Need of port equipment and installations.

The appraisal of the traffic of ports, which represents a major objective for the module, will be largely determined by the existing network of pipelines or of new pipelines to be constructed. Numerous projects are under study to develop the actual network and it is obvious that the choice of solutions could depend upon political factors. These factors have to be identified as well as their impact on practice of traffic organisation in the Caspian region.

From an operational point of view, practical implementation of the traffic tasks will be preceded by sets of data to be collected from the region, for instance:

- Condition of production capacities and reserves of oil and gas, statistics of activity from the last years, composition of social capital and review of various development projects.
- Routing of pipelines, transport capacity, statistics of activity: transported quantity, origin and destination, condition of installations, review of port extension projects: traffic, origin and destination, type of vessels, performance, condition of ports.

The required information will be collected on special forms (presently under preparation) that will be completed and filled step by step during the collection of basic data.

During this phase, discussions and meetings will be organised with corresponding groups of oil and gas industry in western Europe in order to analyse all problems of the region and to identify the strategy of the international oil groups. The first discussion will be held in Paris. According to the results of this first discussion other meetings may be organised in western Europe.

## **2. Preliminary investigations in Kazakhstan**

In order to prepare the ground for tasks E1 and E2, as mentioned above, early investigations were carried out in Kazakhstan, close to Associations and Companies dealing with oil. Also Aktau port was visited.

### ***Kazakhstan Petroleum Association (KPA)***

The chairman of the KPA is presently Managing Director for Texaco. He is of the opinion that the construction of an oil pipeline across the Caspian sea is unlikely for ecological as well as political reasons: Russia and Iran will never let that happen. On the other hand, as an executive with responsibility in the oil sector, he thinks that it is important to have several alternative routes including transport by tankers across the Caspian sea. Improving oil terminal facilities in ports is therefore perfectly actual.

The main clients for an improved oil terminal in Aktau would be Tengizchevroil, Manaigas, Kazakoil, Chevron, Arman, Central Asia Petroleum as well as Texaco (that is involved in a joint-venture concerning the Kachanganan oil field in the Mangistau Peninsula). In any case KazTransOil would be involved since it operates the oil terminal at the Aktau port and owns pipelines and storage facilities there.

In case the financial feasibility of port rehabilitation is established, a possible investor could be the Silk Road Fund of the American Insurance Group (AIG).

### ***KazTransOil***

The vice-president of KazTransOil thinks that the present Traceca Project is actual because the possibility of transporting oil by tanker gives a much needed flexibility. Improvement of ports and vessels also allows to send oil to Iran or to Makachkala, in Dagestan.

After reviewing the project ToR, the vice-president indicates that the data required for the study could be provided but only as answer to an officially sent list of specific questions. He confirms that in Aktau KazTransOil owns the pipelines, the oil storage facilities and the oil loading facilities but not the berths that belong to the commercial port.

He confirms that the focus is, for the time being, on the rehabilitation of berths n°9 and n°10 and on the strengthening of the breakwater. Rehabilitated berths 9 and 10 could allow to export 6 million tonnes of crude oil per year. The capacity could be brought to 9 million tonnes if berth 4 is added (berth 4 is currently out of use) and if berth 5 is repaired. Adding other berths could even further increase the potential throughput. According to a preliminary estimate, the upgrading of the oil loading facilities and the rehabilitation of berths 9 and 10 and of the breakwater would cost about USD 17 to 20 million.

Presently small tankers of between 4,000 and 8,000 DWT are used. It would be desirable to make use of larger tankers. Turkmenistan is building, in a Turkish shipyard, its first oil tanker (about 5,000 DWT).

## **3. Regional oil reserves**

The Caspian sea region oil and gas potential has attracted much international attention since the break-up of Soviet Union. Azerbaijan, Iran, Kazakhstan, Russia, Turkmenistan and Uzbekistan are already major oil and gas producers; their production will increase with additional investment, modern technology and development of new export outlets.

Proven oil reserves for the entire Caspian sea region are estimated at 5 billion tonnes, comparable to those of the United States (3 billion tonnes) and of the North sea (2.5 billion tonnes) together.

Besides the proven 5 billion tonnes, the region oil reserves could yield another 24 billion tonnes of oil.

Most of Azerbaijan oil resources (proven as well as potential reserves) are located offshore and perhaps 30% to 40% of total oil resources of Kazakhstan and Turkmenistan are offshore as well.

### 3.1 Kazakhstan

Kazakh proven reserves amount to 2.8 billion tonnes of oil and condensates (according to KazakhOil), but this does not yet include the last “mammoth” offshore discoveries. Kazakh potential resources are estimated at 12 billion tonnes.

### 3.2 Turkmenistan

Turkmen proven reserves amount to 1.1 billion tonnes of oil and condensates. Turkmen potential resources are estimated at 6 billion tonnes.

### 3.3 Azerbaijan

Onshore, recoverable reserves from 38 fields are set at 0.15 billion tonnes, and reserves under development amount to 0.45 billion tonnes of liquids.

Offshore, confirmed oil reserves in operated fields and estimations from seismic data amount to 1.15 billion tonnes. Evaluation of recoverable hydrocarbon reserves off Azerbaijan coast shows that they could stand between 6 and 10 billion tonnes.

## 4. Regional production and consumption

In 1999, oil and condensate production in the landlocked Caspian region countries was roughly as follows:

- Azerbaijan:	14 million tonnes
- Kazakhstan:	30 million tonnes
- Turkmenistan:	<u>7 million tonnes</u>
	51 million tonnes

Out of this amount were exported:

- From Azerbaijan:	8 million tonnes
- From Kazakhstan:	17 million tonnes
- From Turkmenistan:	<u>4 million tonnes</u>
	29 million tonnes

### 4.1 Kazakhstan

Kazakhstan is the second largest oil producer among former Soviet republics after Russia, with a production of 30 million tonnes of oil/condensates in 1999.

Kazakhstan oil production is concentrated in the west, and 2 export pipelines transport this western oil to refineries and export pipelines in Russia, while the north-eastern part of the country is fed by Russian crude oil from Eastern Siberia.

## KAZAKHSTAN oil fields, refineries & terminals



Almost half of the Kazakh production comes from three large onshore fields (Tengiz, Uzen and Karachaganak), in the western part of the country.

Kazakhstan has undertaken numbers of reforms in order to develop its potential, including privatising a number of existing energy concerns.

Kazakhstan has opened its resources to development by foreign companies. International oil projects have taken the form of joint ventures, production sharing agreements (PSAs) and exploration/field concessions. The KazakhOil Company, 100% state owned, is responsible for monitoring the compliance of foreign oil companies with Kazakh regulations and for administering state interests in "upstream" and "downstream" companies.

### Kazakh production

Kazakh oil production decreased from 1991 to 1994, and has seen a steady increase over the past years.

An estimated summary of oil and condensate production is given in the following table:

(in million tonnes)

Area	1991	1992	1993	1994	1995	1996	1997	1998	1999
Precaspian area	11.1	11.4	11.1	10.5	10.3	12.3	14.7	N/A	18.5
Mangyshlak/Buzachi	14.3	12.2	10.2	9.0	8.4	8.2	8.4	N/A	8.1
Turgay area	1.2	1.3	1.7	0.8	1.9	2.5	2.6	N/A	3.4
Total Kazakhstan	26.6	24.9	23.0	20.3	20.6	23.0	25.7	26.0	30.0

Note:

Precaspian area is located in West Kazakhstan, north of Caspian sea (main fields : *Karachaganak*, *Tengiz*)

Mangyshlak/Buzachi is located in West Kazakhstan, east of Caspian sea (main fields: *Uzen, Kalamkas, Buzachi*)

Turgay area is located in Central Kazakhstan, 1,200 km east of Caspian sea port of Aktau (main field: *Kumkol*)

The 1999 increase came mainly from Tengizchevoil, operating in Precaspian area (+1.24 million tonnes) and from Mangistaumunaygaz, operating in Mangyshlak/Buzachi area (+1.15 million tonnes).

Gas condensates account for about 10% of total liquid production (3 million tonnes in 1999).

### *Refining and national consumption*

Kazakhstan has three oil refineries supplying the following areas of the country:

- northern (Pavlodar; refining capacity : 8.1 million tonnes/year);
- western (Atyrau; refining capacity : 5.2 million tonnes/year);
- southern (Shymkent; refining capacity : 8.0 million tonnes/year).

Kazakhstan oil production is concentrated in the west and 2 export pipelines transport this western oil to refineries and export pipelines in Russia.

Kazakhstan urban and industrial centres are concentrated in the east and, since they are not connected to the oil production centres, they must import oil via pipelines from Siberia.

Subsequently, the current pipeline system is fragmented in two main separate networks, consisting of:

- 2 export pipelines in the west;
- an import pipeline in the east (and a smaller internal line in the south :Kumkol Shymkent).

Western Siberia crude oil is refined at Pavlodar. In 1999, after having been idle in June/July (due to lack of supplies), the refinery was put under the Government control, and received *Kumkol* oil to face a growing shortage of refined products during the harvesting season. Output for first six months of 1999 is only 0.64 million tonnes.

Shymkent refinery is mainly used to process *Kumkol* oil (Central Kazakhstan crude oil). Output in 1998 was reported as 3.7 million tonnes. Up to 50% of this refinery production is consumed in Almaty.

Atyrau refinery runs mainly on domestic crude from northwest Kazakhstan. Output for first six months 1999 is only 0.64 million tonnes.

Kazakhstan production and demand balance is shown below:

*(in million tonnes)*

Area	1990	1995	1997	1999
Production	25.2	20.5	25.7	30.0
Domestic Consumption	27.2	10.4	10.2	13.0
Exports	-2.0	10.1	15.5	17.0

Although Kazakhstan is a big producer (and virtually a big exporter) of oil, its domestic transport network and its refining system are not suitable with regard to the country needs: expensive Russian crude oil has to be imported to Pavlodar refinery, Shymkent refinery is facing difficulties, Atyrau refinery was virtually idle during the first half of 1999.

Mangistau region currently imports refined products from Turkmenistan and Azerbaijan.

### *4.2 Turkmenistan*

Turkmenistan is quite important for world energy markets because it holds over 3 billion cubic meters of proven natural gas reserves, the third largest ones in the world.

Bordering the Caspian sea, this country also owns significant oil reserves.

Turkmenistan's ability to develop its vast gas and oil reserves is complicated by geography. The country is land-locked, with Kazakhstan and Uzbekistan to the north, Iran and Afghanistan to the south, and the landlocked Caspian sea to the west.

After declining during the early 1990's, oil production has been steadily increasing since 1995.

In June 1998 was signed a resolution providing for restructuring of the oil and gas activities of the Ministry of Oil and Gas into five state-owned companies:

- Turkmenrozgaz, in which the Turkmen state is the major owner (with a 44% stake owned by Gazprom, the Russian company), is responsible for gas exports through Russia;
- Turkmenneftgaz is responsible for oil and gas marketing;
- Turkmenneft is in charge of carrying out oil production;
- Turkmenneftgazstroi Oil is responsible of oil and gas-related;
- Turkmengeologia undertakes exploration.

## Production

One of the main obstacles hindering development of Turkmenistan's oil industry is the lack of export route.

Turkmenistan's major oil fields (*Cheleken, Nebit Dag, Kotur Tepe*) are located onshore, in western part of the country, near Turkmenbashi (former Krasnovodsk). Of the countrywide total, production from fields in western Turkmenistan accounts for about 95%, with about 50% contributed by the *Kotur Tepe* field.

The oil production has been steadily increasing since 1995 (20% a year in average), from 3.5 million tonnes (1995) to 7.3 million tonnes (1999).

## TURKMENISTAN oil fields, refineries & terminals



## Refining capacity and national consumption

Turkmenistan has two oil refineries located in:

- Turkmenbashi (refining capacity: 5.8 million tonnes/year), located near the Caspian sea, in western Turkmenistan;
- Chardzhou (refining capacity: 6.0 million tonnes/year), located near the Uzbek border, in the far east of the country.

The oil balance for selected years since 1985 is given below:

*(in million tonnes)*

	1985	1990	1995	1996	1997	1998	1999
Crude oil production	6.1	5.6	3.5	4.0	4.5	6.5	7.3
Refinery output					3.9	4.5	4.6
Domestic consumption	4.8	4.5	4.0	N/A	N/A	N/A	4.2

With an oil production of roughly 7 million tonnes/year, a domestic consumption at level 4 to 4.5 million tonnes/year and a refining capacity of 11.8 million tonnes/year, Turkmenistan could export refined products. As there are no export pipelines for crude oil, this solution is strategically interesting.

Moreover, the Chardzou refinery, in the east of the country, is far from the oil fields and is connected to the Russian pipeline coming from eastern Siberia and feeding upstream Kazakh refineries at Pavlodar and Shymkent.

Turkmenistan produces more oil and Turkmen refineries process more products than the country needs.

In 1999, about 5 million tonnes could be exported (crude oil and products), but the oil balance needs to be further examined for the purpose of this study (Turkmenistan has not yet been visited).

### 4.3 Azerbaijan

Azerbaijan, the oldest known oil-producing region in the world, experienced an oil boom at the beginning of the 20th century and later served as a major refining centre in the former Soviet Union.

#### *Production*

Oil production peaked at about 25 million tonnes/year during World War II, then fell significantly after the 1950's as the Soviet Union redirected resources elsewhere. Production has declined again after Azerbaijan became independent, in 1991, falling to roughly 9 million tonnes in 1997.

Most of Azerbaijan's oil is produced offshore in the Caspian sea, and most of onshore production is located near Baku (Apsheron Peninsula).

State Oil Company of Azerbaijan Republic (SOCAR) is the only state oil company, which represents the State in oil and gas transactions.

In what was described as "the deal of the century", an international consortium - the Azerbaijan International Operating Company (AIOC) - signed a USD 8 billion & 30 years contract in September 1994 to develop three offshore fields: *Azeri*, *Chirag* and the deepwater portions of *Guneshli*, with total reserves estimated at 400 to 700 million tonnes.

SOCAR production (8.8 million tonnes in 1999) is for Azeri refineries (and for export whenever production exceeds domestic demand). Roughly 75% of SOCAR production is from Neft Dashlary (Oily Rocks) offshore field (6.6 million tonnes in 1999).

AIOC "early oil" production (5.2 million tonnes in 1999), which started in 1998, is only for export. It is 100% Chirag field production.

## Refining capacity and national consumption

Azeri crude is refined domestically in two refineries in Baku:

- the Baku refinery ("Azernefityag") with a capacity of 12 million tonnes/year;
- the Novo-Baku refinery ("Azernefityanajag") with a capacity of 10 million tonnes/year.

Both of these refineries have been running at far lower capacity, with overall refinery utilisation rates less than 40%.

In 1999, SOCAR refineries processed 8.4 million tonnes of crude oil into refined products, of which:

- 5.9 million tonnes were consumed in Azerbaijan;
- 2.5 million tonnes were exported (mainly by train) to Russia, Georgia and Ukraine.

Production and crude oil exports since 1994

(in million tonnes/year)

Producer	1994	1995	1996	1997	1998	1999
SOCAR						
Production	9.39	8.98	8.88	8.84	8.86	8.80
Refining	9.35	8.92	8.72	8.64	8.25	8.42
Remainder	0.04	0.10	0.26	0.34	0.24	0.05
Export				0.12	0.71	0.58
AIOC					2.37	5.20
Total Export				0.12	3.08	5.78
Total Production	9.39	8.98	8.88	8.84	11.23	14.00

## AZERBAIJAN oil fields, refineries & terminals



## 5. Caspian region exports

### 5.1 Kazakhstan

As seen above, in 1999 Kazakhstan produced 30 million tonnes of crude oil/condensates, of which 17 million tonnes were exported.

#### *Export routes*

- Kazakhstan's largest oil export line is the Western Kazakhstan pipeline system that transports oil from fields in Atyrau and Mangistau, located in the northern Caspian region (*Kalamkas, Buzachi, Karazhambas, Zhetybay, Tenge, Uzen, Tengiz*) to Russia. The blending of these various crude oil gives the *Uralsk Blend*.  
This 1,800 mile pipeline ("Atyrau-Samara" Pipeline) runs to Samara, to join the Russian Druzhba export pipeline. Although it has a capacity of 10 million tonnes/year, exports have been less because Kazakhstan's annual oil export quota through the Russian pipeline system has been 7.5 million tonnes/year. Capacity of the pipeline is expanded to 15 million tonnes/year, without incidence on Kazakhstan's annual oil export quota.
- The other export pipeline is the Kenkyak-Orsk line that transports oil from western Kazakhstan to Russia. This pipeline runs from the Aktyubinsk fields to the Orsk refinery in Russia, and has a capacity of 6.5 million tonnes/year.
- Exporters of Caspian oil have other options currently available to them:
  - Kazakhstan signed an agreement in 1996 to begin oil swaps with Iran, from the port of Aktau (Kazakhstan) to Tehran refinery, through port of Neka (Iran), but swap volumes have been limited because of contract disputes and infrastructure limitations in Iran.
  - oil is being shipped across the Caspian from Kazakhstan to the port of Dubendi in Azerbaijan for further transshipment westward by rail and pipeline (separate from the AIOC pipeline) to the Black sea. In 1999, 1.83 million tonnes were exported from Kazakhstan along this route (1.60 million tonnes *Tengiz* and 0.23 Million tonnes *Buzachi*).
  - oil can be shipped across the Caspian sea from Kazakhstan to the Russian port of Makhachkala, for further transshipment westward pipeline to Novorossiysk.
  - small amounts of oil can also be shipped by rail and barges through Russia.

In 1999, oil production in Kazakhstan totalled 30 million tonnes, of which about 17 million tonnes were exported. However, only 3 million tonnes were exported outside the former Soviet Union, through the Caspian sea and Azerbaijan/Georgia, or to Iran.

Oil exports should increase substantially as oil flow capacity increases from major joint ventures. Actual production of oil fields is limited by transport capacity.

The major condition is the development of new export routes to bring Kazakhstan's oil to world markets.

#### *Import route*

Oil is imported via the Eastern Kazakhstan and Central Asia pipeline system that transports oil along 1,268 miles from eastern Russia to southern Kazakhstan.

The pipeline has capacity of 23 million tonnes/year, and brings Siberian oil to the Pavlodar refinery (and can also feed Shymkent refinery in southern Kazakhstan, as well as Chardzou refinery in eastern Turkmenistan).

## 5.2 Turkmenistan

Turkmenistan produces less oil than Azerbaijan and Kazakhstan, and the lack of export pipeline makes it difficult to export crude oil. But both its refining capacity and its relatively slight domestic consumption allows this country to export refined products.

As the Chardzou refinery, in the east of the country, receives crude oil from Russia (eastern Siberia) by pipeline, the exact balance between import and export has to be established.

In 1999, about 5 million tonnes could be exported (crude oil and products).

### Crude oil

Exports of crude oil for 1999 can be estimated at 2.75 million tonnes, of which 0.54 million tonnes transited by ship to Baku:

-0.39 million tonnes from Okarem (*Okarem* crude).

-0.15 million tonnes from Aladja (*Cheleken* crude).

**Iran swaps:** in 1998 the U.K.'s Monument Oil reached an agreement with Iran's National Iranian Oil Company (NIOC) to provide oil from the offshore Burun field in western Turkmenistan to the northern border of Iran and swap it for oil to be exported from the Persian Gulf. The oil swaps began in late July 1998, with Turkmen oil being delivered to the Iranian Caspian port of Neka.

In addition to participating in oil swaps, Iran has begun to play an active role in developing Turkmenistan's oil sector.

For their parts, US companies are still barred by U.S. laws from trading with Iran; therefore, none of them can be part of any oil swap deal with Iran.

### Oil products

Turkmenbashi refinery, near upstream oil fields and near Caspian sea, downstream, can easily export refined products by ships, instead of crude oil.

Products export (year 1999) can be estimated as follows:

-1 to 1.2 million tonnes of fuel oil to Baku (by ship).

-1 million tonnes of oil products to Iranian ports (Neka, Bandar Anzali, Bandar Nowshahr), to Black sea via Volga-Don Canal, to Russia (Makhachkala, Astrakhan).

## 5.3 Azerbaijan

Production and crude oil exports since 1994 are as follows (in million tonnes/year):

Producer	1994	1995	1996	1997	1998	1999
SOCAR						
Production	9.39	8.98	8.88	8.84	8.86	8.80
Refining	9.35	8.92	8.72	8.64	8.25	8.42
Remainder	0.04	0.10	0.26	0.34	0.24	0.05
Export				0.12	0.71	0.58
AIOC					2.37	5.20
Total Export				0.12	3.08	5.78
Total Production	9.39	8.98	8.88	8.84	11.23	14.00

Azerbaijan's crude oil export system is composed of three distinct flows:

- Azeri crude exported by AIOC.
- Azeri crude exported by SOCAR.
- Foreign crude in transit from Caspian sea to Black sea.

### *Azeri crude exported by AIOC*

This crude oil, extracted from offshore field Chirag, is transported from the field to a 100,000 m<sup>3</sup> shore storage ("Sangachal Terminal"). From there, all crude oil production is exported by pipeline to Black sea ports of Supsa (Georgia) or Novorossiysk (Russia). BP/Amoco is operator of AIOC fields and of shore storage. Oil production started in late 1997, was 2.4 million tonnes in 1998, and 5.2 million tonnes in 1999.

### *Azeri crude exported by SOCAR*

SOCAR production reached 8.8 million tonnes in 1999, of which 0.58 million tonnes were exported by pipeline to the Russian port of Novorossiysk.

Neft Dashlary production is directly stored in a 200,000 m<sup>3</sup> shore tank farm located at Dubendi, close to Apsheron Terminal (also called Dubendi Terminal).

From there, oil can be pumped either to Boyuk Shore Storage, near Baku refineries, or to the northern pipeline to Novorossiysk.

### *Foreign crude in transit from Caspian sea to Black sea*

Kazakh and Turkmen crude oil is unloaded at Dubendi Terminal. Oil is shipped across the Caspian to the port of Dubendi for further transshipment westward to the Black sea (port of Batumi, Georgia).

This trans-Caspian trip is the first step of an integrated, multi-phased system, implemented in 1996 by Caspian Transco Inc., to transport crude oil from the Caspian area and Central Asia to the Black sea (and from there to world market). Caspian Transco co-operates with an array of institutions in Azerbaijan and in Georgia :

- Caspian sea Ports,
- Caspian Shipping Company,
- SOCAR,
- Azer-Rail,
- Georgian Rail,
- Batumi Terminal.

In 1999, 2.37 million tonnes were unloaded as follows:

- from Kazakhstan, port of Aktau, 1.83 million tonnes:
  - 1.60 million tonnes *Tengiz*
  - 0.23 Million tonnes *Buzachi*
- from Turkmenistan, 0.54 million tonnes:
  - 0.39 million tonnes from port of Okarem (*Okarem*)
  - 0.15 million tonnes from port of Aladja (*Cheleken*)

## 6. Current oil transport system

For the purpose of the present study, will only be taken in consideration the routes, the infrastructures and the resources related to the exportation of oil productions of landlocked Caspian countries towards Western Europe. Capacities on the multi-modal route (integrated by Caspian Transco Inc.) are detailed in the Infrastructures Inventory Report, except for the rail matters.

### 6.0 General considerations upon the traditional pipeline network

In Soviet times the existing pipelines in the Caspian region were designed to link the Soviet Union internally, and were routed through Russia (towards Russian refineries or via “Druzhba” pipeline towards refineries in Eastern Europe, which depended on Soviet crude as primary source of supply).

Nowadays, while Russia has existing pipelines that are under-utilised, these pipelines do not have the capacity to absorb all of the oil (and gas) the Caspian region can produce.

An additional limitation is that most existing oil export pipelines end at the Russian Black sea port of Novorossiysk, requiring tankers to transit the crowded and ecologically and politically sensitive Bosphorus in order to reach the Mediterranean sea and the world markets.

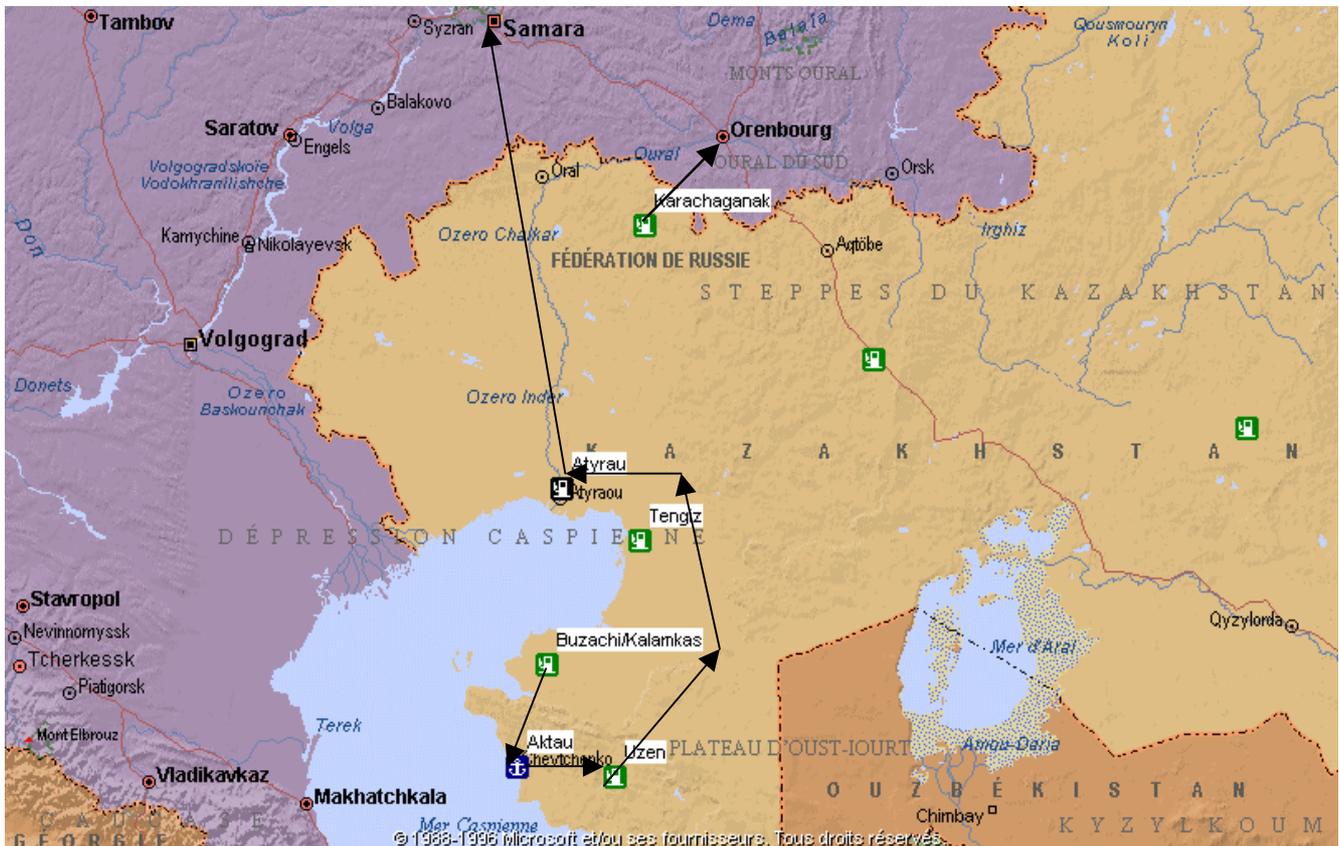
### 6.1 Kazakhstan

The largest oil export line in Western Kazakhstan ("Atyrau-Samara Pipeline") transports oil from fields in Atyrau and Mangistau, located in the northern Caspian region (fields *Kalamkas*, *Buzachi*, *Karazhambas*, *Zhetybay*, *Tenge*, *Uzen*, *Tengiz*) to Russia. The blending of these various crude oils gives the *Uralsk Blend*. In Samara, this crude is exported following the traditional route: the Russian Druzhba export pipeline.

To cope with the sharply increasing production of the giant *Tengiz* oil field, and to comply with the Kazakhstan's annual oil export quota through the Russian pipeline system, Tengizchevroil started in 1997 to ship oil across the Caspian for further transshipment by rail and pipeline through Azerbaijan and Georgia, using the Caspian Transco integrated system.

However, Tengizchevroil cannot not use the pipeline to transport its *Tengiz* oil to Aktau (the general flow runs towards north, see map below):

## KAZAKHSTAN's oil pipeline "Atyrau-Samara"



Therefore *Tengiz* oil is transported by train (750 km) from the field to a pump station close to port of Aktau. This pump station belongs to State Oil Pumping Company "Uzhnefteprovod". This station includes railroad unloading trestle, pumping equipment, storage tanks and internal pipeline system connecting tanks to the port loading terminal (length: 2km).

Storage tanks have a 120,000 m<sup>3</sup> capacity: 22 tanks x 4,750 m<sup>3</sup> (of which 16 were put in operation in 1966, 2 in 1982, 4 in 1999) and 2 tanks x 22,000 m<sup>3</sup> put in operation in 1982.

Capacity of unloading trestle: 2 million tonnes/year.

In 1998 Texaco, which operates *Buzachi North* field, decided to ship its oil across the Caspian, using the Caspian Transco integrated system. Texaco can transport its crude to Aktau by pipe. This oil is also delivered to Aktau pumping station, directly by pipe. Downstream, *Tengiz* and *Buzachi* oils are pumped using segregated pipelines to the port terminal.

Aktau port loading terminal belongs to Aktau Port (infrastructures) and to Kaztransoil (superstructure), it includes 3 operational berths for oil tankers at a maximum draught of 6.5 m: 5,000 DWT tankers (full load) or 12,000 DWT tankers loaded up to 8,500 tonnes only.

- Berth n°4: dedicated to *Buzachi* crude oil (Texaco). Loading rate: 900 t/h
- Berths n°9 & 10: dedicated to *Tengiz* crude oil (Tengizchevroil). Loading rate: 1,000 t/h

Destination of loaded vessels is Dubendi (Caspian Shipping Company vessels, within Caspian Transco integrated system).

Other destinations: Makhachkala, Astrakhan (Russia), Neka (Iran), Black sea ports of Bulgaria and Romania when Volga-Don channel is free of ice.

## 6.2 Turkmenistan

*(To be complemented after site visit)*

No export pipeline.

### *Crude oil*

The ports of Aladja and Okarem are the two ports of Turkmenistan exporting crude oil, due to their respective location near fields of *Cheleken* and *Okarem*.

Supposed capacity of terminals (all traffics included):

- Aladja: one berth receiving 5,000 DWT tankers.
- Okarem: double sided jetty receiving up to 5,000 DWT tankers.

### *Oil products*

Turmenbashi oil terminal is used for unloading crude oil tankers (from Aladja and Okarem to the local refinery), and for exporting oil products. There are 3 berths at oil base site: one for unloading crude oil and two for loading oil products.

- Berth n°1: two sides, two vessels simultaneously (maximum size: 5,000 DWT). Crude or oil products can be handled.
- Berth n°2: two sides, two vessels simultaneously (maximum size: 5,000 DWT). Only oil products can be handled.
- Berth n°3: only for discharge of crude oil. Maximum size of ship: 5,000 DWT).

Assumed capacity of terminal (all traffics included):

- Berth n°1 & 2 :
  - if only black oil is loaded : 5.5 million tonnes/year
  - if only light oil is loaded : 4 million tonnes/year
- Berth n°3 :
  - only crude oil is loaded : 2.5 million tonnes/year

Destination of loaded crude oil vessels is Dubendi (Caspian Shipping Company ships, within Caspian Transco integrated system).

Other destinations: Makhachkala, Astrakhan (Russia), Neka (Iran).

### 6.3 Azerbaijan

Azerbaijan's crude oil export system consists of three flows:

- Azeri crude exported by AIOC (5.20 million tonnes in 1999),
- Azeri crude exported by SOCAR (0.58 million tonnes in 1999),
- Foreign crude in transit from Caspian sea to Black sea (2.37 million tonnes in 1999).

(in million tonnes)

	1997	1998	1999
<i>Azeri oil Exports</i>			
SOCAR	0.12	0.71	0.58
AIOC		2.37	5.20
Total Azeri oil Export	0.12	3.08	5.78
<i>Foreign oil in transit</i>			
Kazakh	0.65	1.77	1.83
Turkmen		0.36	0.54
Total transit oil	0.65	2.13	2.37
Total (export +transit)	0.77	5.21	8.15

Exports from Azerbaijan of Azeri crude oil use two pipelines:

- the "Western Route" : Baku-Supsa (through Georgia)  
(Design capacity : 5 million tonnes/year)
- the "Northern Route" : Baku-Novorossiysk (through Russia)  
(Design capacity : 5 million tonnes/year). Throughput on this route has been limited to 2.5 million tonnes/year because of pump capacity restrictions.

The exports increased in 1998 through the "Northern Route", when AIOC started production of "early oil" from *Chirag* field.

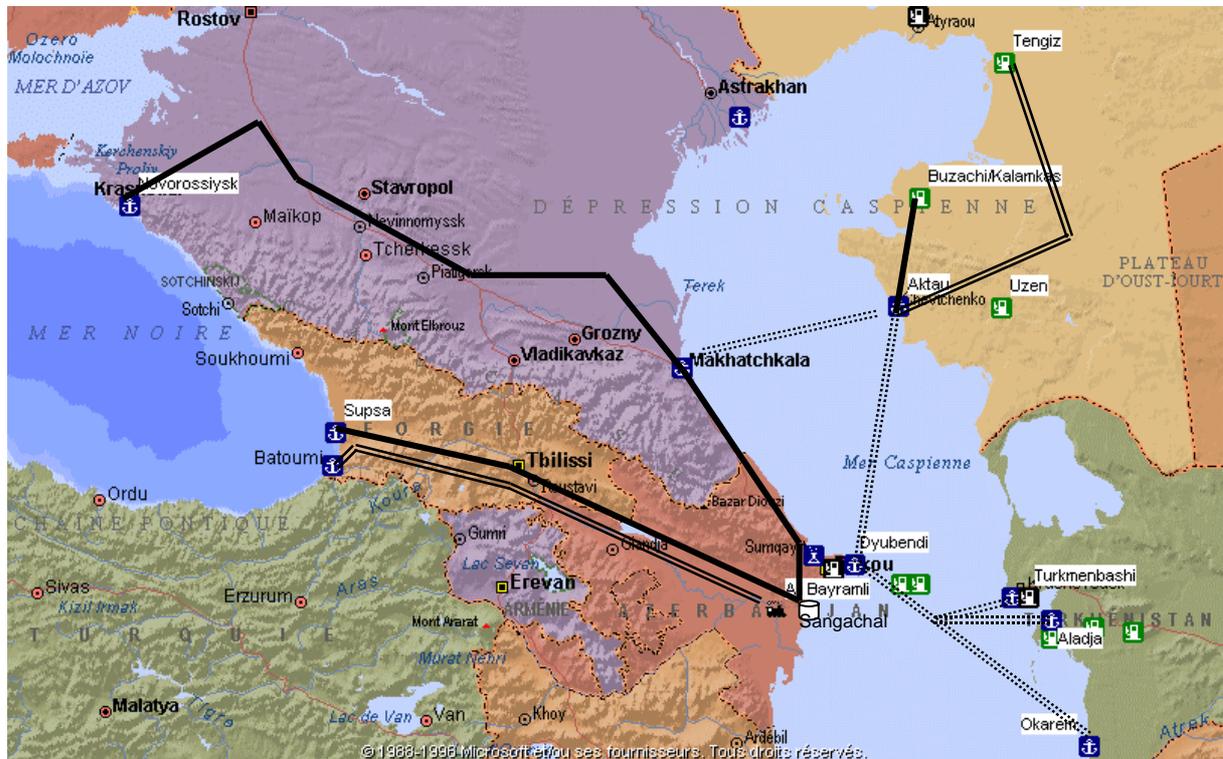
In 1999, AIOC exports increased significantly, with the completion of the "Western Route" for "early oil" from Baku to the Georgian Black sea port of Supsa on 17 April 1999.

Year 1999 was remarkable with frequent interruptions of the Northern Route (Baku-Novorossiysk), and its complete halting in July, because a section of the pipeline was damaged by the Russian bombings near Grozny. As a temporary measure, the Transneft Company (the operator of the Northern Route) started the transportation of Azeri oil by pipeline to Izberbash (Dagestan, Russia). There, oil was filled into rail tanks and shipped to Tikhoretsk by railways. Then it was pumped by pipeline to Novorossiysk.

This bottleneck limited the capacity of the Northern Route to 0.75 million tonnes/year, and did not allow Transneft to implement its obligations to transport not less than 2 million tonnes/year.

A new section is now operational since April 2000, by-passing Chechnya.

## CASPIAN TO BLACK SEA OIL ROUTES



### *Azeri crude exported by AIOC*

This crude oil, extracted from offshore field Chirag, is transported from the field to a 100,000 m<sup>3</sup> shore storage ("Sangachal Terminal").

From there, all crude oil production is exported by pipeline to Black sea ports of:

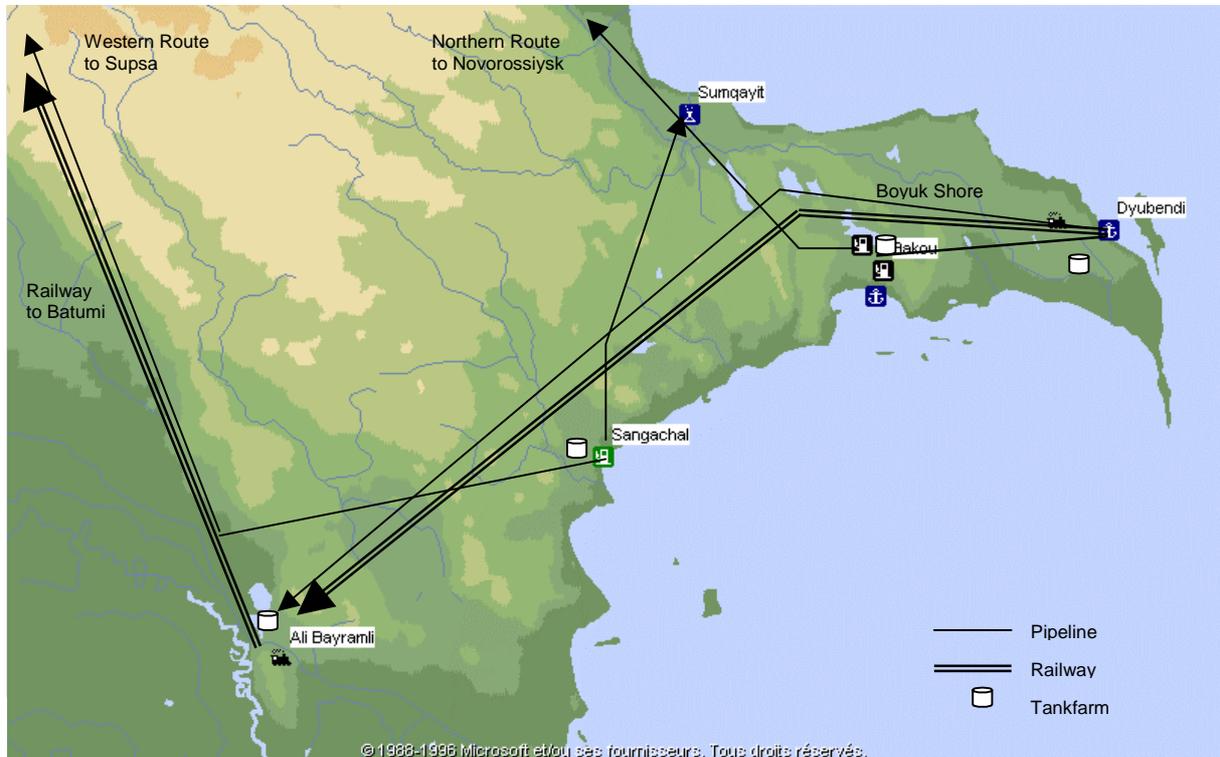
- Supsa (Georgia), using the Western Route (in 1999: 3.9 million tonnes). This port has been developed by and for AIOC, which has exclusive rights.
- or Novorossiysk (Russia), using the Northern Route (in 1999 : 1.3 million tonnes).

### *Azeri crude exported by SOCAR*

Most of Azeri onshore production is located near Baku (Apsheron Peninsula), and most of SOCAR's oil is produced offshore, in the Caspian sea: roughly 75% of production is from Neft Dashlary offshore field (6.6 million tonnes in 1999). Offshore production (*Neft Dashlary, Guneshli, Pirallahi*) and Apsheron Peninsula production are stored in Dubendi tank farm (200,000 m<sup>3</sup>, on which 30,000 m<sup>3</sup> are dedicated to SOCAR's crude oil), from where oil is pumped to Boyuk Shore Terminal (a big storage near Baku refineries). From there, crude oil is either processed, or pumped to Novorossiysk along the Northern Route.

SOCAR did not initially plan to use the Western Route (Baku-Supsa). But the Northern Route may soon become insufficient to carry the large oil flows expected from the AIOC and the possible transit of Kazakh crude oil shipped from Aktau to Makhachkala.

## APSHERON and BAKU PENINSULA (Ports, storages, pipelines, railways)



### *Transit crude oil across the Caspian sea*

To cope with the sharply increasing production of the Kazakh Tengiz oil field, and to comply with the quotas for oil export through Russian pipes, in 1997 Tengizchevroil started to ship oil across the Caspian sea for further transshipment by rail and pipeline through Azerbaijan and Georgia, using the Caspian Transco system.

This system is an integrated, multi-phased system, implemented by Caspian Transco, to transport crude oil from the Caspian area and from Central Asia towards the Black Sea, in order to reach the world market.

To this end Caspian Transco co-operates with an array of institutions in Azerbaijan and in Georgia:

- The Caspian Sea Ports,
- The Caspian Shipping Company,
- The Azeri State Oil Company SOCAR,
- The Azeri Railways Company,
- The Georgian Railways Company,
- The Batumi Terminal.

This crude oil transportation system starts with the Caspian Transco free-on-board reception of crude oil in Eastern Caspian ports (Aktau, Aladja and Okarem). After a one-day journey across the Caspian sea crude oil is discharged at the Dubendi terminal. Oil is stored in onshore tanks at Dubendi tankfarm: 200,000 m<sup>3</sup> total capacity, out of which 135,000 m<sup>3</sup> are dedicated to Caspian Transco.

From the tank farm crude oil is transported further to Batumi along two alternative routes:

- either the Dubendi-Ali Bayramli-Batumi rail link,
- or the Dubendi-Ali Bayramli pipeline, followed by the railway to Batumi.

### **Tanker vessels (owned by the Caspian Shipping Company)**

Maritime transport lines (Aktau/Aladja/Okarem to Apsheron-Dubendi Terminal) are not complicated from a logistical point of view. The marine transport resources are limited to the amount of vessels of the Caspian Shipping Company, as there is an embargo for Russian vessels to enter Azeri ports (and an embargo for Azeri vessels to enter Russian ports).

Caspian Shipping Company is the largest ship-owner in the region. The company's fleet calls at more than 130 ports of the whole world.

The tanker fleet comprises:

3 type "Kafur Mamedov" tankers:	12,334 DWT	Mean load draught: 8.00 m
9 type "Apsheron" tankers:	7,410/5,512 DWT	Mean load draught: 5.3/4.5 m
21 type "G <sup>al</sup> Shikhlinskiy" tankers:	12,334 DWT	Mean load draught: 4.15 m

From the above fleet, 25 tankers presently operate in Caspian sea.

The longest trans-Caspian journey is between Aktau and Dubendi: 207 nautical miles.

A ship can turn over a round trip in roughly three days:

-trip Dubendi-Aktau : 207 nautical miles at 10 knots :	21 hours
-mooring/shipping documents, etc	2 hours
-loading in Aktau : average cargo : 6,000 t, loaded at rate 1,000 t/h :	6 hours
-shipping documents, sailing	2 hours
-trip Aktau-Dubendi: 207 nautical miles at 10 knots :	21 hours
-mooring/shipping documents, etc	2 hours
-unloading in Dubendi : average 6,000 t, unloaded at rate 900 t/h :	7 hours
-shipping documents, sailing	<u>2 hours</u>
-total trip duration	63 hours

Caspian Shipping management staff considers that a current circle trip has a duration between 72 to 78 hours, and that a ship is able to achieve 90 to 100 trips in per year.

One should also note that the operator, due to pump reliability problems, reports the unloading operations at Dubendi to last 16 hours. The 7 hours mentioned above are theoretical.

Since the beginning, in 1997, Caspian Transco's traffic at Apsheron-Dubendi Terminal was as follows (by year and by origin):

	1997			1998			1999		
	KTon	Nb ships	T/ship	KTon	Nb ships	T/ship	KTon	Nb ships	T/ship
Kazakh	654	134	4885	1765	298	5925	1831	260	7044
Turkmen				363	83	4373	536	111	4833
Total	654	134	4885	2128	381	5590	2367	371	6388

The difference in size of ships, between Kazakh and Turkmen origins, is due to difference of maximum draught limitation in loading ports.

All 12,000 DWT tankers are loaded up to 8,500 tonnes in order not to exceed a draught of 6.5 m.

The transport capacity of the fleet depends on the number of ships dedicated to Caspian Transco integrated system.

On the above basis (3 days a trip and 100 trips/ship/year), traffic simulations can be processed in various cases of traffic forecasts.

## Apsheron-Dubendi Terminal

Available draft without dredging is close to 8 m (but a shoal in the access channel restricts draught to 6.5 m) allowing all Caspian Shipping Company's oil tankers to berth fully loaded, except the three 12,000 DWT tankers, which must be limited to a 8,500 tonne load. Dredging would make it possible for ships of 12,000 tonnes.

Port is working 24 hours a day, all around the year. Bad weather prevents use of the port between 30 and 45 days per year.

The Apsheron-Dubendi oil terminal consists of four full-size piers (n°1, 2, 3 and 5). Pier 3 was assigned to the handling of petroleum products in both directions and the other piers to the import of crude oil. Each pier has two symmetrical berths.

Until 1990, Pier 3 was used to export refined petroleum products to Turkmenbashi. Since 1990, one of two berths stands completely idle. The other berth is presently used to unload tankers bringing aviation kerosene from the Baku *Azerneftlyag* refinery. The fuel is pumped into Dubendi tank farms (200,000 m<sup>3</sup>, of which 32,000 m<sup>3</sup> are dedicated to this airport use). From there it is sent to the airport by pipeline.

The pier 1 can still operate. It is said to be able to receive 3 to 4 ships a day. Caspian Transco has an exclusive right to use pier 1 (a contract was signed in 1996, for a 25 year period).

## Dubendi tank-farm

Three kinds of flow are presently transiting through Dubendi:

- Crude oil in transit, imported by tankers from Aktau (*Kazakh Tengizchevroil*) or from Okaren or Aladja (Turkmenistan), by Caspian Transco, using pier n°1.
- Azeri Crude oil: SOCAR's onshore production from Apsheron Peninsula, and SOCAR's offshore production (*Neft Dashlary, Guneshli, Pirallahi*).
- Azerneftlyag products for the airport use.

Storage tanks, close to the port, have an overall capacity of 200,000 m<sup>3</sup>. These storage tanks belong to SOCAR, which shares the capacity as follows:

- Rented to Caspian Transco for transit crude oil: 135,000 m<sup>3</sup>
- SOCAR's Azeri crude oil: 32,000 m<sup>3</sup>
- SOCAR/Azernefityag products: 30,000 m<sup>3</sup>

### **The Dubendi-Batumi rail link**

The rail link begins at the Caspian Transco RTC loading gantry in Dubendi. Completed in late 1997, the gantry is connected to Dubendi tank farm by two 500 mm diameter and 4 km long pipelines.

Caspian Transco personnel can inspect, load, measure and dispatch up to five trains a day at the RTC loading gantry in Dubendi.

### **The Dubendi to Ali Bayramli pipeline and the Ali-Bayramli to Batumi rail link**

The 305 mm diameter long pipeline is operated by both Caspian Transco and SOCAR companies.

This pipeline ends at the Ali Bayramli tank farm, which houses Caspian Transco cargoes (transit crude oil) and onshore Azeri production (*SOBCO, Shirvan*), before being loaded into RTC.

The trains dispatched from Dubendi and from Ali Bayramli go through Buyuk Kesik (Georgian border) where Caspian Transco carries out a visual inspection of the passing trains and finalises the necessary paperwork.

Trains dispatched from Azerbaijan reach Batumi within three days. For traffic simulations, we can consider a RTC turnover time Dubendi-Batumi-Dubendi of 5 days.

At the Batumi terminal, oil is unloaded into buffer tanks by Caspian Transco, in co-operation with the Batumi terminal authorities.

### **The Azeri and Georgian railways**

Officially 2,900 RTC for oil and oil products are available, but actually 800 are out of service. Azerbaijan State Railways also rents 1,000 RTC to Russia.

Most of RTC are 4-axle RTC with a payload of 60-66 tonnes (for product density of 1), and to some extent even 8-axle RTC with 125 tonnes capacity are used.

Azeri railways transported 14 million tonnes in 1999, of which 11 million tonnes (80%) was oil (crude and products).

Total number of Azeri RTC available for crude oil transport may be estimated to 1,000.

Georgian railways have presently 1,200 RTC available for crude oil transport.

The estimation of the transport capacity of Caspian Transco can be made as follows:

- Each train carries 2,000 tonnes of oil (40 RTC loaded at 50 tonnes).
- 2,200 RTC are available for Caspian Transco transport system.

Every RTC can turn round 70 times in a year ( $365/5$ ), which makes ( $70 \times 2,200 \times 50$  t) a transport capacity of 7.7 million tonnes/year. This amount represents 3,850 pairs of trains in a year, i.e. roughly 10 pairs of trains/day.

The Baku to Georgian border track has reportedly a capacity of 120 pairs of trains/day (electrified double track).

The Georgian track is double except for a section at Kasuri, which is single. Speed is limited to 40 km/h, and track capacity is 40 trains/day.

The above estimation does not take in account:

- Lack of RTC maintenance workshops.
- Frequent power failures (electricity) in Georgia: sometimes RTC cannot be unloaded (it may happen that 600 RTC are waiting to be handled).
- Ambient temperature below "pouring point" of cargo (fuel oil, and some crude oils): in winter, the cargo is solidified and Batumi terminal has to heat it by injecting steam inside the cargo, which increases the water content, and dramatically decreases discharge rates (even when power supply is working).

These problems induce needs of additional RTC and increases the average roundtrip time up to 8.5 to 10 days, decreasing transport capacity to roughly 4 / 4.5 million tonnes/year.

## **The Batumi terminal**

The annual productivity of the RTC unloading station is reportedly 4.5 million tonnes/year.

The oil port jetty has three berths. Berth n°1 receives tankers up to 30,000 DWT.

Outside the jetty was built a sea-line with mooring buoys, for tankers up to 50,000 DWT.

The main problem is reportedly the lack of storage capacity for transit crude oil.

## **7. Forecasted production and exports of crude oil**

Landlocked Caspian countries need to solve two major problems in order to further increase oil production:

- Development of offshore potential is slowed by a dispute regarding ownership rights. This disagreement ties in with a broader debate between Caspian sea Region states about how the Caspian sea should be treated under international laws.
- Development of new export routes to bring Caspian oil to world markets.

Therefore, all following forecasts are subject to the implementation of suitable export routes.

These projects, along with other projects currently underway, could help to boost the Caspian sea production to over 200 million tonnes/year, and could increase Caspian oil exports to over 150 million tonnes/year by the end of the next decade. By 2020, production and exports could increase by another 100 million tonnes/year.

According to the International Energy Agency, the Caspian sea oil reserves are between 3,000 and 4,000 million tonnes. At the plateau level, long term production is anticipated at 150/200 million tonnes/year:

- 12.5 million tonnes/year in 1998
- 25 million tonnes/year in 2002
- 50 million tonnes/year in 2005
- etc.

## 7.1 Kazakhstan

Forecasted evolution of the country's production (according to International Energy Agency) is as follows:

(in million tonnes)

<b>High scenario</b>	1999	2005	2010	2020
Production	30	70	100	160
Consumption	13	34	45	84
Exports	17	36	55	76

(in million tonnes)

<b>Low scenario</b>	1999	2005	2010	2020
Production	30	55	75	130
Consumption	13	24	32	52
Exports	17	31	43	78

Main proven reserves in Western Kazakhstan are:

- *Tengiz* (1/1.5 billion tonnes reserves). Tengizchevroil production forecasts:
  - 10 million tonnes/year (1999)
  - 12 million tonnes/year (2001)
  - 35 million tonnes/year by 2010 (expected peak production)
- *Karachaganak* (1 trillion m<sup>3</sup> gas, and 300 million tonnes oil reserves). Present production exported to Orenbourg refinery (Russia). Operating structure projects laying a pipeline Karachaganak-Atyrau. Possible scenario:
  - 3.3 million tonnes/year (1998)
  - 7 million tonnes/year (2005)
  - 12 million tonnes/year (2010)

Capacity of present pipelines:

- "Atyrau-Samara Pipeline" (joins the Russian Druzhba export pipeline). Kazakhstan's annual oil export quota is 7.5 million tonnes/year.
- Kenkyak-Orsk (Aktyubinsk fields to the Orsk refinery in Russia), with a capacity of 6.5 million tonnes/year.

Current pipelines capacity (Western Kazakhstan) is thus 14 million tonnes/year.

New pipelines needs (if Russian current pipelines are still used at current level for export):

(in million tonnes)

	1999	2005	2010	2020
High scenario	3	22	41	62
Low scenario	3	17	29	64

New pipelines needs (if Russian current pipelines are no longer used for export):

*(in million tonnes)*

	1999	2005	2010	2020
High scenario	17	36	55	76
Low scenario	17	31	43	78

## 7.2 Turkmenistan

In August 1999 Turkmen President approved a development programme forecasting that oil production would rise up to 27-30 million tonnes/year by 2010. In this case estimated production forecast might be as follows:

*(in million tonnes)*

	1999	2005	2010	2020
Production	7.3	10	27	45
Consumption	4.5	4.5	8?	15
Exports	2.8	5.5	20?	30

Monument and Mobil estimate that the development of the Garashsyzyk area combined with the expanding production from the Burun field could result in 25 million tonnes/year of oil production from western Turkmenistan by 2006-2007, if a suitable export route becomes available.

## 7.3 Azerbaijan

SOCAR production forecasts are reported below:

*(in million tonnes)*

	1999	2005	2010	2020
Production	14	28	47	100
Consumption	8.2			
Exports	5.8			

AIOC oil production is targeted to increase up to 12.5 million tonnes in 2003. AIOC expects its production to reach 40 million tonnes within the next 15 years.

## 7.4 Total three countries

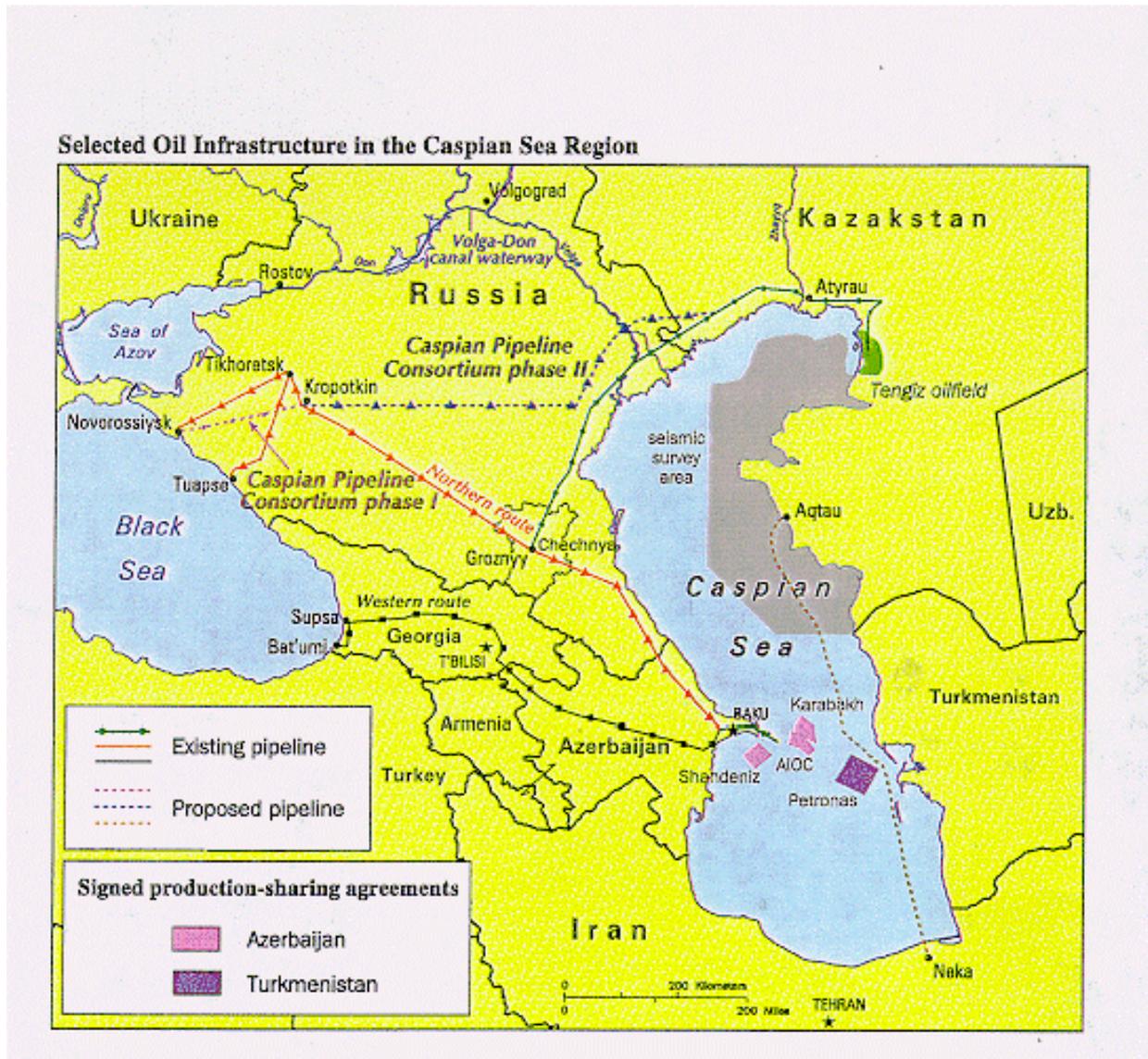
*(To be complemented)*

## Annex 2

### Outline of crude oil flows in the area of Baku

Crude oil flows in the area of Baku can be classified into three groups, which refined product flows are directly linked with:

1. Crude oil produced in Azerbaijan (offshore and on-shore) and refined in Baku.
2. Crude oil produced in Azerbaijan sea waters and exported through Supsa port, Georgia.
3. Crude oil produced in Kazakhstan and in Turkmenistan, exported through Batumi port, Georgia.



#### 1. Crude oil produced in Azerbaijan and refined in Baku

This is under the full control of SOCAR, the State Oil Company of Azerbaijan.

The traffic study points out an exportation of 0,58 Mt of crude oil in 1999.

The initial refining capacity of the two Baku refineries was about 25 Mt/year, since these refineries were designed to feed a much larger territory than Azerbaijan. This is the reason why the berths dedicated to refined products in Baku and Dubendi ports are only partly used.

However, seasonal imports of refined products happen, for fuel oil in winter time, to feed local power plants. This fuel oil comes from Turkmenistan, it is unloaded at pier n°20 in Baku port (the only operating berth is under rehabilitation, it has fuel-oil storage facilities and a Rail Tank Car loading station).

In summer time Baku refineries allow transit of Turkmen fuel oil towards the Black Sea.

Moreover, Azeri white refined products (diesel, gasoil) are shipped from Baku to other oil ports on the Caspian sea.

There is also some jet-fuel traffic, jet-fuel is loaded in Baku at pier n°10 and unloaded in Dubendi at pier n°3, then transferred by pipeline to Baku airport.

From this pattern it could be suggested to use the Baku refineries to refine Kazakh and Turkmen crude oil for their domestic use, but Kazakh and Turkmen Authorities will probably prefer to develop their own refineries.

As mentioned in the traffic study, a share of SOCAR crude oil production is exported through the Baku-Makhachkala-Novorossiysk pipeline. This crude oil is the so-called "Azeri light".

## **2. Crude oil produced in Azerbaijan sea waters and exported through Supsa**

(See map on next page)

This is under the control of AIOC.

The traffic study points out a crude oil export figure of 5,20 Mt in 1999.

This traffic is supported by the Sangachal (south of Baku) to Supsa pipeline.

The Dubendi oil terminal is not concerned by this flow.



Source: AIOC

### 3. Crude oil produced in Kazakhstan & Turkmenistan, exported through Batumi

#### 3.1 Quantitative analysis

The traffic study provides with the following figures in 1999:

Origin	Exports	Transit to Batumi via Dubendi	Market share for the oil port of Dubendi
KAZAKHSTAN (Tengiz)	17 Mt/year	1.6 Mt/year	11 %
KAZAKHSTAN (Buzachi)		0.23 Mt/year	
TURKMENISTAN ( Okerem)	2.75 Mt/year	0.39 Mt/year	20 %
TURKMENISTAN ( Chelekem)		0.15 Mt/year	

As shown above, Dubendi plays a significant role on that route.

#### 3.2 Crude oil characteristics

The table below gives average characteristics of crude oils transiting through the oil terminal of Dubendi. These are of importance for the design of oil handling facilities.

Name of crude quality	Density	Viscosity at 10°C	Viscosity at 20 °C	Flooding Point	Vapour Tensile Value Reid	H2s Content
TENGIZ	788	3.1	2.5	-48	510	75
OKAREM	859	40.3	24.9	+ 27	110	-
CHELEKEM	843	14.7	9.1	+ 18	117	-
BUZACHINSK	905	176.3	91.7	-10	-	-
AZERI LIGHT	851	25.3	13.8	-3	-	-

These products are also blended before being transferred to the international market. However blends do not concern Dubendi, they only affect Batumi facilities.

Name of crude, after blending	Density	Viscosity at 10°C	Viscosity at 20 °C	Flooding Point	Vapour Tensile Value Reid	H2s Content
CHAZOK (20% Chelekem/25% Azeri/50% Okarem)	881	87.2	NA	+ 18	NA	NA
CHOK (50 % Chelekem/50% Okarem)	856	34.4	NA	+ 9	76	NA
CHAZ (Blend Chelekem/Azeri)	867	48.5	27.1	+ 3	110	NA

## Annex 3

### Multi-modal oil transport routes and capacities

#### 1. General



Source: Caspian Transco

To cope with the sharply increasing production of the Kazakh Tengiz oil field, and to comply with the quotas for oil export through Russian pipes, in 1997 Tengizchevroil started to ship oil across the Caspian sea for further transshipment by rail and pipeline through Azerbaijan and Georgia, using the Caspian Transco system.

This system is an integrated, multi-phased system, implemented by Caspian Transco, to transport crude oil from the Caspian area and from Central Asia towards the Black Sea, in order to reach the world market.

To this end Caspian Transco co-operates with an array of institutions in Azerbaijan and in Georgia:

- The Caspian Sea Ports,
- The Caspian Shipping Company,
- The Azeri State Oil Company SOCAR,
- The Azeri Railways Company,
- The Georgian Railways Company,
- The Batumi Terminal.

This crude oil transportation system starts with the Caspian Transco free-on-board reception of crude oil in Eastern Caspian ports (Aktau, Aladja and Okarem). After a one-day journey across the Caspian sea crude oil is discharged at the Dubendi terminal. Oil is stored in onshore tanks at Dubendi tankfarm: 200,000 m<sup>3</sup> total capacity, out of which 135,000 m<sup>3</sup> are dedicated to Caspian Transco.

From the tank farm crude oil is transported further to Batumi along two alternative routes:

- either the Dubendi-Ali Bayramli-Batumi rail link,
- or the Dubendi-Ali Bayramli pipeline, followed by the railway to Batumi.

## 2. Transport capacity across the Caspian sea

Characteristics of Caspian Shipping Company oil tankers:

Type	Official DWT (tonnes)	True max. carrying capacity (tonnes)	Loaded draft (meters)
<i>General Shikhlinskiy</i>	5,000	4,800	4.0
<i>Apsheron</i>	7,000	6,200	5.5
<i>Kafur Mamedov</i>	12,000	8,000	6.6
<i>Kafur Mamedov</i>	12,000	10,000	8.0

A fleet of seven vessels are dedicated to crude oil transport towards Dubendi:

- Three 12,000 DWT vessels, which cannot carry more than 8,000 tonnes to Dubendi because of lack of water depth in the port and its approaches.
- Four 7,000 DWT vessels.

Vessel unloading characteristics:

- Discharge rate = max. 1,250 m<sup>3</sup>/hour
- Discharge pressure = max. 6 bars

Frequent pump failures make unloading operations quite slow: 16 hours as an average for 7,000 to 8,000 tonnes of crude oil.

(A project of investment in new pumps is currently under consideration by the Caspian Shipping Company)

Global average time from Aktau to Aktau appears to be as follows:

12 hours (loading in Aktau)  
+ 26 hours (crossing journey to Dubendi)  
+ 16 hours (unloading in Dubendi)  
+ 24 hours (return journey)  
= 78 hours

On the basis of 100 round trips per year for each tanker, theoretical annual capacity can therefore be close to 5 Mt. The Caspian Shipping Company can increase this figure by renewing vessel pumps and by upgrading other vessels.

### 3. Inland capacities from Dubendi to Batumi

#### 3.1 Dubendi oil berths

The two berths of pier n°1 allow unloading of crude oil.

Taking into account the vessel pumping capacity and the fact that the terminal can only be operated 11 months per year (1 month off because of bad weather conditions), the maximum capacity is only 4.2 Mt/year. This computation is based on a berth occupation rate of 60 % (random law of vessel arrivals):

$$C_{\max} = 0,6 \times 8760 \times 11/12 \times 7000/16 \times 2 = 4,2 \text{ Mt/year}$$

#### 3.2 Storage facilities

##### ***Operated by Caspian Transco in Dubendi***

Current total capacity for crude oil is 135,000 m<sup>3</sup> (approximately 110,000 tonnes). However, since all tanks need repair works, true storage capacity might be lower in the coming years, unless other tanks may be used (it seems possible to rent to SOCAR some unused storage tanks). Furthermore, the turn-over rate of these tanks is linked to the variety of transiting oil qualities. The more it increases, the more the turn-over rate also does, in order to avoid mixing products.

##### ***Operated by Caspian Transco in Puta***

Current total capacity for crude oil is 10,000 m<sup>3</sup> (approximately 8,000 tonnes).

##### ***Total Caspian Transco in Dubendi & Puta***

The current total capacity of crude oil storage can be estimated as 120,000 tonnes. On the basis of a turn-over rate of storage facilities of 40/year (found acceptable by the operator), the maximum current storage capacity upstream the system is:

$$C_{\max} = 120,000 \times 40 = 4.8 \text{ Mt/year}$$

#### 3.3 Pumping stations to RTC loading stations in Dubendi and in Ali Bayramli

##### ***Pumping station to the RTC loading station in Ali Bayramli***

The pumping station includes two pumps of 300 m<sup>3</sup>/h each under a 60 bar pressure. For technical reasons, the only products sent to the loading station of Ali Bayramli are the Tengiz, the Chaz and the Chazok crude oils. It is not possible to send there Azeri-light, nor products with high flooding points such as the Chelekem or the Okarem. The capacity of this pumping station is evaluated to 2 Mt/year.

##### ***Pumping station to the RTC loading station in Dubendi***

The distance between the marine terminal of Dubendi and the recently-reconstructed RTC loading station is 4 km. The pumping station at the marine terminal includes three pumps of 540 m<sup>3</sup>/h per unit under an 8 bar pressure. Since pipelines are insulated and heated, all types of crude oil can be transported from the marine terminal to the rail station. The capacity of this pumping station is evaluated to 7 Mt/year.

### 3.4 Pipes to the RTC loading stations

#### ***Pipes to RTC loading station in Ali Bayramli***

There are only two 12 inch pipelines, co-operated by Transco and by SOCAR. Consequently, the maximum available capacity is quite low, when taking into account current pipelines between Dubendi and Ali Bayramli. This capacity is about 1 Mt/year.

#### ***Pipes to RTC loading station in Dubendi***

There are two 20 inch pipelines only operated by Transco. The capacity of these pipes is consistent with that of the pumping station: 7 Mt/year.

### 3.5 RTC Loading stations

#### ***RTC loading station in Ali Bayramli***

The maximum current capacity is close to 1.5 Mt/year.

#### ***RTC loading station in Dubendi***

The loading station includes two loading stretches of 21 RTC that can be used simultaneously. Each RTC capacity has an average capacity of 50 tonnes. Taking into account the average loading operation duration (4 hours including flowing and emptying of pipelines), maximum capacity is 4.4 Mt/year:

$$C_{\max} = 0,95 \times 8760/4 \times 50 \times 42 = 4.4 \text{ Mt/year}$$

The overall capacity of the two RTC loading stations is thus 6 Mt/year.

### 3.6 Rail links Dubendi – Ali Bayramli – Batumi

The railway capacity is assessed in the traffic part of the report. Only key factors are reminded below:

- Rail-track capacity is more than sufficient for current and projected transported volumes of crude oil and oil products.
- Theoretical calculation leads to a RTC capacity of 7.7 Mt / year.
- When taking into account power reliability problems and unloading difficulties in Batumi the final capacity of the link drops to 4.5 Mt/year.

### 3.7 Oil Terminal Facilities at Batumi

The Batumi oil port reports that, after complete filling of the TERMINALI tanks (40,000 tonnes), remaining oil is unloaded into storage tanks of KAPRESHUMI and KHOLODNAIA SLOBODA. Total capacity of all operational storage tanks appears to be 75,000 tonnes. The total yearly capacity of the Batumi system (storage + pumps + berths) is said to be 4.5 Mt/year.

## 4. Capacity summary

### 4.1 Upstream capacity

Chain elements	Current traffic in Mt/year	Maximum current capacity prior to investments in Mt/year
RTC unloading station in Aktau	1.6	2.0
Oil Berths in Aktau	1.83	6.4
Storage in Aktau	1.83	4.9
Oil Berth in Chelekem (Aladja)	0.15	1.5
Oil Berth in Okarem	0.39	1.7

The above table summarises the calculated capacities on the following basis:

- RTC unloading station in Aktau: 2 x 15 wagons, 6 hours unloading duration (Buzachi oil arrives in Aktau by pipeline).
- Oil Berths in Aktau: 3 active berths, same berthing conditions than in Dubendi.
- Storage in Aktau: 6 x 5,000 + 2 x 20,000 tonnes, same turn-over rate than in Dubendi.
- Oil Berth in Chelekem: 1 active berth, 5,000 DWT ships only.
- Oil Berth in Okarem: 1 active berth, 5,000 DWT and 7,000 DWT ships only.

### 4.2 Integrated system capacity

Chain elements	Current traffic in Mt/year	Maximum current capacity prior to investments in Mt/year
Tanker vessels	2.37	4.9
Oil berths in Dubendi		4.2
Storage in Dubendi & Puta		4.8
Pumping stations in Dubendi		9
Pipelines to the RTC loading stations		8
RTC loading stations		6
Rail link Dubendi – Ali Bayramli – Batumi		7.7
Batumi RTC unloading stations		4.5
Batumi oil Terminal		4.5

### 4.3 Conclusions

Following conclusions can be drawn from the above:

- Current capacity of the crude oil transport system is around 4 Mt/year through the conceded installations of the Caspian Transco.
- The main bottleneck is located in Dubendi port.
- This Dubendi bottleneck has a very comparable tightness with other elements of the chain, such as those of Batumi.
- The RTC unloading station of Aktau is also of major concern.

However, above considerations are just based on capacity calculations, they shouldn't hide other aspects such as safety and deterioration stages.

## Annex 4

### Dubendi facilities: inventory and evaluation

#### 1. Outline

In Soviet times, the Baku area was a major centre for oil processing. Refineries had a capacity of up to 25 million tonnes of crude oil per year. They were processing not only oil extracted in the area but also significant volumes brought from other parts of the Soviet Union, particularly Kazakhstan and Turkmenistan. On the other hand large volumes of petroleum products were exported in direction of those two countries with destinations as far as Siberia or even Kamchatka.

The terminal facilities of the Baku port were at one time handling inflows and outflows, particularly at pier n°20. However, to cope with increasing flows, in the seventies it was decided to build a dedicated oil terminal on the Apsheron Peninsula in a site called Dubendi that is naturally well protected by a near-by island. Dubendi is at a distance of 47 km from Baku by land and 92 nautical miles by sea.

The Dubendi oil terminal mainly consists of four full-size piers (n°1, 2, 3 and 5). Pier 3 was assigned to the handling of refined petroleum products in both directions and the other piers to the import of crude oil. Each pier has two symmetrical berths, each one with a design capacity of 2.8 million tonnes of oil per year. The total capacity was therefore of over 20 million tonnes per year.

Available draft without dredging is almost 8 m. It allows the use of tankers of up to 8,000 DWT. For larger ships alighting is required but it is reported that light dredging would make it possible for ships of 12,000 DWT to use the facilities. A space with a radius of 350 m allows the tankers to turn. Presently tankers in use have typically a capacity of 5,000 tonnes of refined petroleum products or 7,000 tonnes of crude oil.

Over time the facilities suffered progressive degradation. In 1990, "the Caspmorniiproekt", the project Institute, author of the initial design, prepared a project for the rehabilitation of the facilities. The estimated cost was about USD 13.5 million at the exchange rate of the Ruble at that time.

Presently Piers 2 and 5 are no more used and have reached an advanced stage of deterioration. Rehabilitating them might be nearly as costly as building new facilities.

On the other hand, Pier 1 can still operate at nearly full capacity. It is said to be able to receive 90 to 100 ships a month and to unload 600,000 to 700,000 tonnes and even up to 850,000 tonnes per month (this figures look over-estimated). The basic structure still seems strong and sound. It is reported that the major problem is with the fenders and amortisation devices that need complete reconstruction. The unloading devices and pipe system that belong to SOCAR would also require major repair and modernisation. Unloaded oil is pumped through a set of four pipes into six 20,000 tonnes tanks with a total storage capacity of 120,000 tonnes.

For the time being, Pier 1 is far from being used at full capacity. It is said that only 1,650,000 tonnes of crude oil was unloaded in 1999. In a recent typical month, about 38 to 45 ships were unloaded. However some peaks occur such as in November and December 1998 when unloading reached 450,000 tonnes.

Until 1990 during the soviet times, Pier 3 was used to export refined petroleum products. Up to 4 or 5 tankers a day could be loaded and sent to Krasnovodsk (presently Turkmenbashi) after a mere 45 minutes paperwork. Since 1990, one of the two berths stands completely idle. The other berth was shifted to another use some years ago. It is presently used to unload tanker bringing aviation fuel from the Baku refinery. The fuel is pumped into a storage facility consisting of 30 tanks of 5,000 tonnes. From there it is sent to the airport by pipeline. The pipes belong to the "Azerneftiyag" company.

Two kinds of flows are presently transiting by Dubendi:

- Crude oil extracted in the region of the Apsheron Peninsula reaches Dubendi by underwater pipelines. It is shipped by rail to the SOCAR storage facilities in Sangachal before being sent by pipeline to the Supsa port on the Black Sea.
- Crude oil imported by tanker either (the bulk of it) from Aktau (Kazakhstan from where it is shipped by Tengizchevroil) or from Okarem or Aladja (Turkmenistan where it is produced by Mobil and Total). The oil is sent to Batumi port on the Black Sea by the Caspian Transco Company through one of two routes:
  - by wagon all the way from port to port
  - by pipeline through Baku area to the Ali-Bayramli rail terminal and from there forwarded by wagons to the Batumi port (this way is used only if the all-rail way is congested as it was for instance in late 1998).

## 2. Inventory and details

### 2.1 Dubendi oil terminal

The terminal consists of :

<b>Photograph index</b>	<b>Identification</b>	<b>Comments</b>
1	Pier n° 1	Practically 100 % for crude oil import
2	Pier n° 2	Was never used and is out of use No equipment on top
3	Pier n° 3	In use for refined products (2 unloading arms)
5	Pier n° 4	Used for berthing maintenance vessels
2	Pier n° 5	Was never used and is out of use Some equipment on top
0	Surroundings	Port entrance
4.1		Access way to piers n° 1 and 3
4.1		Access way to pier n° 2 (needs repair)
4.2		Access way to pier n° 5 (almost destroyed)
4.3		Breakwater (ruined)
4.4	Piping network	
4.5	Electrical distribution network	

On the other hand, the oil terminal ownership and operation is split out as follows:

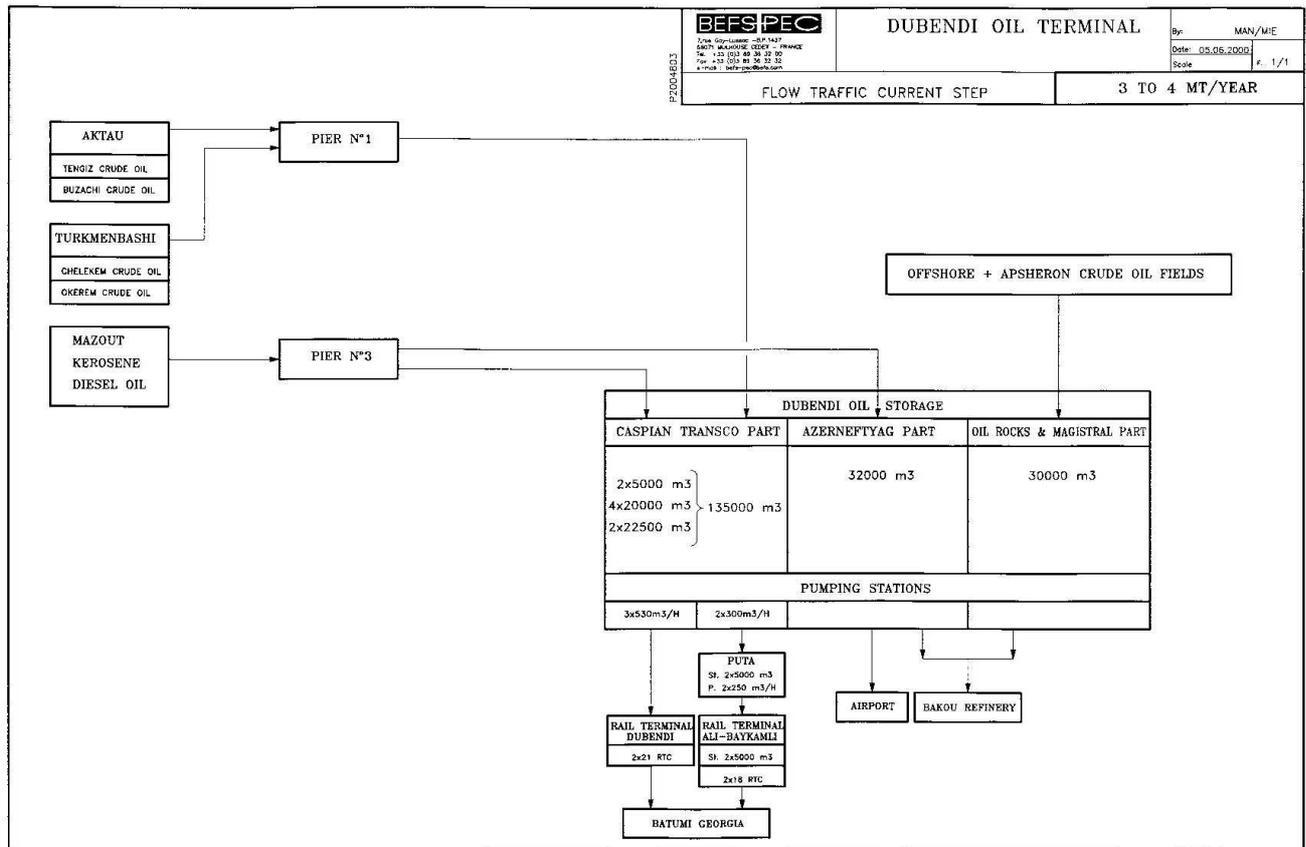
Pier Number	Infrastructures	Equipment	Operated by
	Owned by		
1	BISP	SOCAR	Caspian Transco
2	BISP	SOCAR	Not operated
3	BISP	SOCAR	Azerneftiyag
4	BISP	BISP	BISP
5	BISP	SOCAR	Not operated

BISP : Baku International Sea Port  
 SOCAR : State Oil Company of Azerbaijan

## 2.2 Dubendi storage facilities

Storage facilities are owned by SOCAR and are rented to operators. They are located in two areas:

- The lower area, close to sea level.
- The upper area, approximately 30 meters above sea level.



### **Lower storage area**

It consists of (c.f. attached document 1 and photos 20.1, 20.2, 20.3 & 20.4):

- Tanks :
  1. 4 storage tanks of 5,000 m<sup>3</sup> each with welded roofs, operated by :  
CASPIAN TRANSCO (2 tanks)  
SOCAR (2 tanks)
  2. 6 storage tanks of 5,000 m<sup>3</sup> each with welded roofs, operated by SOCAR.
  3. 4 tanks of 20,000 m<sup>3</sup> each with floating roofs, operated by CASPIAN TRANSCO.
  4. 2 tanks of 22,500 m<sup>3</sup> each with welded roofs, operated by CASPIAN TRANSCO.
  5. 2 tanks of 5,000 m<sup>3</sup> each:
    - 1 for diesel oil
    - 1 for dirty water
- Some administrative buildings located between 2. and 3.
- A water treatment station, in working condition.
- 3 pumping stations:
  - one repaired and operated by CASPIAN TRANSCO,
  - one operated by AZERNEFTYAG,
  - one operated by SOCAR.
- A storage park, situated between 2 and 3, made up of 4 small tanks used for various products.

### **Upper storage area**

It consists of (c.f. attached document 1 and photos 30.1, 30.2 & 30.3):

- A part (1.) operated by SOCAR for Oils Rocks & Magistral, for storage of oil coming from Oil Rocks, composed of 8 tanks of 5,000 m<sup>3</sup> each.
- A part (4.) operated by SOCAR, being under reconstruction to replace storage (1.). It will eventually be composed of 6 tanks of 5,000 m<sup>3</sup> each so as to be able to proceed the revamping of storage (1.).
- A part (2.) operated by SOCAR for AZERNEFTYAG composed of:
  - 4 zones with 8 tanks of 5,000 m<sup>3</sup> each,
  - 1 zone with 7 tanks of 5,000 m<sup>3</sup> each.
- A utility production area, including steam used for pipe and tank heating.

## **2.3 Dubendi rail terminal**

The terminal includes:

- The 2 product supply pipes.
- Two loading stations of 21 RTC each.
- A fire protection foam producing post with distribution system.
- Drip & splash collection and treatment utilities.
- An administrative building.

## 2.4 Others

- A crude-oil transfer pipe between CASPIAN TRANSCO pumping station and ALI BAYRAMLI.
- An intermediate storage and recompression post in Puta for CASPIAN TRANSCO (photo 50.1).
- A rail terminal in ALI BAYRAMLI (2 x 18 RTC) for CASPIAN TRANSCO.
- A terminal storage in SANGACHALI for AIOC (photo 50.2).

## 3. Evaluation

### 3.1 Dubendi Oil Terminal

#### ***Entrance***

Administrative building and access to the port (photo 0): these installations are currently in use and can still be used in the future. However, renovation will be necessary, together with reorganisation of the area, to enable modernisation of the terminal operation. The gate needs to be upgraded, whilst the access roads are to be re-paved.

#### ***Piers***

##### Pier n° 1

Currently, the pier is used on both sides for crude oil unloading.

Although used it does not comply any more with quality norms on the following points:

- Staff circulation (stairs, handrails, passage):
  - . Stairs are dangerous because deformed and do not meet international standards for steps sizing.
  - . Handrails are partly deformed and without any toe boards.
  - . The passages are obstructed and the passages free heights are lower than the usual norm.
  - . No signs for dangerous spots.
  - . Access to piers is uncontrolled and dangerous.
- Unloading arms: Despite the apparent lack of maintenance they seem to work normally.
  - . An evaluation will have to be made to check if they are strained and could be renovated or if they need to be replaced.
- Piping:
  - . Products: in the pier part pipes seem to be in good condition.
  - . Fire protection water: network is not maintained and a lot of valves are leaking, fire posts are not signalised and there is no icing protection, the network is not painted and could be mistaken with the other networks.
  - . Different waters: the networks are in bad condition, with random routings.
- In general:
  - . Low maintenance, even zero,
  - . No marking of the installations,
  - . Lack of organisation for piping passages,
  - . A lot of automatic valves out of service,
  - . A lot of leaking valves.
- Infrastructure: generally usable in its current state and fulfilling its supporting function, a verification of the underwater part should be made.

- Electricity:  
The installation is totally obsolete and dangerous, it does not meet any safety norm.  
A complete reconstruction has to be done.
- Insulation: insulation on product lines is in good condition, but with some stanching to be made on the protections
- Maintenance bridges: maintenance bridges need repairs (corrosion)

#### Pier n° 2

- Infrastructure: underwater parts to be checked
- Above-water parts:
  - . Access way:
    - check bearing capacity
    - renovate pavements, kerbs and handrails
  - . Main pier:
    - check strength
  - . Advanced pier and access bridge: check resistance

#### Pier n° 3

This pier is used for unloading 2 products with 2 arms (initially 8 arms). The 2 remaining arms are in poor condition and should be either replaced or fixed.

Staff circulation is difficult and dangerous and the same remarks as for pier n° 1 can be done.

The piping network is obsolete.

Electrical installation is dangerous and does not meet norms.

Civil engineering: same remark as for the pier n° 1.

Maintenance structures: in very bad condition and does not seem to be used.

#### Pier n° 4

This pier is in use, its condition and available facilities will be evaluated during the feasibility study in the context of all ancillary port installations.

#### Pier n° 5

Same as for pier n° 2.

#### **Others**

General access road and part of pier n° 3 are weak, edges are dangerous.

Access to piers: for the part near pier n° 5 the road is totally ruined and unusable.

Breakwater: to be rebuilt, most probably (current high level of the Caspian sea allows high breaking waves to reach the structure).

Turning basin and access channel: to be dredged.

#### **Piping network**

Except some used lines which should be checked, the whole system is obsolete and partially ruined.

The concrete supports between the post 1 and the posts 2 and 5 are all ruined, as for the rest rehabilitation should be done so for the support structure and the staff bridges.

#### **Infrastructure concrete**

Resistance checks should be done.

Some repairs should be done on the cracked parts, on the unprotected irons, the fixations of the joining up structures of the ships.

### ***Electricity***

All of the electrical system is obsolete and dangerous:

- the cable ways unprotected or in open gutters;
- generally, the junction boxes are open with some cable connections apparent such as splices protected by insulating fabric;
- the light poles are rusty and ready to collapse;
- the electrical stations can not be visited but seem to resemble the rest of the electrical system.

### ***Metallic construction***

Due to the lack of maintenance, all the structures are in bad condition and should either be replaced, or repaired and covered with some protection paint.

## **3.2 Dubendi Storage**

All the storage facilities, pumping stations, piping system should be checked but seem to be usable, after revamping of the existing parts and new constructions in progress. The retention zones exist and should be partially rebuilt to ensure the continuity of the function.

It is the same for the utilities in the storage parks.

Only CASPIAN TRANSCO pumping station has been totally renovated, the two others are in good condition but need renovation.

### ***Safety***

In general, the safety is very precarious compared to the usual practices:

- Staff circulation (access to piers)
- Vehicle circulation (within dangerous areas)
- The driving of arms, flexibles, etc... on the piers

### ***Fire safety***

- The existing fire water network is not maintained and low visible.
- The mobile means (sand pit, etc...) are inadequate.
- No foam type protections.

### ***Environment***

- A floating barrage is visible near the pier n° 1.
- At post 4 was parked a cleaning ship.
- Except those visible elements, it will be necessary in E3 to check the existing means.
- For the storage facilities, the protection mending will be examined in E3.

### ***Ship services***

- The pier n°1 is equipped with fresh water and fuel delivery.
- The pier n° 3 does not seem equipped with the same delivery points.
- The phone links do not exist.

### ***Supervision and command checking***

- Except for the part operated by TRANSCO on the pier n° 1 and in the storage park (TransCo operational staff says), there is no supervision and command checking of the piers and storage facilities.
- The measurement and instrumentation material when it exists is not used because of a lack of maintenance.

### **3.3 Others**

In PUTA and SANGACHALI, installations are new and in good condition. The ALI BAYRAMLI storage was not visited.