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Regulation on the Transport of Dangerous Goods along the TRACECA Corridor

Azerbaijan, Georgia, Kazakhstan, Turkmenistan and Ukraine

Working Paper 2 Transport Forecast Report

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1 Introduction

1.1 Product background LPG

The two commercial products – propane and butane (jointly called LPG)- are both gaseous at ambient temperature and pressure and yet are liquid when stored and transported under pressure or in a refrigerated state. Tank, ships and all other transport media therefore are specialized to deal with these particular properties.

	Specific Gravity	Carriage Temperature (°C)
Propane	0.583	-43
Butane	0.602	-1

LPG usually contains a blend of the 2 fractions whereby the ratios do vary between 50/50 to 80/20. It must be stated that TRACECA production sites must undertake efforts to meet the quality requirements of the consumer markets. Turkey – being one of the strictest market in regards to quality requirements does not accept various LPG specifications – e.g. from Turkmenistan. (Modest) investments at the various productions sites can improve the qualities and make the products acceptable for the markets. The consultant assumes that such investments at production sites can be retrieved via higher prices and better marketability.
LPG storage tanks may be either pressurized or refrigerated. The larger storages at LPG plants from gas processing tend to be refrigerated.
LPG ships may be pressure ships, fully-refrigerated, or semi-refrigerated (able to trade from both pressure and refrigerated storages). Fully-refrigerated ships will require a chiller to cool down “warm“ LPG at a loading port or a re-heater to warm up LPG discharging into pressure storage.
These problematic characteristics made LPG a late developer in the hydrocarbon business. The first commercial production had to wait until the 1920’s, the first international trade until the 1950’s. Seaborne trade in LPG was less than 1 million tons in 1960, reached 17 million tons by 1980, and was in excess of 47 million tons by the year 2000.

1.2 LPG parameters – making it costly to transport

At normal temperatures and pressures, LPG will evaporate. Because of this, LPG is supplied in pressurised or ‘cooled down steeled bottles, tanks, containers, pipes. In order to allow for thermal expansion of the contained liquid, these transport media should not be filled completely – thus loosing transport volumes resulting in price increases; typically, they are filled to between 80% and 85% of their capacity.

The ratio between the volumes of the vaporised gas and the liquified gas varies depending on composition, pressure and temperature, but is typically around 250:1. The pressure at which LPG becomes liquid, called its vapour pressure, likewise varies depending on composition and temperature; for example, it is approximately 220 kilopascals (2.2 bar) for pure butane at 20 °C, and approximately 2.2 megapascals (22 bar) for pure propane at 55 °C. Propane gas is heavier than air, and thus will flow along floors and tend to settle in low spots, such as basements. This should be kept in mind to avoid accidental ignition or suffocation hazards. A powerful odorant, ethanethiol, is added so that leaks can be detected easily. The specific gravity of LPG is below 0,6. Diesel in comparison has a specific gravity of around 0,84. LPG burns very easily and creates explosive blends with air. 1,5 -11 % of LPG in the air can create already an explosive blend.
The above results usually in increased transport costs in comparison to Diesel fuel by a factor of 2-3.

1.3 Transport of LPG in TRACECA region

A typical LPG transport in TRACECA countries (coming from Kazakhstan and Turkmenistan) looks as follows:

- Road transport from production site at Kazakhstan to nearest rail loading terminal (actually this part is a considerable problem currently in Kazakhstan)
- From the Kazakh rail loading terminal LPG is transported via LPG Rail tank cars to various destinations such as Ukrainian Sea Ports (for transit terminal operations for further export), Poland, China and other destinations
- From Turkmenistan LPG is loaded onto Rail Tank Cars which are directed directly to the Iranian border, China, via special Rail ferries to Makhachkala for further transit export to Poland, Black Sea and the Ukrainian sea ports, via special Rail ferries to Baku for further Transport to Batumi

From the receiving LPG terminals in the consumer countries, LPG products are distributed via the special terminal installations:

- to cylinder filing plants for further use of bottles in households
- tank trucks
- rail tank cars
- LPG containers

LPG to be used as autogas may be taken by small bulk distribution tankers to the storage tanks at retail sites.

1.4 Some general economics and outlook

LPG prices (excluding taxes) are comparable to Diesel prices and Diesel fuel is mainly in the Auto gas market one of the main competing respectively benchmark fuels for LPG.

Comparison of LPG with Diesel in respect to transport costs:

	LPG		**Diesel**
Density	0,55		0,84
Intake of (typical) RTC tons	30		57
Cost for 1 RTC US$	70-120.000		30-50.000
Safety costs/issues	high		low
Tanker costs	high e.g. US$ 65 MT	versus	low US$ 25 MT
Terminal costs	higher 2 x		low

The above factors make it 2-3 times more expensive to transport LPG than Diesel. LPG production is therefore much more sensitive to finding long term stable and competitive transport (cost)solutions in comparison with other oil products.
The consultant therefore undertakes considerable efforts to investigate the possibilities for proposing various possibilities of transporting LPG via TRACECA corridors in order to:

- find stable and competitive transport solutions
- have for all parties beneficial possibilities identified
- possibly initiate joint TRACECA activities to build competitive transport routes and to develop a ¨´TRACECA multi country approach´´ to compete against the various other countries

2 Current LPG Flows in the TRACECA corridors

2.1 From Kazakhstan

2.1.1 From Kazakh Fields to Kazakh Rail Stations

Freshly produced LPG is usually transported by LPG trucks to the adjacent rail stations. The problems are that there not enough trucks available and not enough LPG loading installations at the rail stations. The Kazakh loading areas from producing sites are:

- Refineries Cimkent/Pavlodar/Atyrau
- **The Tengiz Field**
  Chevron and the Republic of Kazakhstan are developing the giant Tengiz and nearby Korolev oil fields. This historic partnership, called Tengizchevroil (TCO), was formed in 1993 as a 40-year, $20 billion joint venture. Tengiz, one of the world's largest oil fields, contains some 6 to 9 billion barrels of recoverable oil.
- **The Karachaganak Field**
  In 1997, Texaco teamed up with partners Agip/Eni, BG International and LUKoil to develop the Karachaganak Field, which holds an estimated 1.2 billion tons of oil and condensate, and more than 1.35 trillion cubic meters of gas in place. Located 10 miles from the town of Aksai, the field was first discovered in 1979; new facilities for gas and liquids processing and gas injection began production in 2003. The same year, a 635-kilometer (393-mile) Crude Oil pipeline was completed that connects to Atyrau and the Caspian Pipeline

- From Kumkol area (near Kyzyl Orda)

2.1.2 From Kazakh Rail Stations to the markets

1 Mio. tons of LPG p.a. are getting transported to Moldova, Georgia (very small quantities), Russia for transit to Poland and the Ukraine, Kirgizstan and Afghanistan. It remains to be seen if and which quantities will be shipped to China. The rolling stock of (private only) `standard` GOST SNG RTC´s is some 3-4.000 units.

2.2 From Turkmenistan

800.000 tons LPG are getting transported out of Turkmenistan as follows :
approx. 400.000 tons p.a. to Iran via RTC's directly.

- by RTC's to Afghanistan
- by RTC's to China
- by Ferry boat to Baku and further by rail to Batumi for further Sea export

"Dagestan" numbers deleted
"Mercury-1"
"Akademik Topchubashov"
"Azerbaijan"
"Akademik Hesen Aliyev"
"Professor Gul"
"Nakhchyvan"

FREIGHT-PASSENGER SEA RAILWAY FERRIES Type "Dagestan" Caspian Shipping Company operating Aktyau-Baku and Turkmenbashi-Baku

- By Ferry boat to Makhachkala for further export to Poland, Ukrainian Sea ports and Russian Sea ports (e.g. port Temruk which shall come into operation shortly)
- Caspian Shipping Company (CSC) and Azerbaijan/Georgian Railways have agreed to haul some 18,000 T of LPG from Turkmenbashi to Georgia (Batumi). Two shipments of around 1,000 T each have been completed. A 3rd one seems to be ready but the operations have reportedly been halted (by Azeri authorities) until clarification of the safety risks. It has to be stated that due to the nature of the Dagestan Type ferry boats (closed ferry with closed transport compartments and combined with passenger transport as well as a low intake of below 1.000 tons LPG and the high bunker costs (Diesel fuel mixed with fuel Oil) such ferries cannot be a longer term, stable and economical transport solution for LPG. Caspian Shipping has converted two ferry boats to carry LPG – basically by cutting the loading decks partially open

Makhachkala Sea Port (group of companies Safinat) owned Ferry boat operating Turkmenbashi-Makhachkala and Aktyau-Makhachkala (for illustration purposes and best current practise in the Caspian Sea)

2.3 Ukraine

Ukraine is a transit land for LPG flows from Kazakhstan, Russia and Turkmenistan through their Black Sea Ports. The port of Odessa is handling about 400 KT p.a. LPG volumes from Kazakh 'giant' TCO with destination to Turkey. LPG transport from Georgia to the Ukraine as a possible transit hub to Europe could be effected by Ferry boat or tankers.

2.4 Transport of LPG through Azerbaijan-Georgia

Georgian Railways last year (2005) has reached the transportation capacity of 24 million tons and plan to transport this year 26 million tons. They also forecast to increase the volume up to 30 million tons by 2010 however it remains to be seen which impact the operation of the BTC Crude

Oil pipeline will have on these volumes . LPG transportation share is only about 30 rail wagons per month. Mainly it's import shipments to the Georgian local market .As the Georgian railway does not have the special designed rail wagons for LPG, transportation is done mainly with the importers own rail wagons or wagons belonging to the railway of exporter country. At this stage the Georgian Railway is not interesting in investments to acquire the own wagons as they are only in charge of transit shipments and imports. According their suggestions if there will be demand in increasing of rail park with the special wagons it has to be done in the country of origin or Importer country has to be interested in investment to acquire their own rail park.

2.5 Terminal operations of LPG in Georgia

The only LPG terminal on the Georgian coast line is at Batumi; currently capable of loading vessels of up to 3.000 tons of LPG with a tank capacity of also 3 KT

LPG terminal at Batumi

2.6 Interim findings

- There are currently basically no LPG transports from Kazakhstan and Turkmenistan via Azerbaijan and Georgia. Reason being the lack of X Caspian Sea transport facilities. The only existing sizable operation could be effected X Caspian Sea via the Russian owned ferry boats as above – however they will not operate with destination Baku.
- In order to increase the LPG transport volumes via TRACECA corridors all studies and preparations must be undertaken for financing parties to undertake the required investments

3 Future LPG Transport

3.1 General remarks for truck transport

The consultant considers the transport of LPG by truck only viable for transports from Kazakh Oil (LPG) production sites to the next adjacent rail stations.
In North West Europe LPG trucks are only used for a distance of max 400 to 500 KM (one way). The costs per km are 1,3 to 1,4 €/Km/MT at a total monthly turnover of approx. 14.000 KM.

Western LPG trucks for illustration purposes

3.2 General remarks for rail transport

LPG transport by rail is on short term basis the main transport route in the TRACECA corridor. With an average price of about 8 dollar cents per km it remains to be seen how competitive rail transport can be effected. In comparison to European rail tariffs these costs are obviously very low. In Europe the rail costs for LPG transport are running at around 35 -55% of the Trucking costs – e.g. per Tonne (depending on quantity and railway). The consultant will investigate the difference between tariff costs and actual costs. Due to various factors it can already be said that the actual average speed of the railway system has to be improved to be competitive on such a transport cost sensitive product as LPG.

3.3 General remarks for vessel and Ferry transport

Obviously there is a special case in this project because the Caspian Sea must be crossed. The consultant shall undertake to compare the two alternatives – sea tanker and Ferry boats carrying LPG RTC's.

3.4 General remarks for pipeline transport

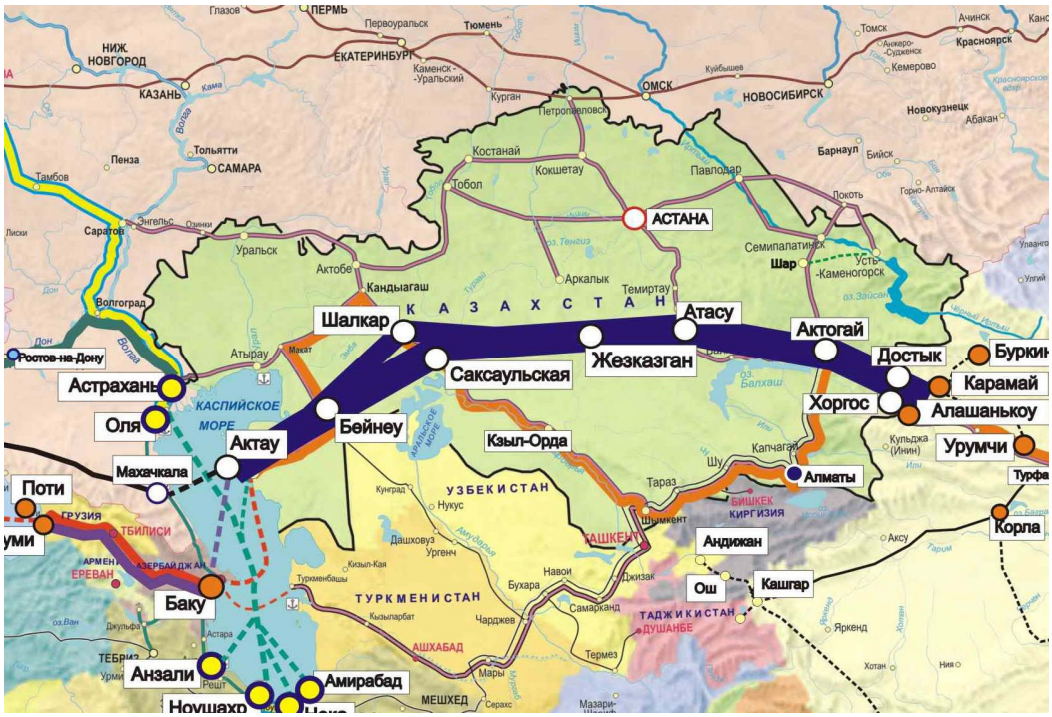
The consultant will undertake some preliminary investigations in how far a LPG pipeline from Baku to the Georgian coast line will be feasible. Obviously any pipeline considerations do require stable long-term product flows for significant quantities of min. 1,5 Mio. tons p.a.

3.5 General remarks for LPG transport in special tank containers

LPG transport in containers may have the advantage to be a solution with the least sensitivity in respect to stable supplies. Further it appears that existing dry cargo handling facilities can be used and transport can start on short notice. The consultant can only advise in WP 6 and upon careful consideration of all costs involved if a LPG transport in containers may be viable.

3.6 From Kazakh Fields to Kazakh Rail Stations

As it can be seen from the attached maps a lot of the Kazakh originated LPG must be transported by truck to the next available rail stations. This is a costly 'bottleneck'. He consultant will further investigate the possibilities to lower the costs for such transportation.



3.7 From Kazakh Rail Stations to the markets

The distances from the Kazakh producing fields to the markets are as follows:

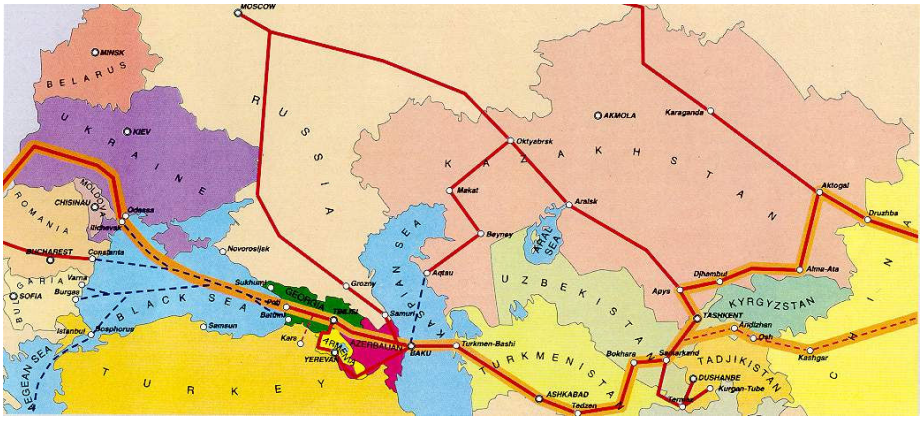
Odessa	>Reni	: 434 km.
Odessa	>Chop	: 1018km. (to Hungary)
Odessa	>Chop	: 1020 km. (to Slovakia)
Tengiz	>Aktau	: 616 km.
Uralsk	>Aturau	: 1075 km.
Karachaganak	>Uralsk	: 118 km.
Aturau	>Aksaraiskaya (Russia)	: 323 km.
Aturau	>Druzhba (China)	: 3250 km.
Kysil Orda	>Aksaraiskaya (Russia)	: 1784 km.
Kysil Orda	>Aktau	: 2039 km.
Aktau	>Druzhba (China)	: 3836 km.

The consultant may consider to look at alternative transport schemes than railways – though the feasibility seems to be not given.

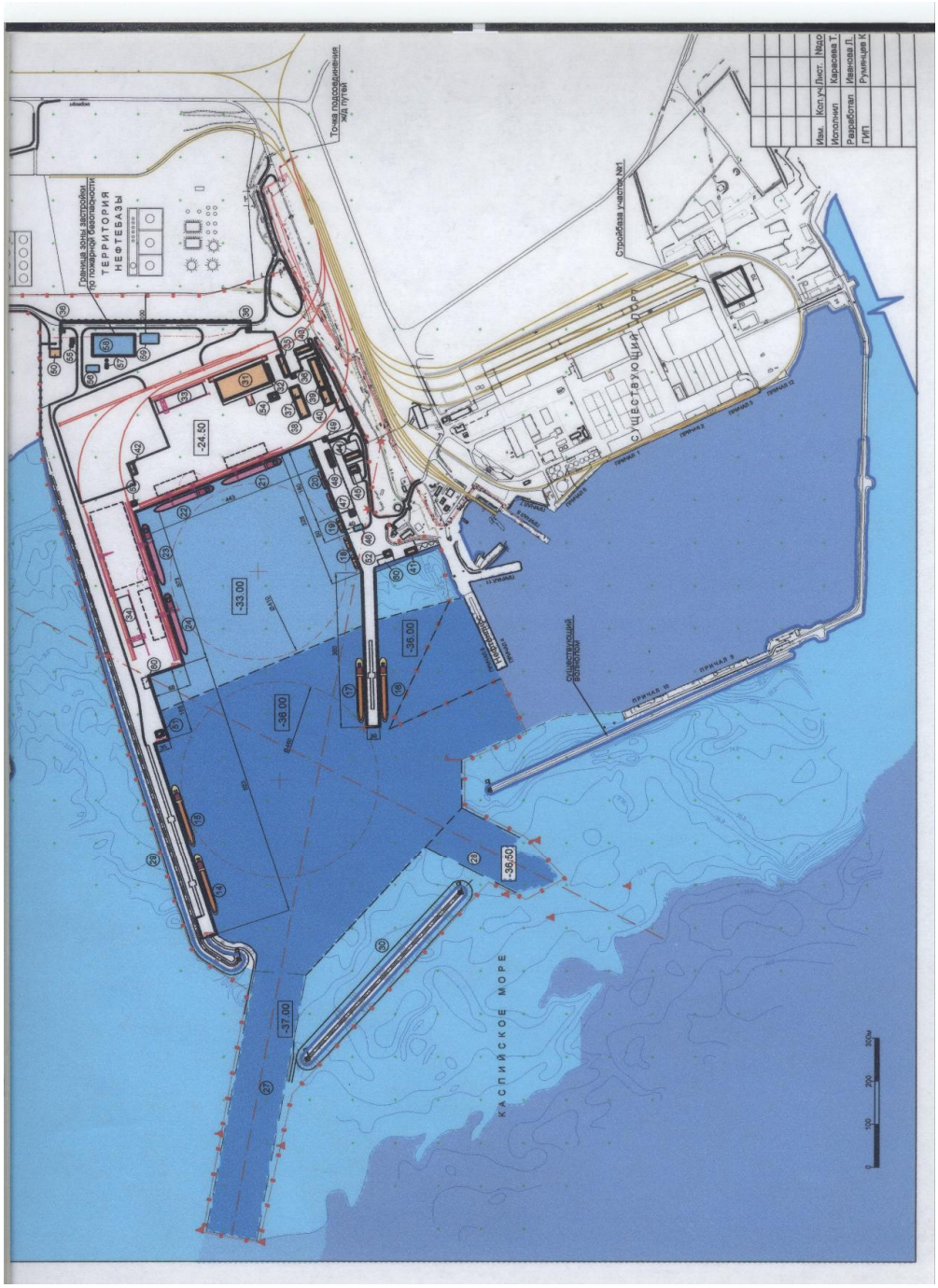
3.8 Terminals for LPG east of Caspian Sea in Kazakhstan

The current situation can be described as follows :

- Aktyau Port with a current max. draft of 7 m is currently the only Kazakh port in the Caspian Sea and handling Oil products and dry cargoes – all cargoes are handled in one port basin.



- The ferry loading installation is situated only approx. 30 meters away from a crude oil loading jetty. The required safety distance though is 100 meters. Therefore it remains doubtful if this installation can be used for LPG loading of RTC's onto Ferry boats – though there are currently investigations regarding this matter taking place. Otherwise the jetty would obviously have the capacity to ship significant volumes of LPG
- Aktyau port is served by 4 incoming private railway lines between Mangischlag being the central railway sorting station of the area. Kaskortransservice is the only operator this 18 km private rail between Mangischlag and Aktyau Port and in Aktyau Port. It must however be said that at peak times up to 2500 RTc`s are waiting in the area (!!). Reasons being weather conditions which does not allow vessels to enter the port/receivers 'problems (e.g. Iran/other reasons). In case (LPG) cargo can be loaded freely onto ferry boats – such RTC´s may not wait but may be bypass such traffic jams. The consultant will check the real waiting times and congestions at a later stage.



- Aktyau Port is generally responsible for the `land`, piers and vessel navigation. All other items and issues like terminals, rail, pipes etc. are privately owned. For loadings of LPG RTC's onto Ferry boats the following points must be clarified: a. safety permissions b. trial runs c. possibly legal issues. The port would have to locate a territory where LPG terminal (s) could be erected. It may be possible to find such territory in the southern part of Aktyau. So far there are no experience and safety permissions to terminal LPG with tank containers. The consultant will investigate this matter at a later stage and is currently actively checking alternatives with Aktyau port

- A new oil terminal is under construction in Kurik some 50 km south of Aktyau. The terminal was originally designed for trans-shipment of oil especially, however an additional terminal for trans-shipment of liquefied gas into gas tankers can be possibly built.
- According to official information, submitted from the harbourmaster of the u port, construction of the LPG terminal on the Kazakhstan coast of the Caspian Sea is envisaged in the designed southern part of the Aktau port and not in the Kurik port.
- The consultant will undertake to investigate the exact planned locations in Kazakhstan. Currently it appears that there is contradicting information. The consultant shall be able to present also better recommendations in respect to the viability of tanker and/or ferry loading terminals – as well as LPG container terminal operations upon respectively during the finalization of WP 6

3.9 Turkmenistan for loading of Tankers; Ferryboats, Pipeline

Turkmenistan's main port is Turkmenbashi, where RTC's can be loaded onto ferry boats as well as LPG containers. No other LPG loading installations are in place in Turkmenistan. The consultant considers the loading facilities inadequate for larger volumes.

3.10 Transport of LPG X Caspian Sea

The consultant does not see the real possibilities for a pipeline across the Caspian Sea due to political and commercial reasons and does therefore not consider this alternative. The Caspian Sea must be crossed by 'boats'. For the time being and in the foreseeable future the 'political' situation in respect to shipping issues in the Caspian Sea is as follows :
Russian flag vessels can approach Kazakh (Aktyau), Turkmen (Turkmenbashi), Iranian (Neka/Anzali) and Russian ports (Mahachkala/Astrachan) – but not into Baku inter alia due to prohibitive port costs.
Azeri and other Flag vessels can approach all ports- though Russian port costs for Azeri Flag vessels are somewhat prohibitive.
Ports/governments tend to charge various – up to prohibitively high – port and channel charges to protect their own fleets and/or act as the political tensions

It must also be understood that the Caspian Sea sometimes shows very heavy winds and 'aggressive' short and steep waves which are serious factors to be considered when considering maritime transport of LPG/dangerous goods.

Therefore the following transport possibilities can be distinguished:

3.10.1 Rail Ferry

The Russian shipping company Safinat (www.safinat.com) operates 4 rail ferries (no other cargo/passengers on board) which carry 52 RTC's on two decks – whereby the decks are not (completely) closed to comply with safety standards. Therefore the carriage capacity for LPG is about 1500-1700 tons which is as outlined before about 50 % of the Diesel volume which can be carried. The ferries are of modern design and were built in Bulgaria. They run cost-effective on Fuel Oil. The consultant considers these Ferry boats as up to today's safety and economical standards. Larger ferries will probably bring the desired lower costs – this must be calculated in WP 6. Azeri ferries (built in 1987) as described above do carry about 28 RTC's in addition to passengers and other (trucked) cargo, which means that approx. 800-900 tons of LPG can be transported. 2 Ferries from Caspian shipping have been converted (we understand the closed rail loading area was 'partly' opened). The ferries are running of Diesel fuel – therefore their economics remains doubtful in comparison with the Russian ferries – 50 % of cargo input and approx. 100 % more fuel costs. Obviously the Caspian Shipping ferries will only serve the port of Baku. In the next 2 years these (type) of Ferry boats will be the only viable and readily available way to transport LPG across the Caspian Sea. In case of rising volumes the following points must be carefully improved through an extensive due diligence and possible investment program:

- The loading jetty at Turkmenbashi is subject to closure due to (port) closure because of heavy winds. It should be investigated if and which measures could improve this situation
- The distance between the jetty and the refinery is approx. 10 km. Actual Time used for turnaround of ferry boats could be improved
- An overall coordinated approach and control system between all ferry boats could increase the productivity of the loading operations
- All ferries do have a combined theoretical transport capacity as follows : 4 Russian Ferries with 52 RTC's with an average roundtrip of 4,5 days and 11 operating months are equal to approx. 500.000 tons p.a. of LPG transport capacity. 2 Caspian shipping ferries with 52 RTC's with an average roundtrip of 3,5 days and 11 operating months are equal to approx. 150.000 tons p.a. of LPG transport capacity.
- In case the Ferry boats prove to be a long term viable and competitive transport solution the existing capacities are not enough for the rising production volumes. Relevant Business plans to justify further investments into additional ferry boats and loading jetties must be undertaken

3.10.2 Tankers

The general navigational and other conditions in the Caspian Sea are as follows:

- Available vessel sizes are 2-3 KT tonnes ('Nefterudovoz' type); 4-5 KT Tonnes (Volgoneft type and Oleg Koshevoy types); 7 KT tonnes and max. Size 12 KT tonnes which so far can only load up to their full capacities at Aktyau; however there are NO LPG tankers operating in the Caspian Sea
- There are plans to bring special ´prefabricated vessel components into the Caspian Sea which will be completed and joined at the Caspian Sea into larger units of 20-40 KT vessel which will not enter the ports anymore but load and discharge at QBM mooring installations which also still must be constructed
- Draft restrictions at the various ports must be considered

- The maximum vessel size is restricted by limitations on river Volga respectively Volga - Don channel; beam, draft (3-4 meters; actual 3,4 meters), air draft, and load restrictions do only allow that approx 12 KT enter the Caspian Sea in ballast
- Tankers could be considered as competitors for ferry boats.
- The general `formula` for costs comparison between tankers (t) and ferry boats (fb) looks as follows : transhipment at loading + sea freight + transhipment at discharge = X Caspian costs t (xt). Roll on and off to Ferry + sea freight = X Caspian costs fb (xfb)
- xt can be estimated to be US$ 45-65 MT. Xfb can be estimated to be US$ 55-75 MT. These figures are a rough estimate based on today's market rates and reflecting the possible (lower) costs for ship-owners
- Ship-owners are Caspian Shipping, Kasmortransflot, Volgotanker, Safinat and other private owners

LPG Tankers suitable to operate in the Caspian Sea for illustration purposes

Omegagas

MV "Omegagas" is a German build LPG carrier. The 3600 m³ carriage capacity LPG-Tanker reaches 15,0 knots with a load of 95,0 m and 15,2 m beam.

Epsilongas

MT "Epsilongas" with Carriage capacity of 5600 m³. Slightly bigger (LOA 108,0 m, Beam 16,4 m) and faster (16,4 knots) than MT 'Omegagas'
This vessel type was further developed with a version of 7600 m³ carriage capacity

It must also be understood that the Caspian Sea does have very heavy winds and 'aggressive' short and steep waves which is a serious factor to be considered. A rough idea for purchase prices of LPG tankers is in the region of US$ 10-30 Mio. - depending on the size and the age of the tankers. Looking at the above the summarized outlook for LPG tankers is as follows :

- The consultant will investigate and calculate the ideal ship size for LPG tankers in WP 6. It seems however that tankers with a LPG intake of about 7 KT may be the max. Size
- WP 6 will also consider the usage of new or used LPG tankers
- The average total time for a roundtrip is about. 5 days. Therefore each LPG tanker needs about 300 KT p.a. of stable LPG flow p.a. (5 KT intake; 11 months p.a. in operation). Any investment decision will be based on such longer-term stable product supplies

3.10.3 Tank containers

Besides the ferry boat option tank containers are an alternative option for today to transport LPG in the TRACECA corridor. The following points shall be taken into consideration:

- Basically no LPG containers are available in the territory but must be bought and/or rented
- Available handling capacities at Aktyau, Turkmenbashi and Baku limit the volumes
- Approx. 9 dry cargo vessels (carriage capacity about 80-100 containers each vessel) are available in the Caspian Sea.
- LPG containers are readily available for purchase and this route may in the shorter term be a possible transport solution because – provided safety parameters are met – the required infrastructure for handling of containers is in place
- Transport costs for LPG containers though may be prohibitive - our calculations and findings as per WP 6 will show

3.10.4 Transhipment of LPG at Baku

There are currently two ways how LPG can be handled at Baku:

- via RTC's arriving in Ferry boats. The RTC handling point is in the middle of Baku. The consultant estimates the max. annual capacities for LPG throughput at this facility of about 100-300 KT considering the existing traffic flows and congestions
- LPG containers at the container terminal at Baku city with an estimated LPG throughput capacity of around 50-200 KT p.a.

Both these facilities do either require major overhauling in case of serious increase in LPG transport volumes. Most probably though the construction of new facilities shall be envisaged.

In respect to the future transhipment of LPG tankers at Azerbaijan two existing installations for transhipment of Crude Oil and Oil Products should be considered because :

- Ports do already exist
- Railway lines likewise
- Various needed infrastructures are in place

The ***Sangachal Terminal*** is located nearby Sangachal district 45 km South of Baku, in Karadag Region. The Terminal is designed for receive and treatment of 115,000 barrels of crude oil a day (5.75 MTA) from Chirag-1 Platform.
Maximum Terminal capacity is 140,000 barrels (appr. 19,170 tone) of crude oil a day. The terminal does have L.P. fuel gas treatment installations. Provisions have been made to facilitate the erection of LPG transhipment capacities – from incoming tankers into RTC's – or into pipeline.

The ***Dubendi Terminal*** is located on the Caspian Sea shore of Azerbaijan, approximately 50 kilometres northeast from Baku. With its current transhipment capacity of 10 million tons per year, Dubendi terminal acts as a major hub for transit transportation of crude oil and oil products from Caspian Region to world markets.
The Dubendi Terminal receives the crude oil and oil products transported by tankers from other Caspian Sea Ports. Dubendi Port is a natural sea port located across Pirallahi Island, which acts as a breakwater. Pirallahi Island protects Dubendi Port from frequent strong wind and high waves of the Caspian Sea and this makes Dubendi Terminal a unique location as the receiving point of transit crude oil and oil products. The distant location of Dubendi Terminal to the city centre and populated areas brings other advantages in terms of protection of the ecology and operational safety. 4 vessels can discharge their cargoes simultaneously at Dubendi Port. Dubendi Port can receive 12.000 DWT vessels of Caspian Shipping Company, which are currently the biggest tankers in Caspian Sea. Construction of a SPM is projected for discharging bigger tankers up to 30.000 DWT in the future.
The storage capacity at Dubendi Terminal is 150.000 m3 for clean products (Gasoline, diesel, naphtha, jet fuel etc.) and 150.000 m3 for black products (crude oil and fuel oil). Clean product tank farm was totally refurbished and put in operation in August 2002 by Middle East Petrol.
Parallel to the investments at the Port and storage facilities, the capacity of the Dubendi Rail Loading Facility was doubled by Middle East, by building a clean product loading rack as an

extension to the black product rack. 78 rail tank cars can be loaded simultaneously within 2 hours at Dubendi.
Therefore it appears that a possible decision to build a LPG terminal (from tankers into pipeline/rail) will be taken between Sangechal and Dubendi.

3.11 Transport of LPG through Azerbaijan-Georgia

3.11.1 Railways

The general conditions for transport of LPG by rail in Azerbaijan and Georgia are as follows:

- The part between Gardabani and Tbilisi is geographically difficult with steep declines
- There are basically no LPG RTC's in the area. Railways do not undertake to purchase and/or hire such RTC's themselves
- The distances are Baku-Bülkesik 502 km and Gardabani-Batumi 396 km and to Poti 360 km
- Locomotives are changed at the border
- The average speed in real terms is about 10-15 km/hour
- Russian/TRACECA LPG RTC`s do have load/discharge valves at the top - diameters DN 32. In case the cargo flow is below 3 cbm (Cubic Metres) separate safety valves cut off the discharge automatically
- European RTC`s are discharged via hydraulic bottom valves with diameters DN 80 with manual safety buttons to stop discharge
- Therefore the turnaround speed of European RTC's is higher. It may be advisable to check if new RTC's operating in TRACECA corridors may be changed accordingly
- The maximum permissible train weight in Azerbaijan (on the main line to Georgia) is 3,000 tons. An 'LPG-RTC' block train of 28 wagons pulled by a VL-8 or VL-11 Electro-locomotive ('soviet' type and technically outdated prevailing locomotives in the area) would not exceed a total weight of 1,600 ton. Common numbers of wagons in (mixed) freight trains in Azerbaijan are around 35 (e.g. in October 2006: 772 freight wagons on 23 trains; the maximum registered is 57)
- Railways were operating in 2005 and 2006 close to their limits with a total transport volume of about 24 Mio. tons of total cargo between Azerbaijan and Georgia. It may be the case that the BTC pipeline will cause lower transport volumes by rail and therefore railways may enough capacities to carry the envisaged additional volumes of about 1,5-3 Mio.tons of LPG p.a.
- The limit at the Georgian border for train crossings is about 25 block trains (of each about 3 KT cargo capacity (Diesel) or 2 KT LPG) per day

Therefore the future improvements in the rail system should look as follows to form the competitive conditions for LPG transport in TRACECA corridor :

- LPG should be transported in special block trains only. A typical train of 48 LPG-RTC wagons pulled by (the equivalent of) a VL-8 or VL-11 electro-locomotive needs to be proposed/determined. Locomotives at Batumi/other Georgian discharge terminals must wait for the discharge of the RTC's and pull the empty trains back immediately after discharge
- The railway speed must be improved. There should be special 'LPG transport corridors with dedicated locomotives, dispatchers and relevant orders to possibly bypass other rail congestions. Though this may not yet be daily routine, it must be possible to achieve:
  Maximum 16 hours for Baku→Border with Georgia (almost 500 km),
  Maximum 2 hours for Azerbaijan-Georgia border crossing,
  Maximum 16 hours for Azeri-Georgian border→Black Sea terminal (also ~500 km). Total 36 hours (1.5 day) rail trip Baku-Black Sea.
  Same timing to apply for the return of RTC's
- Revised construction of RTC's as per western standards should be considered to improve a. The intake up to 40 tons per RTC and b. The technicalities to improve the loading and discharge speed
- Consideration of revised technical specifications for locomotive purchase
- The desire and understanding to form an integrated competitive LPG transport chain from the production sites in Kazakhstan and Turkmenistan up to the customers

3.11.2 Containers

The consultant can only give his view on the issue and viability of LPG containers in the Area in due course after more exact calculations for WP 6 have been undertaken.

3.11.3 Pipeline

The consultant does give below some relevant considerations for a major operation like building a LPG pipeline between Baku and the Georgian coast line. The following main parameters though must be met to take this idea further:

- Commitments from LPG producers to supply the required min. volumes into such pipeline – we assume min. around 1.5 Mio tons p.a.
- Such commitment will only be give from producers in case such pipeline will have the required low transport costs to ensure the best net back for producers on long term basis
- Obviously relevant studies like this one and subsequent feasibility studies prove to show viable results for such a pipeline

To illustrate the possibilities the consultant describes below some points on LPG pipelines in India which may serve as a reference market :

- The Gas Authority of India Ltd (GAIL), 4,000 km of pipeline and has about 95% market share in the natural gas business in India. GAIL is also one of the largest LPG producers in India, with a liquid hydrocarbon production (including LPG) exceeding 1 million tonnes per annum, and it operates the country's largest gas-based LPG extraction plant. GAIL has now introduced the concept of LPG pipelines in India, and is currently operating the world's longest - 1,250 km - exclusive LPG pipeline from Gujarat in western India to Loni near New Delhi in north India. The project cost were about Rs 12.5 billion or about US$ 300 Mio in 2001.
- Indian Oil Corp. (IOC) has announced plans to lay LPG pipelines throughout India, with the commissioning of a feasibility report outlining possible projects. "LPG pipelines could be our future thrust area. We have already set up a group to study the possibility of setting up LPG pipelines across the country. According to company estimates, the pipeline network would reduce LPG transport costs by at least 10% (the consultant considers this as too little savings). As part of the plan, the company is proposing to set up a 275-km LPG pipeline from the Panipat refinery in Uttar Pradesh to Jalandhar in Punjab. The $US34 million project is scheduled to be placed before the IOC Board at its upcoming meeting.

The actual findings on a LPG pipeline through Azerbaijan and Georgia are as follows :

After making the analyze of the pipelines options via Georgia from Caspian region to Black Sea coast of Georgia, we can conclude that the best way to built an LPG pipeline would be to use the existing corridor next to the WREP (Western Route Export Pipeline) Baku –Supsa, which belongs to AIOC (Azerbaijan International Oil Company), a Consortium of 7 major world oil giants.

1. General Information (on pipeline sector in Georgia)

Pipeline starts from Gardabani (Georgian / Azerbaijan border) and ends in Supsa, 10 km south from Poti, where a 160,000 c.ms crude oil terminal is located.
Total length of the pipeline is 375km, with diameter 20” (OD=530 mm).
In total 2 pumping stations constructed on the Georgian pipeline sector.
Maximum capacity of the pipeline is 160,000 bpd (approx.7 mln. mt of crude oil annually).
WREP pipeline is crossing the valleys , mountain systems, civil areas, forests and agriculture zones. Pipeline minimum buried depth is 1.5meter and is increasing up to 2.5m at the places of crossing the rivers.

Along the route, the pipeline is crossing 16 main districts:

- Gardabani
- Mtskheta
- Kaspi
- Gori
- Kareli
- Khashuri
- Sachkhere
- Chiatura
- Zetsaphoni
- Terjola
- Bagdadi
- Vani
- Samtredia
- Chokhatauri
- Abasha
- Lanchkhuti

In addition to the above main districts the pipeline is crossing 95 administration centres and about 120 villages.

Geographically pipeline is located between latitude 41°. 22' N / longitude 45°.03' and latitude 41.5° / longitude 42°. Minimum altitude is in Supsa sea level and maximum Altitude zone is in Chiatura which is 600m from sea level. Average altitude along the pipeline route is about 250 -300m from the sea level.
Pipeline is crossing 80 (medium and small) rivers from which the biggest and mains are:

- Aragvi
- Ksani
- Lekhura
- Tortla
- Liakhvi
- Dzirula
- Kvirila (crossing twice)
- Supsa

The Climate in Georgia is subtropical.
Maximum and minimum temperatures along pipeline route are:

<u>In Mountain</u>
Winter -15°C /min/;
Summer +35°C/max/.

<u>In Valley</u>
Winter - 2°C /min/;
Summer + 40°C /max/.

Pipeline construction zone itself is 33 meters and safety zone is 50 meters (25 m on each side). Total occupied area is 1,875.000 sq meters from which 1/3 is belongs to private and 2/3 to State. About 50% of the State owned land is leased to different individuals and companies.
As per agreements (HGA and PSA) on oil transit via Georgia (adopted by Georgian Parliament in 1998) on the safety zone which 50 meters has been placed indirect effective servitude. This means that restrictions have been put on the whole safety zone for any activity/business/construction and

is limited only to the agriculture works. Any contraction work can be done there only after submission of the project to Authorities and AIOC and after the permission of AIOC (Consortium).

Construction of new LNG pipeline is possible next to the existing WREP pipeline, but will require special agreement with the government, AIOC and Consortium companies. It will require to meet the construction / exploitation standards of LPG pipeline. Right now 2 types of Standards (Austrian and Netherlands) are used in Georgia. Austrian is used for the mountain sector and Netherlands for the valley sectors.

We analysed several existing LPG pipeline projects and some under construction in the Middle East and in India and the following summary has been made.

1. Our calculations are based on annual capacity of pipeline - 1.5 million metric tons (MMTPA)of LPG.

2. Total length of pipeline from Baku to Supsa/Batumi will be around 1000km with diameter 14″-16″ .
   As per our calculations on Georgia side there will be required to build 3 pumping stations. Pumps have to be designed to maintain the necessary threshold pressure of 20 bars in pipeline. Pumps has to have the following specification: 760 kWa with capacity 300 cbm per hour, 830 kWa with capacity 320 cbm per hour and 200 kWa with capacity 260 cbm per hour.
   One of the main components on the pumping station is installation of the supervisory control and data acquisition (SCADA) and telecommunication system. These are required for remote monitoring and computerized control of the performance of pipeline.

3. Project cost estimation +/- 50% as required in scope of work

4. Costs of the pipes are calculated as per current price of Russian manufactures 101USD per meter (14″).

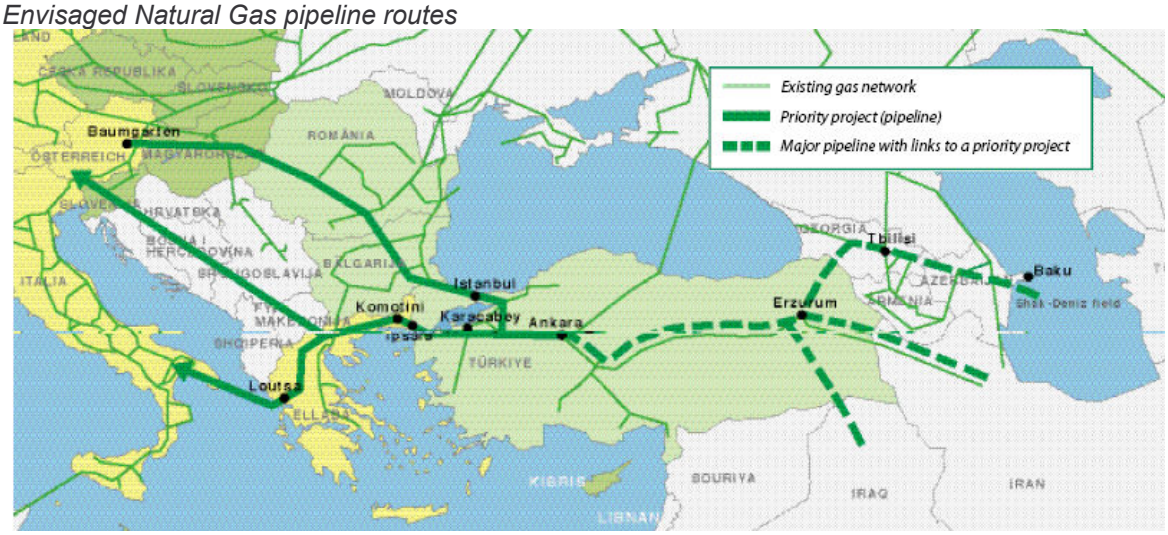
1. Line pipe	$101	million
2. Pipe coating	$15.7	
3. Line fittings	$1.55	
4. Valves	$10.0	
5. Pumps	$11.70	
6. Pipe Laying	$80.00	
7. River Crossing	$0.40	
8. Booster, dispatch and Tap-off Stations	$14.50	
9. Power Supply	$18.10	
10. Construction Camps And/or Townships	$2.60	
11. Surveys	$1.45	
12 Engineering	$12.25	
13. Consulting and training	$0.85	
14. Project management	$16.95	
15 SCADA and Telecommunications Systems	$29.50	
16. Others (Design, bank interest, ROW, Freight, customs duty and tax, etc…)	$87.45	
Total project cost is around	$404	million

Constructing an LPG pipeline from Baku to Supsa/Batumi of around 1,000 km length and diameter 14˝—capacity about 1.5 - 2 million ton/year—is roughly estimated to cost at least US$ 400 million—but more likely US$ 500 million. Adequate storage facilities-cum-seaport terminals are needed in addition at both (Caspian & Black Sea) ends—and at the receiving ends in as far as not already available (at present only in Samsun); constructing a typical LPG terminal with minimum 6-7,000 ton storage capacity (the amount to be pumped daily!) is estimated to cost at least US$ 20 million. The annual capital cost (with 30 years economic lifetime and at 12% interest+ rate—annuity 0.1241) and annual maintenance cost of 1% of the replacement value) would add up to roughly (0.1241+0.01) x (500 + 2 x 20) = US$ 72.5 million which implies a unit cost per ton of US$ 36-48 per ton LPG *excluding the operating costs of the pipeline-cum-terminals*—just to recover the investment and maintenance costs.

Total LPG transport costs Baku-Black Sea (Georgia) would probably be in the order of US$ 60 per ton at an annual throughput level of about 1.5 – 2 million ton/year—and significantly higher at a markedly lower throughput/demand.

The consultant will continue in WP 6 to calculate the pipeline option more accurately to provide for recommendations if such option is viable to continue. For the time being we may foresee however the possibility for cost savings of 10-30 % which may justify further continuations of feasibility studies for such pipeline. A feasibility study should cover the following aspects :

Envisaged Natural Gas pipeline routes



3.12 Transhipment of LPG at Georgian Loading Terminals, Black Sea

Owned by Messrs. Greenoaks Holding Batumi Port has up to date the only LPG terminal in Georgia. The equipment is very modern with European technology and standards. The maximum vessel size which actually is loaded is about 2500 tons. Currently only Azeri LPG is exported via Batumi. Turkmen LPG may arrive for export shortly. The overall quantities are not large yet.

LPG terminal in Batumi

The future for transhipment of LPG in Georgia in order to cope with rising quantities and to provide for competitive services is by the consultant considered to be as follows:

- The existing Batumi terminal must be enlarged
- Alternative terminals at Poti area shall be constructed
- Other terminals than in Batumi and/or Poti are considered as not being viable
- Terminals should allow for the maximum possible vessel size that overall calculations for transport costs up to the final end-users do become favourable

3.13 Shipping issues/sizes ex Georgia

LPG shipping costs based on today's market for vessel size 1500-3000 tons are:

- From Batumi to Albania US$ 70-75 MT
- From Odessa to Samsun US$ 60-65 MT

Currently the large LPG tankers do carry about 23.000 tons. The freight rates for such vessels are consequently much lower than the above figures. The consultant will undertake in the course of WP 6 to calculate the effects in case large vessel can be loaded and which costs and applications are required to load such vessels.

KOREA

Almarona: first LPG tanker completed by STX

AS part of a continuing campaign to diversity into more value-added contracts, STX Shipbuilding was successful in winning orders for two LPG tankers from Qatar Shipping. The first of these, and the first such ship to be built in this medium-sized Korean yard based at Chinhae, was completed in May. *Almarona* is a 23,000m³ design and will be followed by her sister in December this year. The newly delivered vessel is sailing on a five-year charter with Qatar Fertiliser Co, transporting Qatari ammonia to India and countries in the Near East. STX, which had 100 vessels on order at July 1 this year, has already diversified from its bulk carrier and product tanker base into container ships, as we reported in our 2003 and 2002 features. Nevertheless, product tankers still form the main backlog - at July 1 the total was 71, plus six Panamax bulk carriers.

The new LPG designs were created in association with the German gas handling specialist Tractebel Gas Engineering (TGE), which supplied a complete equipment package, including not only the pumps, valves, and skid-mounted modules but also the three prismatic IMO Type A cargo tanks able to load LPG as well as VCM and NH, cargoes. The tanks were fabricated at a special facility operated by Tractebel in the Jiangnan Shipyard, Shanghai, China.

In addition, TGE supervised construction of the cargo-handling plant and carried out pre-commissioning, commissioning, and performance tests. A subsidiary company, Tractebel Marine Engineering, additionally designed the critical steel structures in the vicinity of the cargo area, as well the cargo tanks themselves.

TGE will supply a similar package for the sister tanker but this will differ in one aspect - the ship will additionally be fitted with deck tanks to allow gas changes between cargoes, thus increasing the ship's flexibility.

The tanks in the hull of each tanker are made from low-temperature carbon steel (NV2-4) and

Almarona is the first of two new 23,000m³ LPG tankers - the first of this type to be built by STX - for Qatar Shipping.

TECHNICAL PARTICULARS
QATAR 23,000M³ LPG TANKERS

Length, oa	164.80m
Breadth	26.20m
Depth	15.30m
Draught	8.40m
Deadweight, max	17,000dwt
Cargo capacity	23,000m³
Main engine	STX-MAN B&W 6S50MC-C
Output	9480kW at 127rev/min
Speed service at 85% MCR	16.50knots
Classification	Det Norske Veritas

All three IMO Type A prismatic cargo tanks and the complete gas-handling package for *Almarona* were supplied by the German specialist Tractebel (TGE).

TECHNICAL PARTICULARS
CLIPPER 11,000DWT TANKERS

Length, oa	116.50m
Length, bp	109.00m
Breadth, moulded	20.00m
Depth, moulded	11.70m
Draught, design	8.05m
Draught, scantling	8.40m
Deadweight, design	10,250dwt
Deadweight, scantling	11,000dwt
Cargo tanks	12,400m³
Slop tanks	600m³
Water ballast	4500m³
Heavy fuel	650m³
Diesel oil	55m³
Tankcleaning fresh water	100m³
Main engine	STX-MAN B&W 6S35MC
Output, MCR	4440kW at 173rev/min
Complement	20 plus 4 Suez crew
Flag	Bahamas
Classification	ABS

3.14 From Georgia/Ukraine into the end-user markets

The consultant advises that any considerations should be based on the best economical possibilities :

- 'TRACECA LPG' should land at as many as possible end-users at competitive prices
- Preference for European markets as per the TOR must not restrict any economical consideration – though for obvious reasons European markets will be the key target markets
- All measures must be undertaken to decrease the transport costs from the production sites up to the end-user

3.15 Ukraine LPG transit considerations

The consultant recommends to investigate also the possibilities to develop a competitive corridor from Georgia in Middle Europe (Poland/Hungary/Slovakia/Austria etc.) because :

- Providing 'greater' Europe with LPG supplies from TRACECA corridor
- Exploring possibilities to develop competitive logistical route via the Ukraine

As of today the following information was provided:

- "Ukrferry"(rail ferry boat) is operating large rail ferries from Poti/Batumi to Ilyichevsk – the costs are roughly as follows ($**2280** per one tank-wagon (2 days carriage by sea); ($**0,75** per 1 ton in wagon + $**150)** – terminal fee in port of Poti/Batumi; $**2,5** per 1 ton – terminal fee in the Port of Ilyichevsk)
- only 22 tank-wagons can be loaded only on the upper deck of a ferry boat (as a dangerous cargo)
- There are only 2 trips per week
- Railway tariff - $35,46 per 1 ton from Ilyichevsk to board with Europe (Yagodyn, Batevo, Chop). Transit time is 5 days (200 km per day or less than 10 km's per hour).

So far it appears that such transit tariffs are not competitive. The speed of Ukrainian railways is far below sub standard – inter alia because of 3 to be passed rail districts within the Ukraine with change of personal/locomotives/documents check/cargo check etc. each time. The consultant will undertake to investigate in WP 6 the possibilities for more competitive solutions such as:

- Shipping by vessel to the Ukraine
- Improving the rail tariffs – see other recommendations to railways as above

3.16 Turkmen LPG First Economical Base Case Estimate

A first calculation to transport LPG from Turkmenistan to the Georgian coast looks today roughly as below whereby the following remarks must be made:

- The transport chain works as follows : RTC's must be rented/bought from Ukraine or Russia/RTC's must be 'ballasted' to the loading area at TMB/RTC's will be rolled off the Caspian Shipping Ferry boat and shipped to the about 5 km distant refinery, will get loaded and shipped back and rolled onto the ferry boat (this part must be carefully handled and managed with Turkmen railways; hereinafter RTC's will be rolled off at Baku port and will be shipped to Batumi LPG terminal
- The costs on the Turkmen side to roll on/roll of the RTC's must be exactly calculated; likewise the costs for rent of RTC's, Batumi transhipment charges as well as all other costs such as but not restricted to return of empty RTC's; penalties and bonus on timing above or below certain limits etc.

Turkmen LPG Base Case Estimate*
Railcars : LPG
Route : TMB-Maha-Bat
Days : 10
RTC per day : USD 30,00
Intake tons : 29

	RTC's via Ferries (USD)	Tankers (USD)	Pipeline (USD)
Roll on TMB/Transhipment	15,00	12,00	12,00
Demurrage RTC			
X Caspian Sea freight		25,00	25,00
Azerbaijan rail, pipeline and transhipment	89,00	36,00	33,00
RTC control	1,00	1,00	
RTC 'rent'	10,34	5,75	
Railway Codes			
Return of RTC´s		8,00	
Georgia rail, pipeline	20,00	20,00	20,00
Batumi Terminal	15,00	15,00	11,25
Costs/additional pipeline charges	1,00	1,00	9,00
Losses	-	-	-
Total FOB Batumi	**151,3**	**123,75**	**110,25**
Discount for best case scenarios	**-12,00**	**-5,00**	

*the a.m. figures are based on verbal and written offers from railways, forwarders and shipping companies and are an estimate **only**

The transport charges from Aktyau to Batumi will be about US$ 10,- MT higher because the sea voyage takes about 3 days in total longer than from Turkmenbashi.

The consultant does consider the a.m. figures for ferry and tanker/rail transport as not competitive for the TRACECA corridor to compete with alternative routes on the longer-term basis and to attract the required long terms and stable supply of LPG.

Therefore the consultant will also undertake to investigate the possibilities for pipeline construction. An annual income of about US$ 70-90 Mio. for a LPG volume of about 1,5 Mio. tons transported by pipeline versus an investment volume of US$ 400-500 Mio. may justify such considerations.

3.17 Interim findings

3.17.1 Competitive Analysis

Producers of LPG in Kazakhstan and Turkmenistan will transport LPG via the TRACECA corridor under 3 scenarios :

- Produced quantities do exceed the transport possibilities of alternative logistical routes
- There may be economical/political considerations not to transport all volumes via one route and therefore the TRACECA corridor will be used
- The TRACECA corridor offers lower transport costs and producers get a better net back return

The consultant will undertake in WP 6 to develop scenarios which will only follow the last aspect – the TRACECA corridor must offer better overall logistical costs to producers than others. This would the (only ?!) safe way to attract and finally secure the required investments via stable, safe and long term cargo flow. Producers must be encouraged to produce LPG and to supply such LPG via the TRACECA corridor.

3.17.2 Competing Routes versus TRACECA

The main alternative routes – against which the TRACECA corridor must compete – are as follows:

- via Makhachkala/Russia and further on to the Black Sea or into Central Europe by rail
- via rail into Central Europe/Black Sea
- via Iran for transit to the Persian Gulf and/or for own consumption in Iran

Other routes like shipments into China will be looked at but may be not be the subject of relevant competition. It will be difficult though to estimate the Chinese 'impact' in case their inland demand is sharply going up and other import resources will not hold up to this and China may undertake a strategically world wide buying spree of carbon hydrates as done in the oil business.

4 Conclusions, recommendations, outlook

The consultant summarizes the situation in the TRACECA corridor in respect to this working paper as follows :

- The existing logistics for LPG are not sufficient and competitive to cater for larger quantities of LPG which should be produced until 2015
- Significant investments into Ferry boats, terminals, railways, pipelines, tankers etc. must be undertaken if LPG shall be transported on a larger scale
- Investment amounts to transport 1,5-3 Mio. tons via the planned routes are estimated to be between US$ 150-600 Mio. US$
- Given the much more sensitive price situation and much higher investment requirements of LPG transport versus other oil products all parties (producers and all parties concerning transport) concerned should follow an integrated approach to be competitive and to attract and secure quantities for the TRACECA corridor
- Investors and banks may already be invited for presentation of WP 6
- The final basis for the a.m. investments will be to be undertaken feasibility studies and business plans. WP 6 may form a basis for this. Parties concerned – especially the EU bodies may already prepare and inform financing institutions like EBRD about the project

The final statements could be summarized as follows :

- Oil transports through the TRACECA corridor increased from basically 0 in 1992 up to 1,2 Mio. tons per month in 2006
- The following investments were made to accommodate these volumes : Batumi terminal (upgrade/ renovations)/Poti terminal (new)/ railways (upgrades/renovations/some new RTC´s - may be some locomotives)/Dubeni (upgrades/renovations)/Tankers (upgrades/renovations/some new ones)
- Total investment volume was estimated to be US$ 150-300 Mio. over 16 years versus a Transport volume of may be 50-80 Mio. Tons (1992-2006) and a gross income of 2,5-3,5 Bio. US$
- Today the technical status of railways and tankers in respect to oil transports is far from western standards though some technical improvements were undertaken
- Lack of coordination, planning, other irrationalities and also political `turbulences`did result in the past in partly chaotic (and expensive) logistical waiting times for tankers and RTC´s (at peak times up to 1000 RTC´s and 10 Tankers were waiting) - besides the loss of throughputs
- LPG transport cannot `stand' such situations because a. Waiting times respectively speed of LPG transport are more than double as expensive as for Oil (products) b. Investors will (and should) not put up the required funds without reliable consideration of the above by TRACECA and having TRACECA offered to Investors different structures than the prevailing ones for oil (products) transport. There may be no other way – but to have an integrated transport chain - to ensure the fast, reliable and competitive LPG cargo flow which safeguards the return on investments
- TRACECA may consider to set up a central coordination unit which shall `pool` all parties and overlooks and offers `door (e.g. ex works Kazakhstan) to door (FOB Georgian coast)´ services and contracts
- Constant ´restructuring' of transport organizations cannot take place in the case of larger LPG transport volumes
- In order to transport 20-25 Mio. tons of LPG which may generate also 2,5-3,5 Bio. US$ gross income over the same period of time the required investments are possibly up to US$ 800 Mio., which may be undertaken over the next five years – provided LPG producers commit to ship such volumes.

- Therefore the consultant considers the situation different in comparison to the existing facilities for oil transport and suggests the a.m. approach – the construction of a pipeline provided the results in WP 6 would justify such investment may be one of the solutions

ANNEX I SCOPE OF WORK FOR PRE-FEASIBILITY STUDY FOR THE AZERBAIJAN – GEORGIA LPG PIPELING PROJECT

PURPOSE AND OBJECTIVES

The objectives of this Study are to provide a preliminary analysis of the route, environmental constraints, sizing of main facilities and cost estimate with an accuracy of +/- 50% for the new Azerbaijan – Georgia LPG Pipeline Project.

BASIC DATA AND ASSUMPTIONS

To be determined (TBD)

SCOPE OF WORK

Pipeline route engineering and constraints mapping
The route engineering and constraints mapping will consist of a route corridor analysis and selection desk top study using readily available data for existing infrastructures, topology, geology, seismic, environmental protected areas, population settlements, land use, etc.
The route selection shall be the identified from a preliminary review of technical, environmental, safety, operation and economical issues considering the optimum costs for construction and operation of the pipeline system.
At this pre-feasibility study stage no contacts will be made with regional or local authorities and no spatial development aspects will be considered for the route engineering.
The findings of the route engineering and constraint mapping will be summarized in:

- Topographical maps showing the pipeline corridor (10km width) indicating lengths and elevations (scale of no less than 1:250,000);
- Geological evaluation of the route and estimate of the different types of geological hazards for the pipeline during construction and operation like earthquakes, volcanic eruptions flooding, etc. Seismic maps will be provided in a scale of no less than 1:250,000;
- Analysis of the types of terrain and soil conditions along the route and an assessment of their excavatability (e.g. unconsolidated deposits, consolidated sedimentary rock, bedrock, etc.);
- Analysis of the settlement areas along the pipeline route including archaeological, cultural heritage, tourism, social and ethnic sensitive areas;
- Analysis of surface and ground water resources and courses along the route;
- Analysis of the land use along the route and special land use areas like specialised crop areas such as viniculture or fruit-growing, wooded areas, etc.;
- Analysis of special protected fauna and flora along the route;
- List of crossings along the route (e.g. rivers, smaller water courses, railways, roads, pipelines, cables, etc). An overall description of the most significant environmental crossings will be provided;
- General map showing routing constraints (engineering, geotechnical, environmental, land use, social, security etc).

General environmental and social impact mitigation measures will be identified that could comprise for example: rerouting of pipeline to pass critical areas, time restrictions for construction works, alternative construction techniques (e.g. for crossing of rivers with valuable flora and fauna), increase of wall thickness in critical sections (e.g. urban areas), erection of line valve stations in critical sections (to reduce pollution in case of leakages), etc.

At this pre-feasibility study stage no assessment will be done for the selection of the location for the aboveground installations (AGI) like pump stations, block valve stations, etc.

Hydraulic simulation and preliminary sizing of the pipeline system
At this preliminary stage a hydraulic simulation study will be performed for various pipe size options, operating pressure range, and required number of pump stations and total pumping power with the capacity required for the throughput quantities stated above for each Case TBD.
For each pipe size option, the hydraulic analysis will show the required number of pump stations and total pumping capacity for the initial capacity, capacity expansion steps and ultimate pipeline capacity.
The resulting technical options for each Case TBD will be shown with the following parameters for the different capacity steps:

- the pipe diameter;
- range of operating pressure;
- pipe material and wall thickness;
- number of pumping stations and total pumping power.

In accordance to those parameters resulting from the hydraulic simulations the Study will assume a state-of-the-art pipeline system design in accordance to common international practice for the rest of the facilities and design parameters.
The major facilities of the pipeline system will be described in a general manner and defined only with the level of detailed required for the cost estimate with an accuracy of +/-50%. This relates among other to the following facilities:

- Linepipe;
- Pump stations;
- Block valve stations;
- Cathode protection;
- Telecommunication, SCADA and leak detection system;
- Pigging stations;
- Metering stations.

For example, redundancy in pump stations, power supply for pump stations and block valve stations, and pigging and block valve stations spacing requirements will be assessed based on ILF's experience in similar international projects.

PROJECT COST ESTIMATE

General
The project capital and operating cost estimates for the elaborated technical solutions will be estimated with a level of accuracy of +/- 50%.
Thus, the cost estimate will be based on costs for similar international projects recently realised by ILF considering however local labour cost levels. No further local aspects or requirements will be taken into consideration for the cost estimate.
Capital and operating costs estimates will be provided with a breakdown as per major facilities / cost categories as detailed below.

Capital expenditures (capex)
The capex estimate will be broken down into the following main categories:

- Main pipeline (material & construction);
- Pump stations;
- Other AGIs such as valve stations and metering stations;
- Cathodic protection, SCADA and telecommunication system (material & construction);
- Services for project management, basic design, detail design, environmental and social impact assessment (EIAs), construction management and construction supervision;
- Permits, fees, Right-of-Way/servitude (ROW) and permanent land acquisition costs.

Operating expenditures (opex)
The opex of the project will be estimated and broken down as per the following main opex categories:

- Fixed opex: management, operation, maintenance costs, etc.;
- Variable (throughput-related) opex: energy costs.

Fixed operating costs will be estimated as a percentage of capital costs corrected with a certain factor as per ILF's experience in similar international pipeline projects.
Energy costs will be estimated considering the power consumption requirements shown by the hydraulic analysis and assuming power costs at pump stations as stated above TBD.

Techno-economic optimisation
The purpose of the techno-economic optimisation is to compare the elaborated technical options from an economic point of view and select the most economic one.
The economic comparison of technical options will be based on three major factors:

- Initial capex: smaller pipe size systems require a lower initial investment thus facilitating the financing of the project and lowering risks for the sponsors;
- Life-cycle transportation costs: smaller pipe sizes systems require a lower initial investment than larger pipes but capacity expansion is more costly should that be required in a later step and have higher energy costs especially at high throughput volumes.
- Thus, on a life-cycle bases expressed for instance as transportation costs per tonne, whether smaller or larger pipe size systems are more economic is dictated by the throughput build up and ultimate throughput volume level. A rapid throughput build up and high throughput volumes would lead to larger pipe size systems to have lower life-cycle costs than smaller pipe size ones and vice versa;
- The maximum economic capacity of the pipeline: larger pipe size systems can be ultimately economically expanded to higher throughput volumes than smaller pipe size ones. Thus, larger pipe size systems are more valuable if the initial forecast throughput proves pessimistic.

The life-cycle transportation costs or pipeline tariff will be calculated as per the "levelised life-cycle transportation costs" method.
This method is most common in project economic appraisal practise. In this method constant transport costs are calculated at the level needed to meet, over the life of the project, operating costs and capital costs. The resulting constant transport costs allow for a straight-forward comparison between pipe size options, throughput scenarios and other alternatives to the pipeline system.
More specifically, the levelised life-cycle transportation costs method calculates transport costs by equalling, on a present value basis, the life-cycle operating and capital costs to the "income" that the constant ("levelised") transport costs would generate over the life-cycle with the corresponding defined volumes to be transported.
The discount rate used for discounting the life-cycle costs to their present value is the cost of capital or required return on investment for the project.
The levelised life-cycle transportation costs calculated in this way can also be seen as the "tariff" that a third-party would request from shippers. With a given throughput this "tariff" will cover capital and operating costs and yield a return on invested capital equal to the discount rate applied.

Project simplified economic model
A simplified economic model for the Azerbaijan – Georgia LPG Pipeline Project will be constructed to calculate the project life-cycle costs or tariff (on a dollar per tonne basis). The model calculates into the tariff all project costs including the cost of funds during construction, capital and operating costs throughout the project life. The model also accounts for the throughput build up and the pipeline system required increases in capacity considering the various technical solutions for the Azerbaijan – Georgia LPG Pipeline Project elaborated in the Study.

The model will be constructed on MS-Excel and programmed on VBA and will be provided in soft copy with the Study report to the Client who can then perform sensitivities on throughput built up, return on investment, fuel costs, project commercial life, etc. to evaluate the economic merits of the different pipeline technical solutions for different throughput scenario.

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