The European Union's Tacis TRACECA programme for Armenia, Azerbaijan, Bulgaria, Georgia, Kazakhstan, Kyrgyz Republic, Moldova, Romania, Tajikistan, Turkey, Turkmenistan, Ukraine, Uzbekistan

EUROPEAID/120569/C/SV/MULTI

Regulation on the Transport of Dangerous Goods along the TRACECA Corridor

Azerbaijan, Georgia, Kazakhstan, Turkmenistan and Ukraine

Working Paper 4 SAFETY CONDITIONS

July 2007

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Annexes:

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Abbreviations

ADN	Accord européen relatif un transport international des merchandises dangereuses par voie de navigation intérieure
ADR	European Agreement concerning the International Carriage of Dangerous Goods by Road
ASME	Codes & Standards set by American Society of Mechanical Engineers
BAM	German Federal Institute for Materials Research and Testing
BLEVE	Boiling liquid expanding vapour explosion
CAS	Chemical Abstract Service - database of chemical substance information
CEP	Caspian Environment Programme
EU	European Union
GEF	Global Environment Facility
GOST	Standards originally developed by Gosstandard (State Committee for Standardisation, Metrology, and Certification) and the former Soviet Ministry of the Chemical and Petrochemical Industry
ICS	International Chamber of Shipping
IMDG	International Maritime Dangerous Goods Code (IMDG Code)
IMO	International Maritime Organisation
HAZCHEM	Emergency Action Code
LEL	Lower Explosive Limit
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
MLA	Multi-Lateral Agreement on International Transport in the transport corridor Europe-Caucasus-Central Asia
OECD	Organization of Economic Co-operation and Development
OTIF	Intergovernmental Organisation for International Carriage by Rail
RID	Regulations concerning the international carriage of dangerous goods by rail
SIGTTO	Society of International Gas Tanker and Terminal Operators
SOLAS	International Convention for the Safety of Life at Sea
TDRM	Total Disaster Risk Management
TRACECA	Transport Corridor Europe Caucasus Central Asia
UNEP	United Nations Environment Programme

1 Introduction

1.1 The TRACECA programme

In May 1993 the European Commission organised a conference in Brussels with the newly independent states of Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyz Republic, Tajikistan, Turkmenistan and Uzbekistan[1]. From this conference the TRACECA (Transport Corridor Europe Caucasus Central Asia) programme was created as a component of the Tacis Interstate Programme of the EU. The main objectives are:

- To stimulate co-operation among the participating states in all matters pertaining to the development and improvement of trade and transport within the region.
- To promote the Central Asian - Trans-Caucasian - Europe transport corridor.
- To identify problems and deficiencies in the regional trade and transport systems and promote solutions.
- To launch a Technical Assistance Programme to be financed by the EU.

On 7-8 September 1998, delegations of 32 countries and 13 international organisations gathered in Baku (Azerbaijan) for the International TRACECA Conference. During this conference the Multi-Lateral Agreement on International Transport in the transport corridor Europe-Caucasus-Central Asia (MLA') and four supplementary technical documents on customs, road, maritime and rail transport were signed. The objectives of the MLA and its Technical Annexes are as follows:

- Assisting in the development of economic relations, trade and transport communications in Europe, black Sea region and Asia
- Ensuring access to the world market of road, rail transport and commercial navigation
- Ensuring traffic security, cargo safety and environmental protection
- Harmonisation of transport policy and legal structure in the field of transport
- Creation of equal conditions of competition for transport operations

In the framework of the technical Assistance Programme and the Multi-lateral Agreement a number of projects have been set up, including this project aimed at improving the transport of dangerous goods along the TRACECA corridor.

1.2 Regulation on the transport of dangerous goods along the TRACECA corridor

In the framework of the TRACECA programme the project “Regulation on the transport of dangerous goods along the TRACECA corridor” was initiated.
This project on the transport of dangerous goods (mainly LPG) along the TRACECA Corridor fits very well in the Strategy of the Intergovernmental Commission (IGC) TRACECA for development of the TRACECA Corridor for the period up to 2015, as presented at the 5th Annual Meeting of the IGC TRACECA, Sofia, May 2006.

In the past by-products for oil and gas production in producing countries Kazakhstan and Turkmenistan were mostly flared. To transform them into LPG was not done on a large scale as transport of LPG was economically not viable due to high transport costs (too far away potential markets). However, set against the background of rising oil prices, the market of LPG becomes more and more attractive to develop. This project specifically looks whether transport of LPG via the TRACECA corridor could become feasible, especially in comparison with other corridors. This will be done within the broader scope of transport of dangerous goods as far as this concerns safety, regulation, environmental and institutional issues.

[1] Recently also Turkey has joined the TRACECA initiative

This report is focused on the safety matters of LPG and safety conditions in regions relevant for the TRACECA corridor.

1.3 European Rules on Transport of Dangerous Goods

The European rules on dangerous goods transport cover road and rail transport modes are part of Community legislation, especially Directives 94/55/EC (road), 96/49/EC (rail), 96/35/EC and 2000/18/EC (safety advisers) respectively. Substantial elements of the road and rail directives are based and amended according to international rules (so called ADR and RID), which are in line with the United Nations "Recommendations on the Transport of Dangerous Goods; Model regulations", last amended in 2005.

In recent months the Commission has published it's intention to propose to take a number of clauses redundant (like directives on safety advisers) or obsolete off the Community legislation. Another intention is to propose to merge the current rules on dangerous goods transport by road and rail into one piece of Community legislation, in order to avoid duplication, make application of the rules by operators easier, allow the public to gain of clearer picture of existing rules, and to create a set of uniformly applied rules for all inland transport modes in the territory of the European Union. General conclusions drawn by the Commission are:

- There is a large majority in favour of combining the rules on dangerous goods transport by road and rail in one piece of Community legislation
- A large majority are of the view that the above approach would lead to a simplified and more easily understandable Community legislation;
- A large majority agree that dangerous goods transport should in general be treated in Community legislation in a similar way for all transport modes;
- A significant majority supported the inclusion of inland waterways in the scope of the Community legislation;
- A large majority supported the finding of a mechanism to allow for regular updating of Community legislation on dangerous goods transport to take account of international and technical developments.

Also it is intended to extend Community legislation by including the international rules on dangerous goods transport by inland waterways (so called ADN), which are also based on the UN model.

1.4 Working Paper 4 Safety Conditions

This report contains Working Paper 4, safety conditions assessment. The objective of this assessment is to get an overview on the safety conditions and risk properties of LPG in order to evaluate potential hazards for LPG transported via the TRACECA corridor. Furthermore, the assessment contributes to the technical part of the study evaluating varying transport routes and transport modes. The preliminary results of the safety report have been discussed with main stakeholders from the TRACECA region, during a seminar organised in Hamburg on March 29 and 30, 2007.
Additionally Working Paper 5 (WP 5) will elaborate on the EU legal framework for safety and dangerous goods. WP 5 will, amongst others, discuss the EU Seveso-directives and their implementation in Member States, for instance with obligatory safety plans for sites storing and handling dangerous goods.

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2 LPG – Characteristics and chemical behaviour

2.1 Definition and characteristics of LPG

LPG (also called liquefied petroleum gas, liquid petroleum gas, LP Gas, or auto gas) is a mixture of hydrocarbon gases.

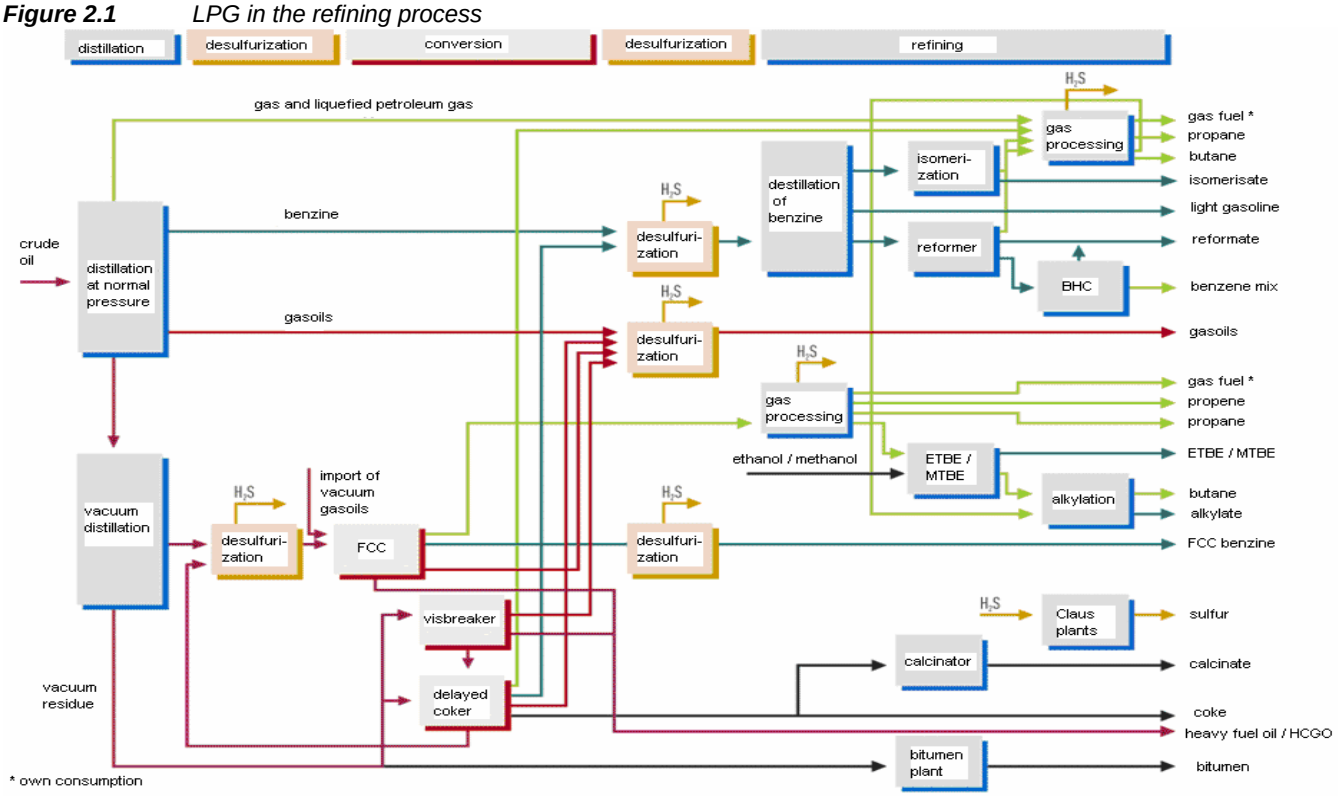
LPG forms part of crude oil processing and regularly occurs as a by-product of crude oil and natural gas exploitation in different percentage and combinations. It stems from two sources. It can be obtained from the refining of crude oil. Simple refining in a crude distillation tower will yield about two percent LPG. When produced this way it is generally in pressurized form.

During the distillation at normal pressure, the crude oil is presorted into gas, gasoils, distillates and atmospheric residues for further refining – here, the hydrocarbons are put in order according to their molecule size (fraction).

Subsequently, the distillates must be further refined: larger hydrocarbons are split into smaller ones (cracking) and certain molecules are reformed (reformation). During the refining, the hydrocarbons are also cleansed of unwanted components. The high-quality liquefied petroleum gas results from further refining of the hydrocarbons in several process steps. For this reason, liquefied petroleum gas is one of the purest and cleanest products of natural gas refining.

An exemplary process in a refinery concerning the formation of LPG is given in the following figure:

Figure 2.1 *LPG in the refining process*



Source: Tytogaz

LPG is also extracted from natural gas or crude oil streams coming from underground reservoirs. It is formed naturally in oil and gas fields and is pumped out from the wells mixed in with other fuels, typically about 0.2 to 0.4 percent of the produced crude oil but much higher proportion is possible. At the oil and gas facilities, butane and propane gases are separated from the heavier fuel and stored in purpose-built storages.

Varieties of LPG bought and sold include mixes that are primarily propane, mixes that are primarily butane, and mixes including both propane and butane, depending on the season—in winter more propane, in summer more butane. Propylene and butylenes are usually also present in small concentration. A powerful odorant, ethanethiol, is added so that leaks can be detected easily.

LPG liquefy at moderate pressures, readily vaporizing upon release of pressure, i.e. at normal temperatures and pressures, it will evaporate. Because of this, LPG is supplied in pressurized steel bottles, tanks, containers, vessels, pipelines. In order to allow for thermal expansion they are filled to between 80% and 85% of their capacity. The ratio between the volumes of the vaporised gas and the liquefied 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 always be kept in mind to avoid accidental ignition or suffocation hazards.

While butane and propane are different chemical compounds, their properties are similar enough to be useful in mixtures. Butane and Propane are both saturated hydrocarbons. They do not react with other. Butane is less volatile and boils at 0.6 deg C. Propane is more volatile and boils at - 42 deg C. Both products are liquids at atmospheric pressure when cooled to temperatures lower than their boiling points. Vaporization is rapid at temperatures above the boiling points. The calorific (heat) values of both are almost equal. Both are thus mixed together to attain the vapour pressure that is required by the end user and depending on the ambient conditions. If the ambient temperature is very low propane is preferred to achieve higher vapour pressure at the given temperature.

Main characteristics of LPG are as follows:

- It is colourless and cannot be seen
- It is odourless. Hence LPG is odorized by adding an odorant prior to supply to the user
- It is slightly heavier than air and hence if there is a leak it flows to lower lying areas.
- In liquid form, its density is half that of water and hence it floats initially before it is vaporized.
- It is non-toxic but can cause asphyxiation in very high concentrations in air.

LPG also contains further components in small amounts (propene, butene and butene-isomers) among the main components propane and butane (see table with data on chemical media).

Table 2.1 *LPG Fuel and heat values (norm values)*

	Fuel Value			**Heat Value**		
	kWh/kg	kWh/l	kWh/m³	kWh/kg	kWh/l	kWh/m³
	liquid	liquid	gaseous	liquid	liquid	gaseous
Propane	13.98	7.42	28.56	12.87	6.83	26.22
n-Butane	13.74	8.18	36.55	12.69	7.55	33.76
Natural Gas H	-	-	11.11	-	-	10.04
Natural Gas L	-	-	10.02	-	-	9.04
Fuel Oil EL	12.68	10.65	-	11.86	9.96	-
Fuel Oil S	12.11	11.38	-	11.39	10.71	-

The figures given in Table 1 refer to a density according to German DIN 51622: propane 2.0372 kg/m³ and butane 2.66 kg/m³; Density liquid 0°C: propane 0.5305 kg/l and butane 0.5950 kg/l[2]

[2] Source: Tytogaz GmbH

Table 2.2 *Chemical Properties of LPG*

	Propane	**Butane**	**(Remarks)**
Chemical Characteristics	Hydrocarbon - C_3H_6	Hydrocarbon - C_4H_8	
Density			(standard)
- liquified	0.53 kg/l	0.60 kg/l	
- gaseous	1.97 kg/m^3	2.59 kg/m^3	
Vapour pressure	4.05 bar	0.84 bar	(at 20 °C)
Freeze point	approx. -187 °C	approx. –138 °C	
boiling range	-48 °C to -1 °C	- 12 °C to 0 °C	
Flashpoint	- 104 °C	- 60 °C	
Auto Ignition Point	430 °C to 510 °C	430 °C to 510 °C	
Flammability Range	2,1 to 9,5 Vol.-%	1,5 to 10 Vol-%	
Fuel Value	13.98 kWh/kg	13.74 kWh/l	
	28.56 kWh / m^3	36.55 kWh / m^3	
Color	colorless	colorless	
Odor	perceptible	not perceptible	
Classification			
UN No.	1978	1011	
Hazard class	2.1	2.1	
CAS-No.	74-98-6	106-97-8	
EU-No.	2008279	2034487	
Hazard-label	highly inflammable, F+		
Safety phrases	S2 – Keep out of reach of children		
	S9 – Keep container storage in well ventilated area		
	S16 – Keep away from sources of ignition smoking prohibited		
	S33 – Measures against static charge		

2.2 Hazards Identification

Under normal conditions of storage and use, LPG will not constitute a health hazard. However, being heavier than air, if released the gas will collect in any confined space and may reach concentrations presenting an asphyxiation or safety hazard. Direct contact of the skin with liquid gas may cause frostbite or cold burns and containers may present a similar hazard when gas is being withdrawn, due to the cooling effect.

Table 2.3 *General Health Information on LPG*

	HEALTH INFORMATION
Inhaled	May cause irritation of the respiratory tract. May also cause headaches or dizziness at moderate exposures. Asphyxiant. Causes unconsciousness and respiratory arrest at elevated exposures. Breathing saturated vapours for a few minutes may be fatal. Saturated vapours can be encountered in confines spaces and/or under conditions of poor ventilation Avoid breathing vapours and fumes as much as possible. If someone is overcome by fumes, remove them to fresh air immediately. However, rescuers should avoid becoming a casualty by wearing suitable respiratory protection. If the affected individual is not breathing, administer artificial respiration. Seek medical advice promptly in serious cases of over-exposure.
Eye	Irritating if the liquid gets into the eyes, with a possible hazard from freezing due to rapid evaporation. Vapours in high concentration may also be irritating. Avoid eye contact with the product. Remove any contact lenses carefully. Hold eyelids open and flush eyes with fresh tepid water for 15 minutes. Seek medical advice immediately for all eye contact. Where significant splashing of LPG liquid may occur, eyewash Facilities stations Should be installed.
Skin	Excessive prolonged contact to the liquid can cause skin irritation and frostbite due to rapid evaporation. Avoid skin contact with the liquid. Remove contaminated clothing and wash the exposed areas with plenty of soap and water. Seek medical advice if irritation or frostbite (see below) occurs
Swallowed	Unlikely to be a problem, owing to high evaporation rate.
Frostbite	Obtain medical assistance. If medical advice is not available immediately, place casualty in a warm area as soon as possible and allow the injured area to warm gradually (further damage may occur if the area of injury warms too rapidly). DO NOT EXPOSE THE INJURED AREA TO EXCESS HEAT OR COLD (such as heat lamps, hot water, snow or ice). Gently cover or drape the injured area with clean material, such as a dressing or sheet. To relieve pain, immerse the injured area in water which is near or at body temperature (35-40° C). If possible, get the casualty to exercise the injured area gradually. Give them something warm to drink, BUT NO ALCOHOL. Seek medical advice as soon as possible.
Chronic	No effects reported from long term industrial exposure to this product. No specific, but symptomatic treatment recommended. At very high levels, propane has narcotic and asphyxiating properties and cases of “sudden death” have been documented in which propane and propylene were identified in blood, urine and cerebrospinal fluid.

2.3 Handling Precautions

Gas leaks or liquid spills readily form flammable mixtures at temperatures below ambient. LPG vapours settle to ground levels and may reach ignition sources remote from the point of escape via drains and other underground passages. A risk of fire or explosion can occur by mechanical impact, friction, sparks, flames or other sources of ignition. Also an explosion can result from incendiary static discharge as material can accumulate static charges.

Table 2.4 *Precausions for Use of LPG*

	FLAMMABILITY
	LP Gas is gaseous and highly flammable at normal temperatures and pressures. The gas is normally stored under pressure in the liquid form. Release of pressure is associated with rapid cooling, the intensity of which is dependent on the rate of release. Containers of LPG are explosive hazards, when exposed to excessive heat.

	EXPOSURE STANDARDS
Odour	Most LP Gas is odorised before transport handling and is detectable to 20% of its LEL. If no stenching agent has been added, LPG has a high odour threshold (in the order of 10 - 25 times the exposure standard). Therefore, unodorised LPG does not have good warning properties.
Control	Ensure there is good ventilation of the area in which the product is used to keep concentrations below the exposure standard or lower explosive limit. While dilution by air may be sufficient in most cases, mechanical exhaust ventilation may be required. In such cases, use sparkproof equipment if possible. A ventilation velocity of at least 0.3 m/s is recommended.

	PERSONAL PROTECTION
	Avoid contact with eyes and skin. Overalls or a long sleeved shirt and closed-in shoes or safety footwear should be worn as a general precaution.
Eye Protection	Eye protection is required (faceshield, chemical safety glasses or side shield glasses) where splashing is likely.
Gloves	Impervious oil and cold resistant gloves should be worn when using this product. Gloves made of PVC are preferred, though gloves made of nitrite and chloroprene should also be satisfactory.
Respiratory Protection	If ventilation of the area is not sufficient, respiratory protection may be required. This should be at least approved air supplied or self-contained breathing apparatus where the exposure standard is likely to be exceeded or if work is required close to large gas leaks.

2.4 Safe Handling Requirements

LPG does not meet the criteria for classification as dangerous to the environment. LPG released into the environment will rapidly evaporate and be dispersed into the atmosphere as a gas. Based on chemical/physical data from the literature, no harmful effects to terrestrial or aquatic habitats would be expected from components of LPG. The hydrocarbon components have been reported to have short atmospheric half-lives and therefore, would not be expected to persist.

The main concern for safe handling having in mind the product's extreme flammable behaviour is to avoid:

- rupture of the pressure vessels
- exposure to extreme heat, and
- contact with oxidizing agents such as liquid chlorine.

Table 2.5 *Safe Handling Requirements for LPG*

	STORAGE AND TRANSPORT
Storage	LPG should be stored in approved areas only either under pressure at ambient temperatures or as a refrigerated liquid. Minimum conditions of storage include dry, cool, secure storage away from heat, sources of ignition and oxidising substances. Keep containers closed and upright when not in use. The design of pressure vessels, fuel systems, safety devices and the operating procedures must comply with national legislation and with recognised codes of good practice
Transport	Large volumes must be transported in approved tankers, and smaller volumes in approved pressure containers.

	SPILLS AND DISPOSAL
Spills	Cut off source of leak. If the release is large, cut off all ignition sources and evacuate all non-essential personnel from the area. If possible, ventilate the area. If the incident is significant, seek immediate assistance from local fire authorities and police. If possible, monitor the vapour concentration until dissipated.
Disposal	If possible, allow to evaporate. Large volumes should be removed by tanker or by controlled burning. LPG can be disposed by approved incineration methods. Contact local supplier or fire brigade for further advice on disposal

	FIRE/EXPLOSION HAZARD
Dangerous Goods Class	UN; ADR/RID; IMO/IMDG: 2.1
Hazchem Code	2WE
Extinguishers	Water spray or BC fire extinguisher.
Procedures	Stay out of gas or vapour. Use water to disperse unignited gas or vapour and to cool equipment. Allow to burn out under controlled conditions, if possible.
Special Precautions	Fire-fighters should wear full protection and breathing apparatus. LPG is heavier than air, and vapours will tend to flow downwards and accumulate in low-lying areas such as drains and pits at ground level.
Containers	Cool fire exposed containers with water spray. If ignition has occurred and water is not available, tank metal may weaken from overheating.
Reactivity	Stable, not subject to polymerization
Incompatibilities	Oxidizers
Combustion Products	Hazardous combustion products of carbon dioxide (carbon monoxide under poor conditions of combustion) and smoke may be produced. Hazardous polymerisation will not occur.

3 Potential Dangers and Experiences with Accidents

3.1 General Remarks

What makes propane/butane capable of causing catastrophic damage and injury are their physical and chemical properties. We have discussed most of these properties already; in fact, the very characteristics that account for the prominence of LPG products in the marketplace are those that also account for their hazards.

As mentioned before propane and butane have boiling points that are below normal atmospheric temperatures, and are thus maintained in their liquid states at ambient temperatures in the atmospheric range under pressure.

When introduced into the atmosphere (from a leak, for example) normally propane will boil instantly, as will butane.

Both of these products expand in volume many times when they are transformed from their liquid to their gaseous states: Propane occupies about 270 times as much volume as a gas as it does as a liquid; butane about 234 times as much. This characteristic, which accounts for the economic advantages of these products, can also be a source of hazard if they are released into the atmosphere under uncontrolled conditions.

Since leaking LPG liquid will boil in the immediate vicinity of the leak, it will have a refrigerant effect on the surrounding air and anything else it comes in contact with. As a result, boiling LPG liquid can cause burns upon contact with the skin or eyes. For this reason, all personnel handling the product wear protective goggles and gauntlet-style gloves during LPG transfers.

Both propane and butane are heavier than air. This means that the vapor will tend to sink to low-lying areas on the ground and concentrate there, especially if there is no breeze to promote dissipation of the gas. It is for this reason that LPG tanks or cylinders should never be placed next to a basement window, and LPG installations should not be located on low-lying ground.

It is also for this reason that, as a rule, a burning jet of LPG vapor (as might result from a leak or from a popping relief valve) should not be extinguished until the source of the leak can be stopped: if the flame is allowed to burn it will consume the vapor as it is emitted; if it is extinguished, the escaping vapor may collect in much larger and more dangerous concentrations elsewhere.

In its natural state, LPG is odorless. However, for safety reasons, an odorant (such as ethyl mercaptan) is added to LPG used as a heating fuel or for engine fuel so that its presence can be detected by this distinctive smell.

Because LPG is stored under pressure and because it expands in volume so rapidly upon vaporization, any significant release of these products is likely to produce relatively high concentrations of flammable gas. Furthermore, the release may be rapid and initially difficult to control. However, in most cases, the combustion speed of LPG is much lesser than the exhaustion speed from a gas container. Therefore, an explosive retrogress of flames into the gas container is seldom to be expected.

Of course, the most dangerous situation that can arise is one in which the storage container ruptures, resulting in an explosive release of vapor. There is very little chance of this happening spontaneously because state-of-the-art LPG storage tanks are designed to maintain their structural integrity at internal pressures that are 7 or 8 times normal operating pressures and 4 times those pressures that would cause the tank pressure relief valves to open.

Conditions that threaten the structural integrity of the system usually result from prolonged exposure of the container to direct flame impingement upon the vapor space of the tank shell. However, such failure

of the tank shell will not result from simple exposure of the tank to fire. This fact can best be illustrated by taking into account what happens inside a storage tank when it is exposed to fire.

A fire, whether from leaking product that has ignited or from some other burning material, is most likely to occur around the lower region of the storage tank, and its heat will therefore be transferred most directly to the portion of the tank that contains liquid product. As long as product remains enclosed within the system there is no possibility of ignition, since there will be no oxygen in the tank to produce a flammable mixture. However, as the heat of the fire is conducted through the container wall to the liquid product, it will quickly elevate the temperature of the liquid.

As the temperature of the liquid rises, some of it will vaporize, increasing the pressure inside the tank. Eventually, the pressure in the tank will reach a point that could threaten the integrity of the tank. To prevent such a point from being reached, the system is equipped with one or more pressure relief valves, which are designed to open when the internal pressure of the container reaches a predetermined level, resulting in a controlled venting of product vapor to the atmosphere and relieving pressure inside the tank. This venting may itself pose some hazard, but this will be minimal in comparison to the hazard that would result from rupture of the container.

The valves are designed to close automatically as soon as the pressure in the tank is reduced to a reasonable level. The valves will open again if necessary to prevent the build-up of excessive pressure in the tank.

On rare occasions, tanks have been known to rupture violently because of concentrated flame impingement on the vapor space of the tank. Since there is no liquid phase in the immediate area of the flame impingement to cool the exposed metal, the temperature of the tank will increase rapidly in a comparatively small area, resulting in a weak spot in the tank shell, which ultimately becomes the point of initiation of failure of the shell.

In the unlikely event that a tank does rupture, anyone in the area surrounding the ruptured tank, even those wearing protective clothing, would be in danger. Consequently, if there is any indication that a tank is about to rupture with the potential of a BLEVE, the area should be cleared immediately.

3.2 BLEVE

LPG containers that are subjected to fire of sufficient duration and intensity can result in a BLEVE. **BLEVE** is an acronym for "**boiling liquid expanding vapour explosion**".

This is typically a concern for large refineries and petrochemical plants that maintain very large containers. The remedy is to equip such containers with a measure to provide a fire-resistance rating. If the containers are cylindrical and horizontal, they are referred to as "cigars", whereas circular ones are "spheres". Large, spherical LPG containers may have up to a 15 cm steel wall thickness. Ordinarily, they are equipped with an approved pressure relief valve on the top, in the centre.

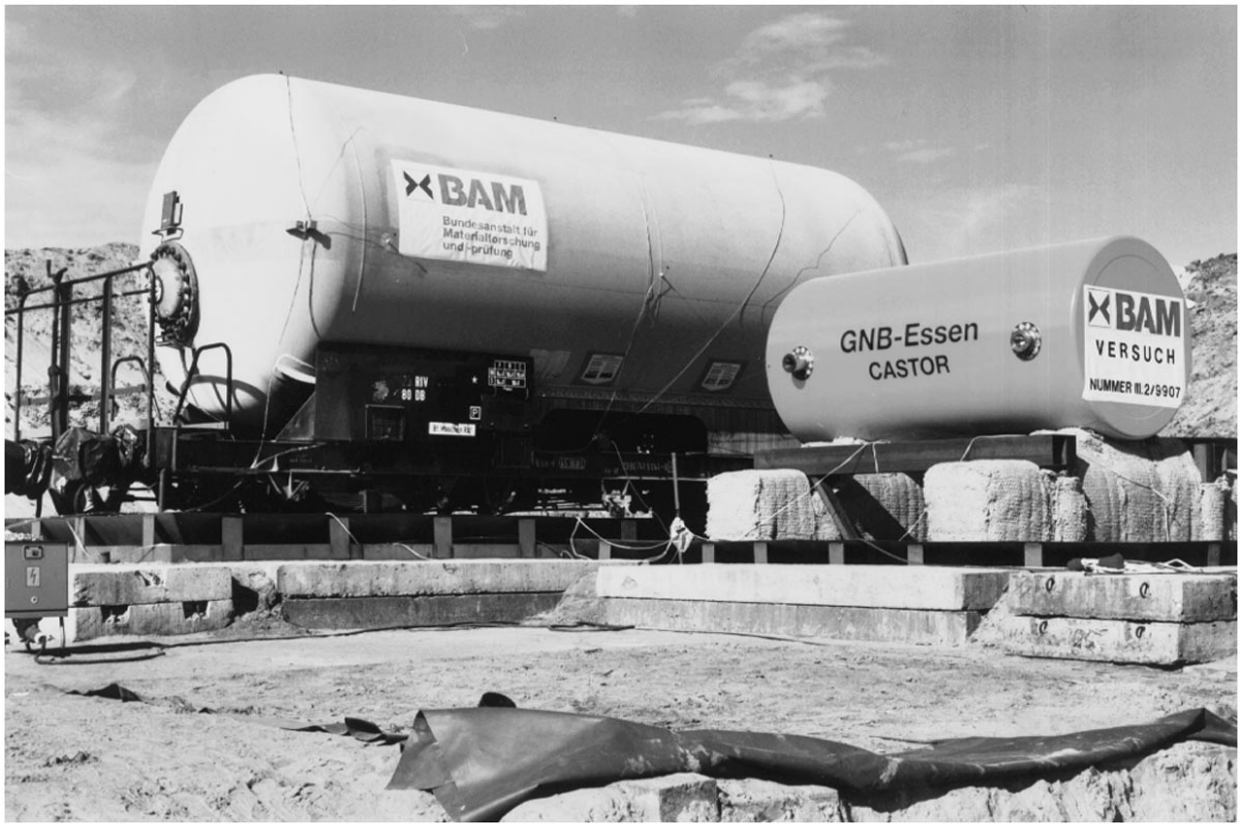
One of the main dangers is that accidental spills of hydrocarbons may ignite and heat an LPG container, which increases its temperature and pressure, following the basic gas laws. The relief valve on the top is designed to vent off excess pressure in order to prevent the rupture of the tank itself. Given a fire of sufficient duration and intensity, the pressure being generated by the boiling and expanding gas can exceed the ability of the valve to vent the excess. When that occurs, an overexposed tank may rupture violently, launching pieces at high velocity, while the released products can ignite as well, potentially causing catastrophic damage to anything nearby, including other tanks. In the case of "cigars", a midway rupture may send two "rockets" going off each way, with plenty of fuel in each to propel each segment at high speed until the fuel is spent.

If a tank is ruptured the vapor portion may rapidly leak, dropping the pressure inside the container and releasing a wave of overpressure from the point of rupture. This sudden drop in pressure inside the container causes violent boiling of the liquid, which rapidly liberates large amounts of vapour in the process. The pressure of this vapor can be extremely high, causing a second, much more significant

wave of overpressure (i.e., a BLEVE forming a fireball and a gas-air explosion) which may completely destroy the storage tank and project it as shrapnels over the surrounding area.

In analyzing a BLEVE the only realistic exposure of a small fireproof LPG tank was done at the Braunschweig test facility of "BAM", the German Agency for Materials Testing and Materials Research (BAM, Berlin). In an outdoor-test a railway tank-wagon containing around 10 m^3 Propane was broiled by a fuel oil fire.

Picture 3.1 LPG rail tank car before the test.



Within 2 minutes of fire exposure the pressure in the tank-wagon started to increase. After 15 minutes when the pressure arrived at about 25 bar, the tank wagon exploded in a BLEVE. The parts of the tank which collapsed first had at the time of explosion a temperature of about 500° C.[3]

[3] see „Untersuchung der Versagensgrenzen eines mit Flüssiggas gefüllten Eisenbahnkesselwagens bei Unterfeuerung“ Abschlußbericht, BAM – Bundesanstalt für Materialforschung und –prüfung, Berlin September 1999. Ch. 6.3/6.4. Supplementary information is given in the TNO-Report for the ECE-TC Economic Council for Europe – Inland Transport Committee, Working Paper on the Transport of Dangerous Goods (WP.15) “Reduction of the Risk for a BLEVE” INF.3, December 2005

Picture 3.2 LPG rail tank car after the test.

Felix K. Gmünder et al. underline these accident scenarios in their paper „The Control of Major Chemical Hazards in Switzerland in the Framework of Sustainable Development – Liquefied Petroleum Gas, Ammonia and Chlorine as Examples" (Switzerland, 1994)

3.3 Mitigation Measures

Mitigation measures include separating LPG tanks from potential sources of fire. In the case of rail transport, for instance, LPG tanks can be staggered, so that other goods are put in between them. This is not always done, but it does represent a low-cost remedy to the problem. LPG rail wagons are easy to spot from the relief valves on top, typically with railings all around.

In the case of new LPG containers installed on-site, one may simply bury them, only leaving valves and armatures exposed, for easy maintenance. Great care must be taken there though, as mechanical damage has been known to occur to the primers, which has resulted in hazardous corrosion of the containers. For the buried container, only the exposed parts need to be treated with approved fireproofing materials, such as intumescent and or endothermic coatings, or even fireproofing plasters. The rest are amply protected by soil. Special removable covers exist for easy access to the dials and components that must be accessed for proper maintenance and operation of the equipment.

As indicated earlier, the primary hazard of LPG is from fire. Both propane and butane may be ignited relatively easily by flame, spark, or static discharge. Ignition of propane or butane clouds frequently results in damage very similar to an explosion, especially if the vapour was in a confined space. Secondary ignition is a potential hazard if the fire is extinguished before the fuel supply can be shut off. As mentioned above, flame impingement on the tank (especially on the vapor space) also poses a very serious situation.

A cardinal rule of fighting LPG fires is to place first priority on cooling the tank (and piping, if appropriate) to reduce the build-up of internal pressure. The fire itself should be extinguished only if the source of fuel can be controlled. If the fire is extinguished before the source of fuel is controlled, re-ignition can occur, often with more serious consequences than would have happened with the original fire. Failure to observe this practice has been the cause of serious accidents which otherwise could have been avoided.

Combustion of propane or butane requires air (oxygen), but both of these products have rather narrow limits of flammability in air. For example, Propane has a narrow range of flammability when compared with other petroleum products. In order to ignite, the propane/air mix must contain from 2.2 to 9.6 percent propane vapor. If the mixture contains less than 2.2 percent gas, it is too lean to burn. If it contains more than 9.6 percent, it is too rich to burn. The limits of flammability for butane in air are even narrower (1.9 percent and 8.6 percent). This property contributes to the safety of LPG products since a combustible concentration of gas in air is relatively difficult to produce or maintain unless it is artificially controlled. On the other hand, any unintentional release should be treated as a potentially dangerous situation, as a concentration of flammability can be reached also far away from the original evaporation site.

Risk analysis for the most credible accidents has been carried out for a LPG pipeline project in India, and it was found that the impact area would be confined to less than 200 m from the pipeline. This means the distance from the pipeline at different sections wherein the LPG concentration is high (low flame level) enough to ignite.[4]

If LPG is released from a pressurized pipeline, a substantial fraction of it flashes to vapour almost instantaneously. This rapid evaporation entrains much of the remaining liquid into the air as fine droplets. Consequently, a release from a pressurized containment is assumed to convert immediately and totally to the vapour phase, commonly called the aerosol cloud. A considerable amount of air mixes with the LPG vapour during evaporation, depending on the precise conditions of release, and the cloud will travel under the influence of wind and gravity. As the cloud travels it is further diluted. The flammable cloud formed by the escaping LPG vapour is denser than air and generally forms a thin layer on the ground.

[4] see Environmental Impact Assessment LPG Pipeline Project in India; May 1997

This cloud flows into depressions and trenches and can travel considerable distances. Even low wind speed in the area can move the cloud downwind and gradually dilutes it.

Three major types of combustion have been recognized.

The first type is called the jet flame. A jet flame has a very limited impact area, normally within the plant boundary. Its main impact is weakening of surrounding structures, which may cause ruptures and further release of LPG.

The second type is known as pool fire, characterized by a long and smoky flame. The wind may blow the flame towards the ground, causing secondary fires. The radiation intensity may be very high around the flame, but it drops rapidly such that at distances of 3-5 times the diameter of the flame the radiation intensity is tolerable to fire-fighters. Damage due to pool flames is more intensive than that caused by jet flames, but is limited to the immediate vicinity of the take-off or dispatch station.

The third flame type is the cloud vapour flame, which may sustain propagating fires when ignited. In certain cases the flame may spread rapidly through the cloud from the point of ignition. Radiation intensity could be high, and if the flame travels fast enough, overpressure or blast effects will be created that can cause damage at considerable distances from the source of release. Most of the severe accidents in LPG installations have been caused by unconfined vapour cloud explosion. If released LPG is unignited, it causes very little damage aside from possible asphyxiation at very high concentration in the immediate vicinity of release.

3.4 Sample of Accidents

A review of the accidents involving LPG clearly indicates that there is no significant extraordinary risk for LPG. Most of the accidents occur during the last step of distribution by tank-truck and wagon or in the consumers' storage area. Special studies like Peter Burger et. al. „Severe Accidents in Fossil Energy Chains: Individual Chain Results and Aggregated Evaluations", Villigen, Switzerland, are to be mentioned here. However, it must be stated that no comprehensive analyses are published on LPG accidents or similar events worldwide.

During the preparation of this working paper a freight train accident resulting in leakage of chloroacetic acid occurred near Hamburg, Germany on 22 January 2007. It is pointed out here, because this accident shows quite simply and transparently what can occur in a 'conventional' accident case scenario. During the railway journey from Denmark to Italy one of two heavy steel coils loaded on the first wagon behind the locomotive found its way through the wagon platform to the rail basement causing the derailment of the following 19 wagons. Due to the noxious acid fumes leaking from one of the wagons recovery workers kept a 100-meter distance from the site of the accident. The line was interrupted several days, but fortunately, an explosion has not taken place like in another accident ten years ago.

On 1 June 1996, 12 of 18 tank wagons loaded with vinyl chloride on the way from Belgium to Germany derailed near Magdeburg. One of these wagons while touching the electrical grid was immediately inflamed. Four other wagons were disrupted and started to burn, too. The explosion of the gas caused fire in parts of a nearby machinery plant. In the run of the explosion the platform of wagon 16 was pitch forked across a distance of 55 meters. The mushroom cloud elevated to a height of 800 m above ground.

In both cases trans-boundary shipments took place. For such circumstances, unified safety standards have been specially fixed in the so-called RID Cargo Treaty of 1989 signed by various European railway companies. However, paper doesn't blush. For example, if no heat protective plates for sun protection are installed the minimum pressure in a tank wagon must be 11 bar or above, with appropriate installations at least 10 bar. In the case of the Magdeburg accident no such installations were given. However, the pressure in most wagons was just 9.8 to 10.0 bar. This fact was not supposed to have caused or contributed to the accident, but it shows that enforcement and control of rules is not easy in Western Europe, too.

Fire involving gas is usually burned under fire brigade supervision with cooling of parts and areas by lots of water. In spring 1996, 37 of 81 wagons of a freight train derailed at the village of Weyauwega, Wisconsin, USA. One of 15 wagons containing LPG exploded and three others were inflamed. The fire brigade evacuated the municipality of 1,700 inhabitants and the wagons burned-out under control. Only when there is absolute safety that no additional gas can emit and explode the gas flame is allowed to be extinguished. As a secure method to extinguish gas fires the involvement of nitrogen through pipes into the containers or by bypasses in pipelines is to be considered.

On 24 February 1978, a LPG tank wagon was igniting with explosive force in Waverly, Tennessee, USA. The cause was a crack causing from a derailment which actually happened two days earlier. As a result, 16 persons died and 43 were injured. 18 buildings and 26 motor vehicles were destroyed.

On 24 August 1996 an 8-inch-diameter LPG pipeline transporting liquid butane ruptured near Lively, Texas, sending a butane vapour cloud into a surrounding residential area. The butane vapour ignited as two residents in a pickup truck drove into the vapour cloud. The two people died at the accident site from thermal injuries. The US National Transportation Safety Board determined that the probable cause of this accident was the failure of the private pipeline operator to adequately protect its pipeline from corrosion. A second major safety issue identified by this investigation was the effectiveness of a public education and awareness building programme, particularly with respect to educating residents near the pipeline about recognizing hazards and responding appropriately during the pipeline leak.[5]

An explosion in a shopping mall in San Juan, Puerto Rico, took place on 21 November 1996 causing the death of 33 people. After intensive investigations it was found out, that the BLEVE was caused by propane from a leakage in a dead end of a municipality distribution pipeline system. The propane found its way through the soil floating water-like to the deepest point in the area a street-complex away from the leakage – the basement floor of the shopping mall.

Picture 3.3 Propane rail tank wagon derailment and explosions near Oneida, USA, March 2007

On 12 March 2007 a freight train traveling from Buffalo to Selkirk (USA) was carrying liquid propane and other chemicals through Oneida when 28 of its 80 cars derailed. The derailment sent a huge fireball into the sky, causing propane tankers to burn throughout the morning and forcing people to evacuate their homes. No personal injuries have been reported. Oneida Fire Chief Don Hudson said that two cars

[5] see NTSB Pipeline Accident Summary Report, PB98-918503; Washington 1998

containing liquid propane exploded and burned out while two other tankers of liquid petroleum and a fifth rail car with the solvent toluene burned. Officials declared a state of emergency for a half-mile area around the accident, which was expected to affect eight homes. Officials also evacuated various areas a mile around the accident, including most of downtown Oneida, which has a population of 10,000. The story also detailed that up to 4,000 people live in the affected area and that evacuation was mandatory only for those homes closest to the blast. Around 100 people reported to a local shelter while local jail officials had to move 78 prisoners to a jail in nearby Chenango County. Four firefighters were exposed to liquid chloride and had to be decontaminated before going back to fight the blaze.

According to SIGTTO, the international gas-trade organisation, there has never been an explosion of a gas cargo as a result of fire aboard a ship. According to this source, LPG has a spotless record of non-explosiveness at sea. One illustrative example given is the case of LPG tanker 'Gaz Fountain' carrying 16,725 tons of liquefied gas when it was hit with three rockets in the Persian Gulf during the Iraq-Iran war. A large hole was blown directly in one of its cargo tanks. The propane in that tank caught fire, but the crew got off the ship without injury or loss of life. A tug arrived and extinguished the fire. The rest of the propane aboard was transferred to another vessel and the tanker was later repaired.[6]

Table 3.1 Accident ratios for ships

Ship type	**Number of ships** (2000)	**Serious accidents** (1978-2000)	**Frequency** (incidents/ship year)
LPG tankers	982	20	0.00091
LNG tankers	121	1	0.00037
Oil tankers	9678	314	0.00144
Cargo/bulk carries	21407	1203	0.00250

Table 3.1 Ship casualties, source Lloyds Maritime Information Service

[6] Portsmouth Herald 19.04.2002

4 Safety Considerations for the Different Transport Modes

4.1 General Remarks

Whereas the history of large scale LPG consumption is rather short (see Working Paper 1) other flammable gases, e.g. LNG = Liquified Natural Gas, are used for decades in large quantities worldwide.

Therefore, in most regions and countries substantial technical and legal rules and regulations were elaborated, in which the proper handling of such gases is fixed. In addition, appropriate transport of LPG and similar gases is regulated by the „UN-Recommendations on the Transport of Dangerous Goods“ as well as in the special regulations concerning maritime transport as stated in the IMDG Code and SOLAS (International Convention for the Safety of Life at Sea) Regulations.

The IMDG Code was developed as a uniform international code for the transport of dangerous goods by sea covering such matters as packing, marking, labelling and stowage of dangerous goods with particular reference to the segregation of incompatible substances.

The Code operated as a recommendatory instrument since its adoption at International Maritime Organization (IMO) in 1965. It has undergone many changes both in appearance and content to keep pace with the ever-changing needs of the industry. Amendments to the Code originate from two sources: proposals submitted directly to IMO by Member States; and amendments required taking account of changes to the United Nations Recommendations on the Transport of Dangerous Goods which set the requirement for all transport modes and referred to as the Orange Book. Amendments to this book are made on a two yearly cycle. These amendments are adopted by various competent authorities to ensure that difficulties are not encountered at inter modal interfaces Amendments to the provisions of the United Nations Recommendations are made on a two yearly cycle, and, approximately two years after their adoption, they are adopted by authorities responsible for regulating the various transport modes in various countries. In that way, a basic set of requirements applicable to all modes of transport is established and implemented, thus ensuring that difficulties are not encountered at inter modal interfaces.

Amendments to SOLAS Chapter VII to make the IMDG Code mandatory from 1st January 2004 were adopted in 2002 through IMO Resolution MSC 123(75) and MSC 122(75).

In addition to these international bodies, major players in energy business, trans-national enterprises as well as pressure groups, have published voluminous manuals and guidelines on safety matters and handling procedures of gases generally and, in particular, of LPG. Only to mention here the volume „LP Gas Safety – Guidelines for Good Safety Practice in the LP Gas Industry“ edited by „The World LPG Association“ in cooperation with UNEP, the „United Nations Environment Programme“.

Technical Specifications on handling principles of individual substances, materials, properties are enforced on a national and partly on an international scale

Final objective of all these LPG related regulations can be described as follows:

1. LPG is to be contained in a manner which prevents unintentional/unchecked emissions during intended operations,
2. to prevent emissions in the case of an accident as far as possible
3. to hinder unperceived agglomeration of LPG – Gas, and
4. to eliminate any sources of ignition.

Hereby, the safety of operating personnel as well as the public should be raised to the highest degree.

Nevertheless, it remains task of public safety authorities as well as rescue services to be informed on the risks and dangers of LPG and related gases and to make appropriate provisions for any failure or hazardous incident. Such involvement should not be confined to efficient disaster control and emergency response planning but should start as early as in the planning phase of storage or distribution facilities, and the designing of tracks, terminals and pipelines. In this context the „OECD Guiding Principles for Chemical Accident Prevention, Preparedness and Response“, OECD, Paris 2003 can be mentioned as a valuable source.

4.2 Road

According to the UN model regulations, the ADR is responsible for the road haulage in Europe and its bordering states. It particularly describes the LPG transportation requirements for packaging, containers, tank containers and tank trucks.

As a result of the biennial cycle of the regulation developments, both, technical innovations and knowledge from damaging events are adopted in the body of rules and regulations.

Beside the technical specifications, the ADR also sets requirements for the transport vehicle (trailer, truck, etc.), the qualification of the driver and the conditions of the transportation.

The national authorities shall determine organizational measures, which have a regulating influence on the transport, e.g. specific requirements of route of transports or a negative list of prohibited routes.

The biggest risk of an accident with LPG on the road is caused by two factors:

a. inappropriate operation of the technical facilities / human failure
b. a traffic accident of a tank truck or a trailer truck with tank container, resulting in a damage of the tank and /or its armature and a leakage.

In both cases, fire can occur.

Otherwise, an uncontrolled gas phase dispersion (e.g. via the sewage system, downhill territory or the like) and an accumulation in lower situated areas is possible. A subsequent ignition of the gas phase could occur.

As far as the ADR is not applied in all the Traceca beneficiary states, it should be the common aim to introduce it swiftly. Only the application of international regulations, based on the UN-regulations, can guarantee a smooth transportation between producers and consumers on a trans-national basis.

Table 4.1 *Adherence to ADR Convention*

Country	Convention on Transport of Dangerous Goods by Road (ADR)
Azerbaijan	Party State
Georgia	No Party State
Kazakhstan	Party State
Turkmenistan	No Party State
Ukraine	Party State

as of 31 December 2006

4.3 Rail

The situation of tank car transport on rail is similar to the situation of road haulage which can best be reflected by the more and more integrated regulations on the National and International Carriage of Dangerous Goods by Road and Rail as planned or adopted in several EU countries. In 2006, the European Commission has published an open consultation on the revision of Community legislation on the Inland transport of dangerous goods. The purpose is to merge the current rules on dangerous goods transport by road and rail into one piece of Community legislation and to extend Community legislation in order to include the international rules on dangerous goods transport by inland waterways (so called ADN), which are also based on the United Nations model. The Commission believes that such extension would be a logical supplement to Community legislation, in order to create a set of uniformly applied rules for all inland transport modes in the territory of the European Union.

For rail transport in the international context, the Regulation concerning the International Carriage of Dangerous Goods by Rail (RID - Appendix C to the Convention concerning International Carriage by Rail (COTIF) of 9 May 1980 in the version of the Protocol of Modification of 3 June 1999) applies.

However, for accident scenarios the attention shall be turned to the rail system with its tracks and the traffic control. Railway accidents are often the result of derailing. On the one hand, technical defects, often related to by insufficient maintenance (e.g. of wagon brakes or of the tracks and switches), are the cause of the derailing. On the other hand, human error by railway control staff or technical problems with the signal system may lead to train collisions which otherwise would not occur.

Even collisions at small speed can result in derailments or deformation of the wagons. Standard railcar crash buffers can only absorb the energy of 70 kJ, just enough for a shunting process of 12-15 km/h. This is neither enough to protect sensible cargo during shunting nor in the case of accidents caused by derailments and the parallel stacking of wagons. Especially for tank wagons newly developed crash buffers (e.g. EST G1-200M/K) can absorb 10-20times the energy of conventional ones. This allows for a braking speed of about 30 km/h. These crash absorption capacities were enforced for tank wagons in European legislation (RID) for toxic substances as of 1.1.2005 and for inflammables in beginning of 2007 (see New European Standard EN 15561 for buffer and crash buffer, draft version, implemented in 2007).

4.4 Ship (Ferry, Tanker)

The SOLAS Chapter VII requires carriage of dangerous goods to be in compliance with the relevant provisions of the International Maritime Dangerous Goods Code (IMDG Code). The IMDG Code was first adopted by IMO in 1965 and has been kept up to date by regular amendments, including those needed to keep it in line with United Nations Recommendations on the Transport of Dangerous Goods which sets the basic requirements for all the transport modes.

4.4.1 Ferry

SOLAS VII, Part A - Carriage of dangerous goods in packaged form - includes provisions for the classification, packing, marking, labelling and placarding, documentation and stowage of dangerous goods. Contracting Governments are required to issue instructions at the national level and the Chapter makes mandatory the International Maritime Dangerous Goods (IMDG) Code, developed by IMO, which is constantly updated to accommodate new dangerous goods and to supplement or revise existing provisions.

Transport safety and security on the ferry is related to the state and conditions of the actual transport means as well as with the vessel installations.

The tank cars, road tank vehicles, trailers and trucks with tank containers transported by ferry must correspond to the local road and rail transportation standards.

The suitability of the vessel / the ferry is fundamentally determined by a testing (“certificate”) carried out by external analytic expertise in consideration of the international regulations for vessels of the International Maritime Organisation (IMO). Moreover, the capability of transport of dangerous cargo is also regulated in this certificate.[7]

In case of Ro-Ro transport, the IMDG-Code puts up additional requirements considering the danger in regard to:

a. Prevention of gas accumulation and its uncontrollable diffusion
b. Absence of possible ignition sources
c. Prevention of trespassing

In this context, the IMDG-Code, Amendment No. 32 is quoted below in some detail:

7.4.5 Stowage of cargo transport units in Ro-Ro cargo spaces

7.4.5.1 Loading and unloading operations on each vehicle deck shall take place under the supervision of either a working party consisting of officers and other crew members or responsible persons appointed by the master.

7.4.5.2 Passengers and other unauthorized persons shall be excluded from vehicle decks on which dangerous goods have been loaded. All doors leading directly to these decks shall be securely closed during the voyage and notices or signs prohibiting entrance to such decks shall be conspicuously displayed.

[7] see Hughes, J.R. Storage and Handling of Petroleum Liquids, 3rd rev. edition, London 1987 Ch. 9: Liquefied Petroleum Gases; Emergency action in the event of leakages of LPG from containers, pp.318

7.4.5.3 During the voyage, access to such decks by passengers and other unauthorized persons shall only be permitted when such persons are accompanied by an authorized crew member.

7.4.5.4 The transport of dangerous goods shall be prohibited on any vehicle deck on which the foregoing provisions cannot be met.

7.4.5.5 Closing arrangements for the openings between Ro-Ro cargo spaces and machinery and accommodation spaces shall be such as to avoid the possibility of dangerous vapours and liquids entering such spaces. Such openings shall normally be kept securely closed when dangerous cargo is on board, except to permit access by authorized persons or for emergency use.

7.4.5.6 Ro-Ro ships may carry dangerous goods in cargo transport units or stowed in the conventional way on vehicle decks, in cargo holds or on weather decks. The provisions for such stowage shall be in compliance with the relevant provisions laid down elsewhere in this Code.

7.4.5.7 Dangerous goods required to be carried out *on deck* shall not be carried on closed vehicle decks, but may be carried on open vehicle decks when authorized by the competent authority concerned.

7.4.5.8 Flammable gases or liquids having a flashpoint of 23°C c.c. or less shall not be stowed in a closed Ro-Ro space or special category unless:

- the design, construction and equipment of the space comply with the provisions of regulation II-2/19 of SOLAS 74, as amended, or regulation II-2/54 of SOLAS 74, as amended by the resolutions indicated in II-2/1.2.1, as applicable, and the ventilation system is operated to maintain at least six air changes per hour; or
- the ventilation system of the space is operated to maintain at least ten air changes per hour and non-certified safe electrical systems in the space are capable of being isolated by means other than removal of fuses in the event of failure of the ventilation system or any other circumstance likely to cause accumulation of flammable vapours.

Otherwise stowage is restricted to *on deck* only.

7.4.5.9 The provisions in this paragraph are without prejudice to relevant ventilation requirements of SOLAS 74, as amended.

In stowage conditions defined in 7.1.1, if continuous ventilation is impracticable in a closed Ro-Ro cargo space other than a special category space, ventilation fans shall be operated daily for a limited period, as weather permits. In any case, prior to discharge, the fans shall be operated for a reasonable period. The Ro-Ro cargo space shall be proved gas-free at the end of the period. When the ventilation is not continuous, electrical systems which are not certified safe shall be isolated.

7.4.5.10 Certain dangerous goods are required “to be stowed in a mechanically ventilated space”. When such goods are transported in a closed Ro-Ro cargo space or a special category space, this space shall be mechanically ventilated.

7.4.5.11 Cargo transport units packed or loaded with flammable gases or liquids having a flashpoint of 23°C c.c. or less and transported on deck shall be stowed “away from” (as defined in 7.2.2.2.1.1) possible sources of ignition.

7.4.5.12 Mechanically operated refrigeration or heating equipment fitted to any cargo transport unit shall not be operated during the voyage when stowed in a closed Ro-Ro cargo space or a special category space.

7.4.5.13 Electrically operated refrigeration or heating equipment fitted to any cargo transport unit stowed in a closed ro-ro cargo space or special category space shall not be operated when flammable gases or liquids having a flashpoint of 23°C c.c. or less may be present in the cargo transport unit or in the same space, unless:

- the design, construction and equipment of the space comply with the provisions of regulation II-2/19 of SOLAS 1974, as amended, and the refrigeration or heating equipment of the cargo transport unit complies with paragraph 7.7.3; or
- the ventilation system of the space is operated to maintain at least ten air changes per hour and all electrical systems in the space are capable of being isolated by means other than removal of fuses in the event of ventilation failure or other circumstance likely to cause accumulation of flammable vapours.

7.4.5.14 Stowage of portable tanks, road tank vehicles and railway tank wagons containing dangerous goods shall be in accordance with the provisions of the Dangerous Goods List and chapter 7.1

7.4.5.15 The master of a ship carrying dangerous goods on vehicle decks shall ensure that, during loading and unloading operations and during the voyage, regular inspections of these decks are made by an authorized crew member or responsible person in order to achieve early detection of any hazard."

Considering the safe loading and unloading of a ferry, the **Guidelines for Packaging of Cargo Transport Units (CTU)** are to be taken into consideration, too.

4.4.2 Tanker

For the design of hull and tank structure of liquid gas transport ships, such as LPG carriers, the International Maritime Organization adopted the International Gas Carrier Code in order to prevent the significant secondary damage from accidental damage to ships. Tankers can be seen to have higher standards than ships in general and high standards of construction and operation are applied to LPG tankers, in particular. There are three types of tank structure for liquid gas transport ships: pressure type, low temperature type and semi-refrigerated type.

The pressure type is designed to prevent the cargo gas from boiling under ambient air conditions. On the other hand, the low temperature type is designed to operate at a sufficiently low temperature to keep cargo gas as a liquid under the atmospheric pressure. Most small gas carriers are pressure type, and large LPG (and LNG) carriers are of the low temperature type. The low temperature type is suitable for mass transport because the tank size restriction is not severe.[8]

In addition to general ship certificates (see IMO FAL/Circ.90;MEPC/Circ.368;MSC/Circ.946; 3 July 2000) any gas carrier shall carry a **Certificate of Fitness for the Carriage of Liquefied Gases in Bulk** (according to model form of which is set out in the appendix to the IMO Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk" amended 23 May 1994 [MSC 34(63)]; 05 December 1996 [MSC 60(67)]; 05 December 2000 [MSC 107(73)]) to be issued after an initial or periodical survey to a gas carrier which complies with the relevant requirements of the Code;

or an **International Certificate of Fitness for the Carriage of Liquefied Gases in Bulk** (according to the model form set out in the appendix to the IMO "International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk" of 17 June 1983 " [MSC 5 (48)] amended 24 May 1990 [MSC 17(58)]; 11 December 1992 [MSC 30(61)]; 23 May 1994 [MSC 32(63)]; 05 December 1996 [MSC 59(67)]; 05 December 2000 [MSC 103(73)]) to be issued after an initial or periodical survey to a gas carrier which complies with the relevant requirements of the Code. **Note:** The International Code is mandatory under chapter VII of SOLAS 1974 for gas carriers constructed on or after 1 July 1986.

Also the following international standards must be considered

[8] for further details see also the presentation on "LPG Tank Ships and Terminals – Safety in General and Safe Cargo Operations", Project Workshop in Hamburg 29/03/2007

IMO Model Course 1.06 - Training for Liquefied Gas Tankers
ICS Tanker Safety Guide (Liquefied Gas)
SIGTTO Liquefied Gas Handling Principles on Ships and in Terminals.

The positive enforcement of these standards on a global scale can best be reflected by the extraordinary safety records (see Table 4.2).

Table 4.2 *Statistics of Serious Vessel Incidents (depending on the ship type)*

Ship type	Number of ships (2000)	serious incidents (1978-2000)	Frequency (incidents/ship/ year)
LPG tankers	982	20	0.00091
LNG tankers	121	1	0.00037
Oil tankers	9678	314	0.00144
Cargo/bulk carriers	21407	1203	0.00250

Source: IPCC Special Report on Carbon dioxide Capture and Storage

For basic requirements for LPG transport by tanker see Annex 3; esp. Part C - Bulk Liquefied Gases reflecting 'Ship/Shore Safety Checklist" published by International Chamber of Shipping, Oil Companies International Marine Forum; International Association of Ports and Harbours; "International Safety Guide for Oil Tankers and Terminal"; 4th edition; London 1996 (Appendix A).

4.5 Pipeline

In contrast to the other means of LPG transport described above, pipelines are a somewhat "immobile" transport system. Therefore, risks considering pipelines follow other criteria.

A pipeline is generally laid deep in the ground. In this case, the following problems can be avoided from the start:
1. mechanical damages of every kind (rockfall, vehicle collisions, etc.)
2. effect of fire and extreme climatic changes
3. sabotage

From a spatial view, focus must be laid on the following criteria, among others:
4. soil conditions and geology (mechanical pressure on the pipeline)
5. distance to built-up areas and areas with special protection requirements
6. areas with mechanical ground treatment (agriculture, mining area)

With the laying of longer pipeline installations, the following must be considered in particular:
7. design according to the expected operating conditions (pressure, temperature, expansion)
8. selection of the right material
9. resistance to the transported material
10. resistance to external corrosion
11. quality proof of pipeline design.

Particular attention is generally paid to the over-ground technical installations. These are equipped as technical facilities (compressor, pumps, valves) with mechanical and electrical elements which again bear the risk of a defect. Additionally, the pipelines in these segments without soil coverage are exposed to the first three situations described above. Therefore, components in these segments shall meet similar requirements as installations regarding storage and turnover.

Pipelines can be laid underground for hundreds of kilometres. In remote areas an operability check is hard to perform. Nevertheless, a supervision and inspection system must be established which reliably recognizes damages, particularly corrosion, and at the same time minimizes the effect of leakages. For this, it is particularly necessary to divide the pipeline into safety sections, which can be fast and reliably sealed off in case of damage. An administration centre shall be able to supervise the operating condition

of the pipeline and to automatically monitor the safety sections. However, this does not replace a periodic physical supervision of the entire line in any way.

Excerpts from the German **"Technical Rules for Pipeline Installations"**, an exemplary regulation in this field, are given in Annex 2. These rules particularly compile the requirements for long-distance pipelines in Germany, for which special generally valid technical and legal requirements exist and which are not used for municipal gas supplies and include the relevant norms concerning the condition of the materials and component parts and their inspection and confirmation, like Technical Guideline for Inflammable Liquids "Guideline for Pipelines Transporting Inflammable Liquids, Technical Rules for Gas High Pressure Pipelines, Guideline for Pipelines Transporting Substances Hazardous to Water" and Administrative Regulations on the Oxygen Pipeline Ordinance of the Land of North-Rhine Westphalia .

4.6 Plants and Tank Farms

For safety reasons tank installations should be erected outdoors. Here, the following points must, among others, be observed, taking into account again the German rules:

1. Tank installations must be erected so that there is adequate air circulation around the tank (TRB 610 No. 3.2.1).
2. Tank installations must be erected so that access to them is assured (TRB 610 No. 3.2.1.2).
3. Tank installations may not be erected on pedestrian walkways or roads or near open-air installations (TRB 610 No. 3.2.1.3).
4. The ground area under the connections of tank installations with refrigerated liquid gases must consist of fire-resistant materials and be free of oil, grease and other combustible materials (TRB 610 No. 3.2.1.5).
5. There may not be any open ducts, duct inlets without liquid seals, openings to lower-lying rooms or air extraction openings 5 m around openings in tank installations for refrigerated liquefied gases (TRB 610 No. 3.2.3.1.1).
6. Tank installations must be protected against mechanical damage (TRB 610 No. 3.2.3.2).
7. Tank installations must be protected against fire (TRB 610 No. 3.2.3.3). This requirement can be realised with a safety distance, a protective wall, earth cover, fire protection insulation or sprinkler system.

The TRB numbers above correspond with the pattern requirements of German pressure vessel regulations and especially the Technical Rules for Pressure Vessels (TRB; esp. TRB 610 see BArbBl. 11/1995 p. 56; 2/1997 p. 51, 3/2000 p. 66; 1/2001 p. 73; 9/2002 p. 129), which are taken again as an example here. Further, storage of inflammable gases is subject to the German Federal Immissions Control Act upwards of certain quantities. Various accident prevention regulations (e.g. VBG 61 "Gases", VBG 15 "Welding and Cutting") must be observed as well for the construction, fitting and operation of equipment downstream of the tank installation (pipeline, control station, consumer).

4.7 EU SEVESO Directives

Major accidents in chemical industry have occurred world-wide. In Europe, following the Seveso accident in 1976 prompted the adoption of legislation aimed at the prevention and control of such accidents. In 1982, the first EU Directive 82/501/EEC – so-called Seveso Directive – was adopted. On 9 December 1996, the Seveso Directive was replaced by Council Directive 96/82/EC, so-called Seveso II Directive. This directive was extended by the Directive 2003/105/EC. The Seveso II Directive applies to some thousands of industrial establishments where dangerous substances are present in quantities exceeding the thresholds in the directive. Working paper 5 will look more to Seveso II Directive in detail, for instance to the corresponding safety plans and developing a safety policy in EU Member States with regard to dangerous goods.

5 Safety Situation for LPG Transport in TRACECA Countries

5.1 Safety Conditions (for Different Transport Modes)

5.1.1 Rail

Safety and environmental hazards of rail transport in the countries concerned are not particular issues at present. The railway operating procedures, from the safety aspect, have not been called into question, neither by TRACECA's railway's operating record nor by outside consultants.[9]

Rolling stock is regularly inspected and is not dispatched if it does not meet standards. Some border crossing delays arise because there is a transfer of responsibility for rolling stock at these points, and checks are carried out.

Speed restrictions are imposed if track use has exceeded quantitative thresholds without renewal. Most of the networks' maximum operating speeds are low compared to state-of-the-art railway potential.

Some investment in new inspection equipment was done in the past. It was also remarked that there has been a long period of under-investment in the CIS railways. Consequently many of the systems on which safety is dependent such as signalling, telecoms, and alarm circuitry are sometimes obsolete.

Just as the safety record has up until now not given cause for alarm, there is also no record of negative environmental impacts from rail transport. This is in spite of the fact that a high proportion of rail freight traffic is potentially dangerous. For example, typically 60% or more of tonnage carried by CIS railways is petroleum products.

Although safeties of persons and of the environment are not issues at present, there are increasing risks of future problems in certain areas due to a lack of investment. The number of wagons went down sharply. At the time of independence for instance the number of freight wagons in Kazakhstan was estimated at about 128 000. In 2001 the number was down to 86,000. Out of those at least 30% and probably much more are out-of-service.[10] The situation is not the same for each type of wagon. Shortage of tank wagons is more felt where the production of oil or petroleum products has increased. In countries where traffic began to pick up such as Kazakhstan the situation may soon become serious because few new wagons are purchased and overhauling old ones may not be enough. Therefore, in Kazakhstan private companies have started buying and operating wagons. Companies that are thinking now of buying wagons are large integrated mining and industrial groups that will use them for their own needs.

Ageing of the locomotive fleet does not imply a risk of shortage in the short-term, but the problem is rather obsolescence. Replacing old engines by more modern ones can not only extend locomotives life but also increase their availability. However, the situation is not the same in each country. It varies according to which was received from the old Soviet fleet and how the traffic changed in recent years. It is more serious in Turkmenistan that had a relatively smaller fleet. The replacement programme for diesel-electric locomotives under way in Kazakhstan is essentially to improve economic performances. It is planned to procure 150 locomotives between 2004 and 2009.[11] For example, the European Bank for Reconstruction and Development has extended loans to Kazakhstan (US$65 million) for the rehabilitation of railways on the basis of TRACECA projects, which have identified the condition of the rail systems in the Caucasus and Central Asia. Several small-scale investment projects were financed under the TRACECA Programme including the reconstruction of the rail ferry ramp in Aktau, Kazakhstan.

[9] see CAREC Harmonization and Simplification of Transport Agreements, Cross Border Documents and Transport Regulations 2005
[10] see Central Asia: Reassessment of the Regional Transport Sector Strategy Draft Strategy
[11] see Jenkins,I./ Pezant,P 2003 p. 16

The main railway link crossing the Caucasus seldom allows a top speed of 60 km/h. The average speed comes to 40-45 km/h with limits of 10 Km/h on single track bridges and repair lines with poor conditions (see WP III). Though it also happened in the past that the routes to Batumi were totally congested which would have a negative impact for any increase in LPG traffic, the opening of the Baku – Ceyhan pipeline has brought less oil transit by rail and opens possibilities for LPG RTCs due to open railway capacities.

At the borderline between Azerbaijanand Georgia the procedures are as follows: trains are arriving at the 'neutral zone', the locomotive is put on hold, its driver walks to the other side and exchanges documents (sometimes the procedure especially on return of empty RTC's is not fully transparent) and the locomotive from the other country is pulling the trains across the border. Current capacities are merely about 20 block trains per day.

Some improvement for this key linkage function can be expected in the near future. On 7 February 2007 after fourteen years of negotiations, Azerbaijan, Georgia and Turkey signed a framework agreement on the construction of the new Baku-Tbilisi-Kars railway line. Under this agreement, the existing railway connection between Baku and Tbilisi will be modernized, too. It includes the joint financed operations of the Georgian/Turkish Link with Gauge-changing site of track lines close to the Georgian Border. The village of Ninotsminda (close to Akhalkalaki) will direct the Railway line to Turkish Border and reach the Hub at City of Kars on Turkish Territory, just after changing gauge to Western Europe size. For Georgia it is just a transit–rail-function in favour to the agreement between Azerbaijan and Turkey. The re-financing for Georgia comes out of the revenues for the railway-distance on Georgian territory. The works on the Turkish part are expected to be launched in summer 2007 and it is assumed that the new railway link could be operational within 3 years. The anticipated capacity of the line is 20 million tonnes of cargo per year. [12]

Consequently, the Georgian Railway will invest in some parts of needed equipment, e.g. six new locomotives on long term planning, and maintenance of more than 50 old locomotives within the current years. Also around one third of their rolling stock is overaged and tank wagons should be renewed. Most of the tracklines inside Georgia have to be maintained and modernized (work has already started) and more than 80 % of the distance between Poti and Azeri Border is already dual line, except a small part between Poti and Zestafoni, which has only single trackline.

At present the Georgian Railway is using some own tank wagons for crude oil, but no RTCs for LPG. Most of the today's rolling stock for gas transport in the Caucasus is owned by the gas producing companies, some by lease companies and a very rare number is owned by foreign railway companies (i.e Turkmen, Kasakh, Ukrainian, Russian railways). Georgian Railways is expecting that if LPG business is increasing it will be dominantly driven by the same or similar companies being involved in the Oil business today.[13] Here, they have reliable safety records of maintenance, supply and storage contracts with the owners of lease companies for Tank Wagons with fixed rates for full and empty transportation. There are companies like EVA, Ermefer, VTG, Azpetrol, AE & E, BP and others in operation. These companies have left their equipment on the Transcaucasian Routes for several years, by a minimum operating time of one year.

With regard to dangerous goods and operating matters, the transport by rail of normal LPG products like Butane and Propane are not falling under special restrictions. LPG has already been transported by train from Turkmenbashi via Baku to Batumi and was after short intermediate storage at the Batumi Gas & Oil Terminal owned by the Greenoak company pumped into special tankers (2,000 cbm each). There are no limitation of LPG cargo amount per train, limits are given by the capacity of weight and length of the rolling stock involved, nothing else. By employing the latest edition of special Gas Wagons (100 cbm, by pressure up to 20 bar the cargo weight could be appr. 60 tons/Wagon that means for such train about 1,700 tons net cargo and appr. 900 tons of Wagon weight. In total such train could have gross weight (28 wagons) of 2.600 tons. With the right locomotives taken, no further limit to train length or total weight are given. In fact, LPG would be handled like the latest oil trains from Baku to Batumi. Here, trains with

[12] see Railway Market CEE Review No 2/2007p 26-29
[13] verbal information kindly provided by Mr. Irakli Ezugbaia, General Director of Georgian Railways

42 4-axle-Wagons (crude Oil) were transported with a gross weight of 3,200 tons, pulled by refurbished, but old locomotives. Since last year, when it was agreed between Azerbaijan and Georgia, such dedicated oil trains have to get the highest priority in transit procedure (even higher than the "VIP-Passenger Express Train"). As this is applied for both ways, also with empty wagons, **theoretical** turnaround transit times Baku-Batumi, with unloading in Batumi, re-assembling of empty Wagons and way back from Batumi to Baku in total of not more than 5 days are described. For this purpose a regional coordinating unit at Azeri Rail in Baku was established which is on duty for the quick oil cargo flow and the rolling Stock for both (Georgian and Azeri) Railways.[14]

During numerous interviews the consultants got the impression, that the same priority like oil trains (if given by decree of Ministers) will get the LPG-Trains as well. Furthermore, a favorable safety record of oil logistics on the Traceca railway link was often cited in this context.

5.1.2 Road

The transport of LPG by truck may put tremendous problems on the highway networks. LPG has to be transported in pressurized tanks. It is heavier than air, and leaks could spread on the ground up to 200 m before it is diluted by air below its explosive and flammable concentrations. The transport of LPG may pose a serious threat to drivers and communities along the route in case of accident.

Parallel, increasing LPG traffic levels would result in increasing accidents unless appropriate road safety programs are developed and implemented. This requires national road safety programs to take account of the particular issues raised by international transport, such as:

- the possible need to control length of drivers hours on long hauls,
- the need perhaps for higher safety vehicle and driver standards for large trucks and buses,
- particular concerns raised by international carriage of dangerous goods, and
- ensuring that minimum third party insurance requirements are adequate to cover compensation needs.

For example, road accidents are significantly increasing in Azerbaijan since beginning of the century. The 2,388 road accidents in 2004 resulted in 811 fatalities and 2,766 injuries. The fatality rate in 2004 was about 17 per 10,000 vehicles, much higher than in western European countries. Annual economic loss from road accidents was more than $110 million, accounting for 1.7% of GDP.[15] The major causes include poor road conditions, lack of safety features and facilities, weak enforcement of road safety regulations, intoxicated driving, and inadequate driver education. Although the State Road Safety Commission is coordinating activities of concerned government agencies, it does not have executive powers. To improve road safety, the Government is now developing a road safety program that requires establishing improvement of the legislation and regulations on road safety, road accident monitoring, reporting, and information systems.

Against this background, LPG transport by road on a large scale is not recommendable at all.

5.1.3 Ship

In the Black Sea ferry boats of the "Heroes of Shipki" type (2 Ukrainian and 2 Bulgarian) of "Ukrferry" Shipping Company (closed JSC) are working on the line Ilyichevsk-Poti. They can carry up to 40 LPG tank wagons each trip. One of the ferry boats "was upgraded to enable the carrying of fire hazardous cargo on internal decks and now can accommodate for carriage up to 80 tank wagons with LPG each trip.

In taking into account that freight ferry boats make average two portcalls to Poti per week, the monthly carrying capacity of a ferry terminal on the route Poti-Ilyichevsk is up to 500 LPG tank wagons (i.e. 10-11 thousand tons). Transit time of delivery from Poti to Ilyichevsk is 3 days including 2 days as a sea days, an one day for loading/unloading.

[14] see TRACECA project on oil logistics centre 2003
[15] see ADB: East–West Highway Improvement Project, November 2005

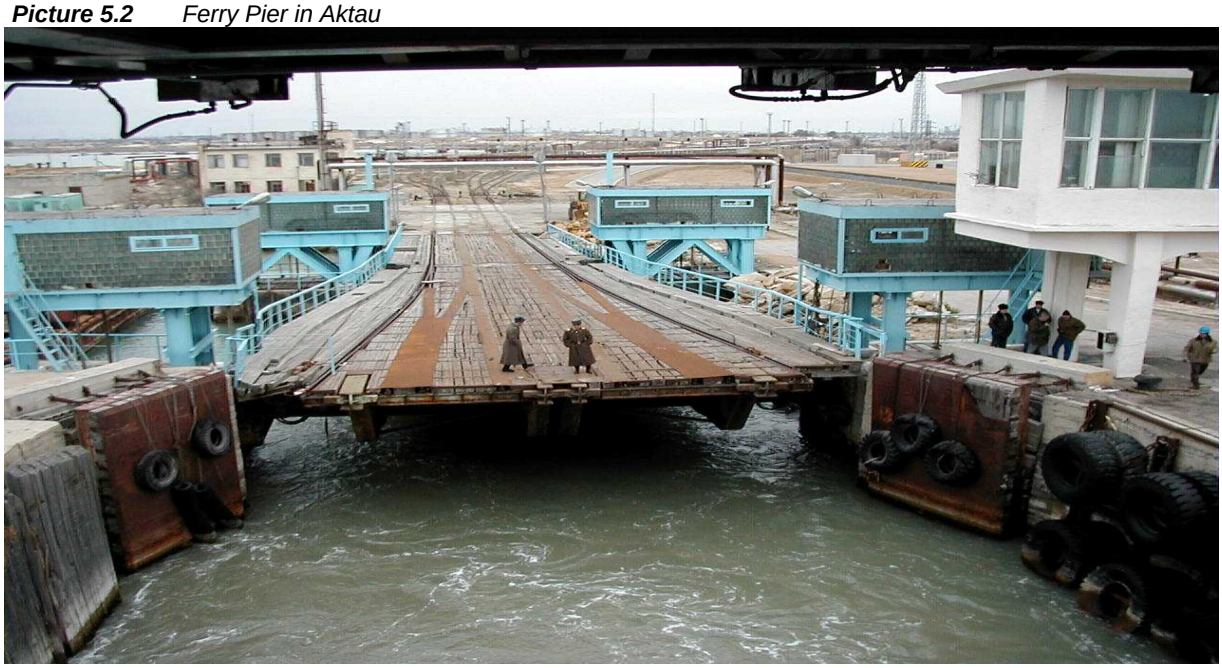
The carriage is implemented according to current tariff policy (it is published on web-site of both "Ukrferry" company and Bulgarian Maritime Fleet – BMF EAD) with increase by 1,2 times (increasing coefficient on fire hazardous cargo).

Furthermore, it is expected that the ferry line Kerch-Poti is put into operation in July 2007. This will reduce delivery time to 2 days, and carrying capacity will be increased by 2 times.

Picture 5.1 *Ferry Boat at Iiyichevsk*

In the Caspian Sea, four units of specialized ferries for the transport of liquefied gas from Aktau to Makhachkala are in operation. Such a vessel can carry up to 56 tanks or wagons. Liquefied gas was also transported on the route Turkmenbashi-Baku and Turkmenbashi-Makhachkala by ferries of the type "Sovetski Dagestan" with a capacity of 28 tanks. There were also used ferries with a capacity of 56 tanks.

Picture 5.2 *Ferry Pier in Aktau*



The ferry pier M8 in the port of Aktau is an universal one, used for processing of oil tankers and cargo vessels. In the case of gas being shipped, the capacity of the ferry terminal used to be 448 tanks per month, considering the use of a ferry “Sovetski Dagestan” and a capacity of 28 tanks. In 2006, the ferry pier capacity of the port in Aktau has been upgraded to receive ferries with 56 tanks. Thus, the transport gas volume can be increased to 832 tanks per month.

Table 5.1 *LPG consumption, export and import per region in Kazakhstan*

Name of the region	Liquefied propane and butane , thousand tons		
	Consumption on internal market	export	import
Akmolinsk	31,8	-	-
Aktjubinsk	5,6	-	-
Almaty	40,1	-	-
Atyrau	17,0	725,1	-
Eastern Kazakhstan	13,5	10,9	-
Zhambyl	6,1	0,0	-
Western Kazakhstan	7,3	-	-
Karaganda	25,6	-	0,5
Kostanay	8,6	-	0,3
Kyzylorda	9,8	43,8	0,0
Mangistau	12,3	-	-
Pavlodar	131,0	15,0	-
Northern Kazakhstan	25,5	-	6,3
Southern Kazakhstan	38,6	-	-
City of Astana	34,5	2,3	-
City of Almaty	84,4	32,8	0,0

Source: Statistics data of RK agency

At this point, the port of Aktau has no access to backyard storage tanks for gas arriving at the port. As a consequence direct loading of RTCs is the only option for now. Loading at the same time both, oil and gas, at the ferry are realised to be subject to separate carriage in different holds or compartments

(according to IMDG"). The regulations governing the safety of handling and transporting are the IMDG rules and the General and Special rules on the transport of liquid cargo.

Travel time by ferry from Aktau to Baku amounts to 18 hours. On average, the loading time of the ferry is about three to four hours at the respective ports.

Despite some initial contradictions it came out during the Hamburg workshop that apparently there should be no technical obstacles to load LPG via Ferry boats at Aktau port via the multi modal Jetty – always provided that the safety of the ferry boats is given (see Chapter 4.4).

5.1.4 Plants and Tank Farms

The Kazakh gas processing plant (Kaz GPP) was constructed in 1973 (first line). The plant was designed for processing associated gas from the oilfields, which are located nearby, the so-called Uzen bush (Eastern Uzen, Western Tenge, etc) and Zhetybay bush (Southern Zhetybay, Tasbulat, Aktas, Eastern Normaul). The production capacity was intended to reach a volume of 2,9 billion m3/year. In 1979 the plant was modernized in order to supply raw material to the petrochemical plant for polyethylene production in Aktau. During that process of modernization a pipeline for the ethane transportation was also constructed.

The Tengiz gas processing plant (Tengiz GPP), located in the region of the oil and gas deposit "Tengiz", reached the annual output obtaining 2,5 billion m3/years of treated gas. In the following years, the increasing volumes of the produced oil and, as consequence, the increase of obtained gas resulted in the construction of the second line of the plant. At present two projects are being implemented – the Project of Second Generation of the plant (PSG) and the project of Unstripped Gas Injection (UGI) into the layer for oil recovery increase. The objects and technological equipment for oil and gas separation, crude oil stabilization, gas desulphurization and liquefied carbohydrates, sulfur, etc separation will be placed on the PSG section. The special compressor for high pressure gas compressing necessary for gas injections into the collectors will be placed on the UGI section.

The associated gas from Tengiz deposit is characterized by its high content of butane and propane fractions and is distinguished by a very high content of hydrogen sulphide In addition its characteristics are the presence of carbon-dioxide gas and associated components which need to be purified and processed.

The Zhazhanol gas processing plant (ZhGPP) was initially designed for processing a volume of 710 mio m3 anually. After reconstruction has been executed by the company "CNPC - Aktobeymunaygas" the plant capacity reached a level of 800 mio m3 per year. However, the gas obtained after purification does not meet the required standards of sulphides content and exceeds the GOST standard level 0.036 g/m3 by 5-8 times. According to Chinese specialists, the further reconstruction of this particular GPP will not improve the functioning of the plant.

In September 2003 the second Zhazhanol Gas-Processing Plant with a production capacity of up to 1.4 billions m3 of natural gas per year had its start-up, and in 2004 the construction of the third plant was commenced. This ensures full utilization of increasing production volumes of associated gas with further export. The gas produced recently was used mainly for the own needs for power generation of the CNPC company and, to a smaller extent, a gas amount of up to 360 mio m3 per year was sold to consumers in Aktjubinsk region at discounted prices (because of the standard requirements mismatch).

Three oil processing plants of the country produce liquefied gas as by-product, the volume of which, primarily, depends on the volumes of oil processing. However gas obtained at Atyrau and Shimkent OPP is sold on the internal market of the republic (liquefied hydrocarbon gases for communal-general consumption). Some volumes of liquefied gas are exported by Pavlodar petrochemical plant (PCP).

Table 5.2 *Characteristics of active gas-processing plants of Kazakhstan*

Name of gas process. plant (GPP)	Start-up year	Planned production capacity		Actually produced in 2002		Expected capacity after reconstruction for 2010	
		Per natural gas mln m^3	Per liquefied gas thous. tons	Per natural gas mln m^3	Per liquefied gas thous. tons	Per natural gas mln m^3	Per liquefied gas thous. tons
Kazakh GPP (city of Zhanaozen)	1973 – 1st line 1997 – 2nd line	2900	80	940	77,3	Technological modernization of the plant without processing capacity expanding is envisaged	
Tengis GPP	1995-1999 stepwise 3 techno-logical lines (КТЛ)	2550	90 on 1 line propane, butane	2550	684 propane, butane	up to 6439 (as per some indices with start-up of the 2nd line – up to 14000)	1330 propane, butane
Zhanazhol GPP	2003	1400	60	920	-	4400	150

Safety standards at existing and newly to be established tank farms in the region are considered to follow international safety standards. Site visits of the consultant (e.g at Batumi Port, see below) proved reliability.

Picture 5.3 *LPG terminal Batumi*

The new Oil-and Gas-Port of Kulevi, north of Poti on Georgian side will also go into handling of LPG cargo. Here, are new constructed storage tank facilities (over 100.000 cbm) on site of an artificial new harbour area which is going to be developed. This harbour area should get its own railway-link to the main station of Samtredia (where the Railway is split into the direction to both the Ports of Batumi and Poti and into the other direction to Tbilisi and further to Azerbaijan). The sea-area is planned to be dredged in a “Canal-to-Port”-waterway to serve Tankers up to 50.000 tdw or even more. In the first phase, the Kulevi Terminal should go into operation end of 2007. The main investor is a Georgian private Company, but minority share should be taken by a Subsidiary of the State owned Azeri Oil Company.

In the Ukraine, there are two existing storages and transhipment possibilities at the whole Black Sea coast: an old one in Illychevsk, built in Soviet times and a new one in the Port of Odessa. Next to this two facilities able to serve bigger LPG tank ships there is a smaller storage with 1.200 mton capacity in the Danube port of Reni inaugurated a few years ago but not ready to serve big vessels as loading pier is still insufficient. In this context it must be taken into account that there is only one LPG vessel (capacity approx. 1.000 ton) serving the whole lower part of the Danube and sailing under Bulgarian flag. Beside of that, an EBRD-supported/financed project to create a new modern LPG transfer facility at the Ukrainian sea fishing port of Kerch (Eastern Krim at the Strait between Azov and Black Sea) is on the way.

5.1.5 Pipeline

As mentioned earlier, LPG is heavier than air. Leaks in the pipeline and in the take-off and storage facilities would not be dispersed in the atmosphere but could travel considerable distances before being diluted to concentrations below the flammable limits. While the pipeline is expected to operate for a long time, it must be properly purged before abandonment to prevent accidental explosion from residual LPG.

If economically feasible, a pipeline project will have a positive impact during operation by reducing the risk from road and railway accidents involving tankers filled with LPG.

However, one has to consider that such a pipeline is situated in the seismically active Caucasus region which experiences frequent earthquakes. For example, if built along the line of the recently established BTC oil pipeline, it will cross in Azerbaijan four seismically active fault zones and run through areas in the vicinity of active mud volcanoes. Furthermore, the majority of this pipeline route is underlain with relatively soft sediments that can be easily excavated. The Environmental and Social Impact Assessment for the BTC pipeline states: "World-renowned specialists have advised on how the risks from these geohazards should be mitigated in the pipeline design."[16] Similar expertise would have to be seeken if a LPG pipeline is going to be realised.

Picture 5.4 *Landslide in Georgia*[17]

5.2 Sensitive Areas and Emergency Response

Transport of dangerous goods implies safety, security and technical risks, and asks for techniques to assess, quantify and mitigate them.

On the Trans-Caucasus railway link there are **no special surroundings of towns or Villages** for trains with dangerous cargo like LPG. In Azerbaijan only 30 meter open space to each side of rail track is required by law. All the way from Baku until Batumi/Poti such trains are using the normal track lines as the designed ways during the Soviet-time have not foreseen such surroundings.

If some cargo of extremely danger, for example ammunition or explosives, should be transported (for military purposes), the operating experts ordering a special time interval for transiting through some special areas, and no counter-traffic is accepted at that time. Nevertheless, even in that case it could happen that such train, which normally should not stop during transiting, crosses a station with normal

[16] BTC Pipeline ESIA Azerbaijan, Final ESIA, Executive Summary, December 2002
[17] Source: Irma Gurguliani, Ministry of Environment Protection and Natural Resources of Georgia: Environmental Security in Georgia NATO CCMS Workshop Athens 9 June 2006

passenger traffic. In case of doubt it could happen, that by Ministry decrees the train transportation would be prohibited (e.g. for bridges or tunnels) and the cargo has to be loaded on trucks, which are guided by Police or Army, taking a city-surrounding and load outside of endangered area again onto train. Of course, such a method is not feasible for large scale LPG transport. And having in mind the properties of LPG discussed earlier in this paper it is also not necessary.

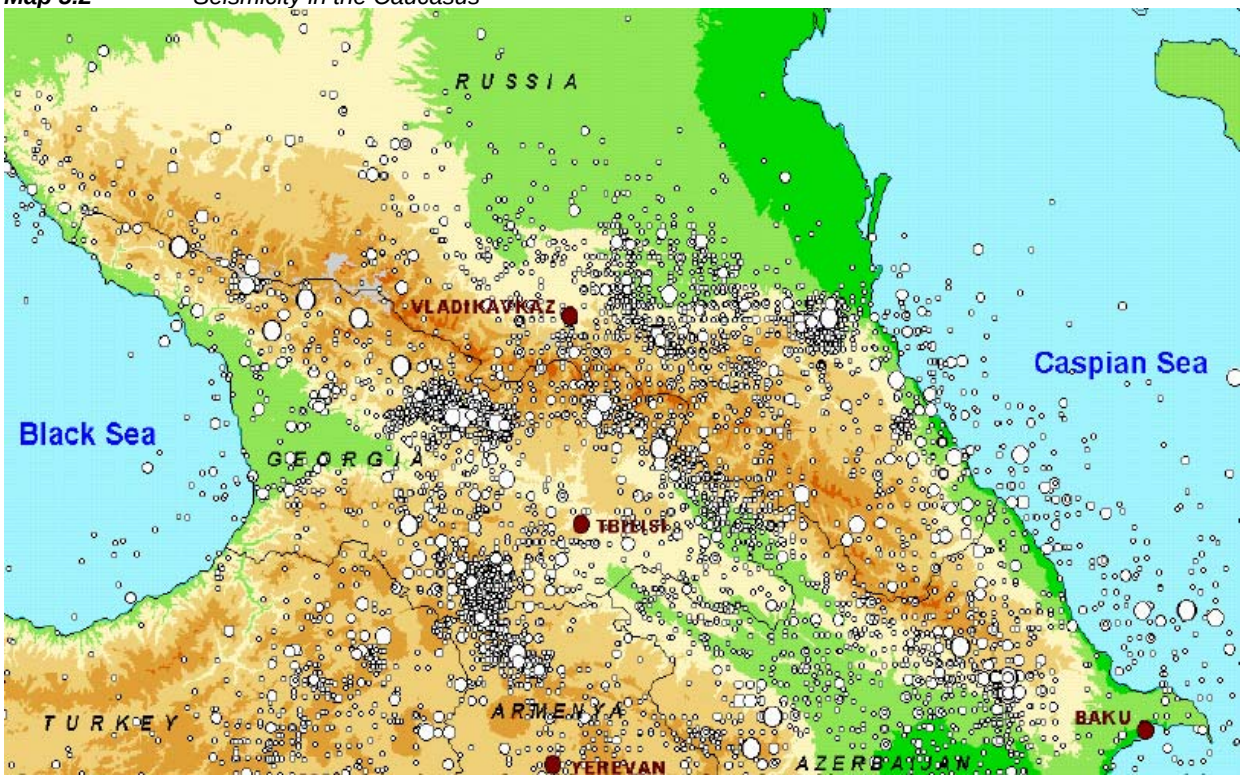
Nevertheless, the biggest hazard potential for LPG transport in the countries concerned is related to geomorphology and natural conditions. In a lot of sections of the Trans-Caucasus railway link we face very steep uphill/downhill sections (Tbilisi/Samtredia/Poti/Batumi/Kutaisi/Sestafa).

Taking the map of Kutaisi below as an example and the tendency of LPG to 'flow' to the deepest point, if released, it is obvious that in the case of an accident released LPG may concentrate in populated areas.

Map 5.1 *Kutaisi*

Beyond the good safety record of the railways concerned the region is exposed to natural hazards like earthquakes and to man-made hazards like terrorist attacks.

Map 5.2 *Seismicity in the Caucasus*[18]



Such conditions require reliable and concerted emergency response. Accordingly, already in 2003 at during a Meeting on Disaster Reduction for the Caucasus and Central Asia in Kobe, Japan a Total Disaster Risk Management (TDRM) Programme was promoted. The Background was described as follows:

"The Caucasus consists of three countries, Republic of Armenia, Republic of Azerbaijan, and Georgia, and is situated on the west of the Caucasian mountain range. The region of the Caucasus lies between the Black Sea to the west and the Caspian Sea to the east and its neighbouring countries include: Republic of Turkey to the southwest, Russian Federation to the north, and Islamic Republic of Iran to the southeast. The region is prone to most natural disasters such as earthquakes, floods, landslides, rock falls, mudflows, lightning, hail, volcanic eruption, and forest fires. The Caucasus is one of the most active segments of the Alpine-Himalayan seismic belt. At the same time, it is a collision zone between the Arabian and Eurasian and, therefore, is associated with intense earthquake activities in the region. The Spitak Earthquake of 1988, which took lives of at least 25,000 people and destroyed two cities, Spitak and Leninakan (present Gumri), represents recent major earthquakes in the region. The Spitak Earthquake, despite the negative impacts caused, contributed in raising awareness of the people in Armenia and surrounding countries as well as of the governments to pay more attention to reduce seismic risk and to protect people from earthquakes disasters.

Central Asia consists of five countries, Republic of Kazakhstan, Kyrgyz Republic, Republic of Tajikistan, Turkmenistan, and Republic of Uzbekistan, and is situated on the east of the Caspian Sea. Its neighbouring countries include: Islamic Republic of Iran to the southwest, Afghanistan and Islamic Republic of Pakistan to the south, People's Republic of China to the southeast, Russian Federation to the north. The countries in the sub-region are also prone to most natural disasters such as earthquakes, floods, avalanches, landslides, rock falls, mudflows, forest fires, outbursts of glacier lakes, and droughts.

[18] Source: Irma Gurguliani, Ministry of Environment Protection and Natural Resources of Georgia: Environmental Security in Georgia NATO CCMS Workshop Athens 9 June 2006

Major earthquakes in Central Asia can be represented by the 1948 earthquake in Ashkabad (Turkmenistan) and the 1966 earthquake in Tashkent (Uzbekistan)..".[19]

Remedy should be found in the rationale to drastically reduce disaster risk in Caucasus and Central Asia by strengthening cooperation, to promote the exchange of information and expertise, and to enhance capacity of the governments and communities to cope with disasters. Such a Total Disaster Risk Management (TDRM) is described as a comprehensive approach that embraces all the phases of disaster management cycle, the enormity of the disaster problem today and in the foreseeable future calls for a more proactive approach that ensures effective disaster reduction at all levels towards sustainable development.

However, that combined approaches can not be realised easily in the region can best be shown by the Caspian Environment Programme assisted by GEF and the EU (Addressing Transboundary Environmental Issues in the Caspian Environment Programme (CEP)). CEP is a regional umbrella programme developed for and by the five Caspian Littoral States, Azerbaijan, I.R. Iran, Kazakhstan, Russia and Turkmenistan, aiming to halt the deterioration of environmental conditions of the Caspian Sea and to promote sustainable development in the area. It includes an on-going dialogue which may lead to a long-term environmental partnership with the oil and gas industry. CEP has been in operation since 1998 with a budget of over 29 million US-$. In 2006, the following interim results were presented[20]:

- *The region not yet ready to adopt the Protocol and the Cooperation Plan mostly due bureaucratic and political/reasons*
- *National Plans not updated /not approved .*
- *National response capacities not satisfactory.*
- *No agreed Regional Centre*
- *Legal regime issues, undefined spheres of responsibility*
- *No risk assessment for oil and hazardous substances spillage from shipping, pipelines offshore and onshore production and storage facilities*
- *No guidelines for oil spills in line with the Civil Liability Convention.*
- *Continued Pollution from existing and de-commissioned coastal and off shore oil and gas facilities.*
- *No regional agreement on minimum standards of maintenance of existing tanker fleet and no harmonized system of port state control.*
- *No protocols on environmental standards for gas and oil activities in the Caspian waters.*

[19] The International Conference on Total Disaster Risk Management, Kobe, Japan 2-4 December 2003
[20] see UNDP Caspian Workshop Baku 11.07.2006; www.un-az.org/UNDP

Map 5.3 *Caspian Sea and CEP*

However on the individual state level, emergency response has quite properly been implemented. For example, in Kazakhstan, the President's Decree enacted on August 21, 1991 created the State Commission on Extreme Situations. In addition, the Law on Civil Defence and the Law on Emergency Situations of a Natural and Technological Character serve as fundamental policies on protecting the people of Kazakhstan in emergency situations including threats from natural disasters.

The Ministry for Emergency Situations is the prime organization at the central government, which carries out response activities for large emergencies and disasters. It controls industrial technical safety, coordinates measures on the prevention, supervises national fire service, and serves as coordinating body for civil defence. It has also created an equipped Republican Rapid Rescue Group.

In the Ukraine according to President's Decree from 28 October 1996 the Ukrainian Ministry of Emergencies was specified as central institution of administrative authority in this field. Cooperation in the area of Civil Emergency Planning and Disaster Preparedness is a key component of the NATO-Ukraine Charter signed in Madrid in July 1997. An Ukraine-NATO Joint Group on Civil Emergency Planning was established for planning and coordination of joint activities.

Providing of fire prevention arrangements on transport facilities and enterprise's installations related to management sector of the Ministry of Transport and Communication, is being secured by departmental fire service of Ukrzaliznytsa and Ukrmorrechflot respectively.

There are 68 firefighting trains in operation, including Donetsk oblast -10, Lvov oblast – 11, Odessa oblast – 9, South-West railway -8, South railway -9, TransDnieper railway – 11 on railroads of Ukraine in alert crews as a part of fire brigades and separate fire trains.

Rolling-stock of rail transport (locomotives, diesel trains, electrical trains, passenger cars, specific rolling-stock) is equipped with firefighting appliances according to regulatory document "Standards for equipping of installations and rolling-stock of rail transport with fire engineering and fire-tools".

To secure fire safety in commercial sea ports (CSP), it was created 12 departmental fire brigades, which do sentry-go and have in service 28 firefighting vehicles, 7 fire vessels and fireboats, as well as 31 ships adapted to firefighting purpose.

According to current instructions concerning interaction of departmental firefighting service of Ukrzaliznytsa and Ukrmorrechflot, if necessary for recovery of fire consequences occurred on enterprise's installations, rolling-stock of rail transport, or waterborne vehicles, the departments of State Firefighting Service of Ukraine are being engaged.

6 Conclusions: Implications for Safe LPG Transport in the TRACECA Region

1. With regard to rules and regulations in the region safe LPG transport is provided for.
2. However, all the states concerned should obtain all the international standards on transport of dangerous goods, in order to get a common platform comparable in all aspects.
3. The consultant did not hear and was not informed about any accidents – this on the basis of an annual LPG transport flow of about 0,5-1 Mio. tons in Ukraine; 1 Mio. tons in Kazakhstan and a few ten thousand tons p.a. in Azerbaijan and Georgia.
4. Physical conditions in the Caucasus may put some threat on safe LPG transport.
5. Whereas emergency response on the individual state level is implemented, a joint Total Disaster Risk Management (TDRM) Programme is to be highly promoted, which should also focus on accident scenarios of LPG transport.
6. In foreseeing increasing LPG transport volumes in the region a public awareness programme should be launched describing the properties of LPG and reaction in the case of detection.

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Annex 1 Pattern of safety instructions relating to the handling at stations and during rail and road transportation of LPG tank containers

Pattern of safety instructions relating to the handling at stations and during rail and road transportation of LPG tank containers

Chapter 1

Scope of the instructions and safety-related responsibilities

Article 1: Scope of the Instructions

1.1 These instructions are intended to set out the safety measures to be taken during the various stages that apply when moving LPG tank containers, and primarily during handling at train stations (loading and unloading) and rail transportation.

1.2 LPG Definition
LPG stands for **L**iquid **P**etroleum **G**as and is made up of butane or propane gases or a mixture of propane and butane. Two LPG liquefaction processes are currently in use: liquefaction under pressure and cryogenic liquefaction at very low temperature under atmospheric pressure.

1.3 These instructions apply for bi-modal transportation by Road (from the departure point or destination to the railway station and vice versa) and by Rail (from the departure station to the destination station and vice versa) of LPG under pressure.

1.4 These instructions apply to all economic operators involved in the handling and transportation by rail and road of tank containers of bulk LPG.

1.5 These instructions do not void or replace other applicable safety and security instructions.

1.6 In the same way, these instruction do not affect national regulations in force, which remain applicable in their respective areas, especially:
- the highway or road traffic code
- the regulations governing transportation of dangerous matters
- the regulations governing equipment containing pressurised gas
- the regulations governing lifting equipment
- the regulations governing rail transport

1.7 Access to industrial estates and port terminals, the movement and parking within this zone of vehicles, trains of tank cars, are additionally subject to the measures set out in the safety and security regulations that are specific to this area.

Article 2: Filling and transfer
2.1 Safety while filling tank containers at the LPG product loading centres is the responsibility of the operators involved.

2.2 Security during the transfer of tank containers at filling centre level is the responsibility of the operators involved.

2.3 Before any tank container filling or transfer operation, always ensure that tank containers are grounded.

Article 3: Road transport stage
3.1 Safety during road transportation of tank containers to the rail or combined transport departure station, their loading onto rail trucks, their unloading at the destination stations and their transportation by road is the responsibility of the sender or the contracted intermodal transport operator.

Article 4: Rail transport stage
The responsibility for transporting LPG tank containers by rail is that of the railway operator, from the departure station to the destination station.
This responsibility relates to the following points: checking that the load is strapped down, immobilising parked rail trucks, performing manoeuvres in stations, complying with braking rules the composition and monitoring of trains. These safety measures are repeated in the railway operators in-house corporate regulations. Railway personnel operating trains that transport tank containers of bulk LPG must comply with the specific safety measures and with applicable procedures relative to access specified for handling in industrial estates.

Chapter 2

Safety instructions when moving tank containers

Article 5: Step definition
The three successive steps in moving tank containers that are covered by this chapter consist of:
5.1 The **outbound** and **return** road sections.

5.2 Handling at rail stations, for loading, unloading, and strapping down the containers on the rail trucks.

5.3 Container rail transportation.

Article 6: Safety instructions for truck drivers

6.1 Vehicle condition

6.1.1 The vehicle must be kept perfectly maintained and in perfect operating condition, especially as regards the braking system, the electrical equipment and tyres.

6.1.2 The tank container must be fitted with two 6 to 9 kg dry powder fire extinguishers, covered and easily accessible and operable.

6.1.3 The tank container must be suitably labelled and accompanied by the on-board documents comprising especially the:
- Testing certificate
- Applicable safety instructions
- Type of product

6.1.4 The vehicle's loading bed must be equipped fixtures compliant with standards in force for strapping down containers.

6.2 Running instructions

6.2.1 The driver is bound to comply strictly with the stipulations of the highway code and instructions that are specific to the transportation of hazardous materials.

6.2.2 Any person carrying any kind of flame is forbidden from approaching the vehicle.

6.2.3 The sender is bound to define the routes of tank container vehicles ahead of time, in line with applicable regulatory stipulations.

6.2.4 Stopping along the route should be avoided; momentary stops, when inevitable, must wherever possible be made outside of built-up areas.

6.2.5 If stopping along the route is inevitable, abandoning the vehicle without surveillance on a public road is forbidden.

6.2.6 In the event of a breakdown, the vehicle must not be abandoned on a public road.

6.2.7 If stopping the vehicle is inevitable, it must be kept:
- more than ten metres away from homes
- away from naked flames
- away from buildings containing combustible materials.

6.2.8 Before every full container leaves, the driver must ensure that all of the valves are closed, that the box is locked and that the container is strapped down.

6.3 Conduct to apply when loading or unloading the container carrier vehicle in train stations

6.3.1 On entering the railway station, the driver becomes subject to the authority of the combined transport manager in charge.

6.3.2 The driver must stop the vehicle at the indicated location; immediately after stopping, the following operations must be performed:
- Turn off engine
- Apply handbrake
- Switch off electrical equipment
- Chock wheels

6.3.3 During handling, the driver must not move away from the vehicle.

6.3.4 As soon as handling is finished, the driver must clear their vehicle from the station.

Article 7: Safety instructions for the stacker operator

7.1 Only a qualified stacker handling device operator may drive the stacker.

7.2 The stacker must be perfectly maintained and in perfect operating condition, and subject to periodic regulation technical inspections.

7.3 An operating and maintenance manual intended for handling device operators and drawn up in line with the manufacturer's stipulations must be made available to the operator by the sender.

7.4 Carrying personnel is strictly forbidden.

7.5 Leaving the station area without permission is forbidden.

7.6 Abandoning the handling device with its engine running is forbidden.

7.7 Manoeuvres to hook up or clamp down tank containers must be performed in line with an indication plan.

Article 8: Safety instructions for handling operations in stations

8.1 Before any rail loading and unloading of rail trucks or of the container carrying vehicle, the operator must ensure that:

- The train of rail trucks is immobilised using screw brakes.
- Container condition does not show any visible anomaly or defect.
- Valves are closed and that the tank and accessories do not show any leaks.
- Grounding is correctly carried out.
- Safety instructions for loading and unloading containers are displayed, understood and most importantly, applied.

8.2 During handling, no flames or source of fire must be found close to the moving tanks.

8.3 Container loading and unloading operations must be performed with the help of a guide person to direct the handling device operator.

8.4 Tank container valve boxes must all be located on the same side of the train.

8.5 Care required when locking down containers

8.5.1 The intermodal facility or logistics managers must ensure that before each train leaves, all of the boxes are locked and the locking down pins are in place.

8.5.2 Designate railway staff must ensure that the containers are properly locked down on the rail trucks.

8.5.3 Locking down using any other process (e.g. straps or chains) is forbidden.

8.6 Care required when manoeuvring rail trucks in stations

8.6.1 The rail trucks must not be manoeuvred by launching nor may they be hump shunted. These rail trucks must be manoeuvred with care and vigilance, at low speed and avoiding violent impact.

8.6.2 It is also forbidden to allow loaded rail trucks to be hit by other launched rail trucks

Article 9: Routing rail trucks loaded with LPG tank containers

In addition to the stipulations of the rules for transporting hazardous materials by rail (RID), the following safety rules must also be complied with.

9.1 The rail trucks containing empty or loaded tank containers must travel with valves, taps and all openings closed.

9.2 The rail truck containing the loaded containers cannot be the first nor the last car in a train; it must be separated from the locomotive by at least one buffer truck.

9.3 LPG tank containers carried by rail must be fitted with 6 to 9 kg dry powder fire extinguishers.

9.4 The routes taken by trains of container trucks must be direct and, wherever possible avoid stopping between stations or at intermediate stations.

9.5 Whenever a train of container trucks stops, and this cannot be avoided, the stoppage must take place under close surveillance by railway personnel.

9.6 To carry LPG, the train must be fitted with communication equipment suitable for dealing with any dangerous situation.

Article 10: Safety Measures and Instructions applied at industrial estates and port terminals

10.1 In addition to the above-mentioned safety instructions, the transport operators are bound to comply strictly with the stipulations of the specifications for the industrial estates or port terminals, as set out for safety matters.

Access by the LPG container train to industrial estates and port terminals

10.2 The LPG container train will, upon entry to the train station at the industrial estate, be subjected to a search and full inspection by the security organisation that covers the Industrial estate.

Access to and movement of container carrier trucks within the industrial estate and port terminals

10.3 Container carrier trucks must have a card issued by the industrial estate, in order to access the industrial estate. The vehicle will be subjected to a search and full inspection by the security organisation that covers the industrial estate or port terminal.

10.4 The driver of the container carrier truck must, when moving within the industrial estate, ensure that the vehicle complies with all of the stipulations in the above-mentioned articles in these instructions, covering vehicle condition and movement instructions.

Measures to be taken should an incident occur affecting the container carrier truck

10.5 If the container carrier truck safety guarantees are no longer fulfilled or if an incident occurs, the following measures must immediately be implemented by the driver: - Apply the measures set out in Chapter 4 and contingency planning.

Measures to be taken should an incident occur at the train station in the industrial estate or port terminal

10.6 Should an incident occur at the train station in the industrial estate, the following measures must immediately be implemented: - Apply the response measures that are specific to the train station or port terminal for contingency planning.

Chapter 3

Article 11: Personnel training level required and availability of useful information and contact data

11.1 All of the entities involved are bound to provide training for their respective staff members working in bi-modal bulk LPG transportation using removable tank containers, on the dangers of the product itself, the instructions to be complied with and the measures to take should an incident arise, as set out in these instructions. Training must be provided before any of the personnel start work.

11.2 Drivers of tank container carrier trucks and handling equipment as well as LPG tank container train personnel must undergo rigorous training on all of the points set out in these instructions.

11.3 The entities involved must make available to their staff members concerned by the measures set out in these instructions, all necessary information and contact data.

Chapter 4

Measures to be taken in case of Incident

Article 12: General measures to be taken when during transportation if the load no longer offers the requisite guarantees

12.1 If the condition of an LPG tank container load no longer, for any reason, offers the guarantees required by applicable regulations (due to an accident, impact, damage to the container, product leak), the necessary safety precautions must be taken immediately.

12.2 If this observation is made in-transit, the transportation car must stopped at the most suitable location, either so that it may be unloaded if handling can be performed safely, or so that it can be immobilised if unloading cannot be performed safely.

12.3 If the condition of the load may cause a serious danger (risk of explosion, fire hazard), it must be moved as far away as possible from any built-up area and public highways; the sender and/or client and the defined emergency control agency must, in such cases, be informed immediately by the carrier and asked for their instructions.

12.4 In cases of emergency (danger, seepage or major leak) and in the absence of skilled personnel, the local authorities must be called on to immediately take the necessary safety measures; the sender or client and the defined emergency control agency must be informed by the carrier and asked to take part in the necessary safety measures.

Article 13: Organisation Procedures in Case of Emergency
As soon as an incident or accident is observed, the following measures must be taken:

a- **If the train is in a station**

The stationmaster or department manager must:

13.1 Forbid the public from approaching the train transporting tank containers

13.2 Isolate the train truck with an anomaly

13.3 Alert local railway management, the Regional Emergency Command Post, Civil protection authorities, sender and/or client, as well as Local Authorities.

13.4 Maintain these stipulations in force until the return to normal takes place after intervention by Civil Protection authorities.

b- **If the train is outside of a station** (on open tracks or in a closed station)
The Train Chief must:

13.5 Inform the previous and next stations on the line to alert the Regional Emergency Command Post and the Local Authorities.

13.6 Move the train away to an area as far away as possible from all built-up areas and public highways.

13.7 Even if the local intervention has made it possible to momentarily correct the anomaly, the railway representative in charge must:

- Have the rail truck deferred by affixing a failure bulletin on it
- Inform the sender so that an assessment may be made of the container

13.8 In the event of a derailment, the initiatives taken are left up to the visitor and Train Manager present on-site.

Article 14: Organisations to alert

14.1 In cases where the incident or accident implies a danger that requires resorting to outside assistance, the following organisations should be informed:

- Local civil protection authorities
- The nearest brigade of Gendarmes or police station
- …

Article 15: General rules relating to LPG fires

15.1 The general rule is to not extinguish a burning gas leak other than by stopping the leak, i.e. in practice by shutting a valve located upstream from the leak.

15.2 If a gas leak has caught fire, it is relatively easy to limit the material damage and avoid any extension of the fire by protecting the fire's surroundings: by spraying with water and forming a water curtain.

15.3 In the medium term, a water tank provided with the means to project water will be incorporated into the train, making it possible to cool LPG rail tank trucks in case of fire. The capacity of the water tank and the range of the projection equipment will be defined in line with the number of rail trucks.

Technical rules in the case of a leak that has caught fire
Priority action = close the valve upstream from the leak
Otherwise, cool the burning container and establish a water curtain to protect surrounding installations until the product is burnt up.

15.4 The same does not apply for a leak that has not caught fire and which when spreading as a layer, may be lit at a distance from its point of origin by any naked flame and will cause an explosion with unpredictable consequences.

Technical rules in the case of a leak that has not caught fire
Priority action = close the valve upstream from the leak
- Otherwise, establish a safety cordon around the leak - Stop vehicle traffic - Cut the power to all surrounding installations and/or facilities, - Extinguish all naked flames - Neutralize the leak using a water sprays - Alert the authorities and organisations involved (see Article 12.1)

Appendix to Chapter 4

Intervention techniques in case of Incident or accident

1. An incident causing damage to valves and/or accessories but which does not cause the tank container to overturn.

2. An incident/accident or impact causing damage to tank panels but which does not lead to the derailing or overturning of the tank container.

3. An incident/accident that leads to the derailing and overturning of the tank container and damage to the tank and/or the valves.

Incidents or accidents affecting LPG tank containers

These incidents may occur for one of the following reasons.

1. If there is impact damage to the valves and/or accessories but that does not cause the tank container to overturn.

1.1 If there is no leak. Drive the vehicle to a safe place where it is possible to transfer the product contained in the tank to another tank, prior to refurbishing.

1.2 If there is a leak affecting the valves or the accessories.

1.2.1 If the leak has not caught fire.

1.2.1.1 If the leak is a small scale one, dispersing easily into the atmosphere.

- carefully drive the vehicle to an isolated, well ventilated, location,
- forbid anyone from approaching with a naked flame,
- attempt to find the leak:
  by sound, or
  by seeing a gaseous release, or
  with the help of a foaming product
  once the leak has been located, attempt to seal it [21]:
  by tightening the device down onto its base, or
  by forcibly inserting a suitably shaped piece of wood, or
  by applying, around the leaking device and only if the leak is in the liquid phase, a damp cloth (which may freeze) and which is held in place by an improvised ligature (strap, steel wire, etc.).

1.2.1.2 If the leak is significant, with the formation of a gas cloud

- whenever possible, leave the vehicle in place and isolate it to avoid causing the gas cloud to ignite on an incandescent point,
- the Gendarmerie or Police and Civil Protection authorities must be alerted to ensure protection by forming a safety cordon at an adequate distance around the vehicle,
- spraying water over the gas jet must be performed with the aim of directing the gas cloud and accelerating its dilution,
- where necessary, form a curtain of sprayed water to avoid any gas cloud propagation,

[21] The operator must in this case wear gloves, that should, if possible be impermeable, and possibly wear eye protection.

- take all necessary measures to eliminate any naked flames in the area that the gas cloud is heading towards,
- in conjunction with other professionals in the sector, consider the possibility of requesting the emergency dispatch of a specialised empty tank truck for carrying the product involved, if the transfer of this product appears possible and necessary.

1.2.2 If the leak has caught fire.

1.2.2.1 If the leak is small and able, once extinguished, to easily disperse into the atmosphere – then extinguish it, if necessary with a powder fire extinguisher – seal off the leak as described in 1.2.1.1.

1.2.2.2 If the leak is significant and it cannot be extinguished or there is no desire to extinguish it for fear of the potential hazards entailed.

- In both cases, the Gendarmerie or Police and Civil Protection authorities must be alerted to ensure protection by forming a safety cordon at an adequate distance around the vehicle.
- Avoid needlessly exposing personnel.
- In all cases, and until the incident is brought under control, spray with water the parts of the tank and its equipment likely to rise in temperature, so as to avoid any weakening of the metal used caused by overheating.

Furthermore, in conjunction with other professionals in the sector, the possibility should be considered of:

- Recovery of the product, or
- Setting up a torch to burn off the product, far enough away from the vehicle to avoid excessively intense heat radiation effects.

2. Collision or impact that damage the tank structure without overturning it

2.1 If there is no leak.

After first ensuring that there truly is no leakage, check that the valves and accessories are not damaged.
If possible, carefully drive the vehicle away from traffic and any built up area, in order to allow specialist inspection.

2.2 If there is a leak and the tank panels are cracked

The following measures must be taken:

- The Gendarmerie or Police and Civil Protection authorities must be alerted to ensure protection by forming a safety cordon at an adequate distance around the vehicle.
- In conjunction with other professionals in the sector, the possibility should be considered of requesting the dispatch of an empty specialised tank truck for carrying the product involved, in order to transfer the product.

2.2.1 If the leak has not ignited

2.2.1.1 If it is not a significant leak and its direction does not threaten the environment.

- Forbid anyone from approaching with a naked flame within the safety cordon.
- If it is possible to approach the tank, in liaison with the profession, it is possible to envisage, under the protection of a water spray fog(1), connecting a product recovery line directed:
  at an empty tank truck specialising in the transport of the product in question,
  or
  at a burn off torch that is located far enough away. In both cases, maintain a water spray curtain between the damaged vehicle or the torch and the recovery vehicle.

2.2.1.2 If it is a significant leak and its direction does threaten the environment

- The vehicle must, immediately if possible, be moved away from traffic or homes.
- Take all necessary measures to eliminate any naked flames within the safety cordon.
- A gas jet must be sprayed with the aim of directing the gas cloud and accelerating its dispersion (with the help of a water spray, for example).
- Aim the nozzle towards the operator, who must be equipped with gloves and a helmet and face screen, so that the connection can be made with as little risk as possible.

2.2.2 If the leak has ignited

2.2.2.1 If it is not a significant leak and the flame is not causing any immediate damage to the tank and its environment
- it is preferable to extinguish it and proceed as in 2.2.1.1.

2.2.2.2 If it is a significant leak and its direction does threaten the tank and its environment.

- Evacuate the vicinity,
- To limit the heat rise, spraying the leaking container carrier vehicle may be attempted if necessary, but without needlessly exposing personnel,
- Where possible, move the vehicle away from traffic or homes while continuing to spray it with water.

3. Accident causing the tank container to derail and damaging the tank and/or valves

3.1 If there is no leak
The Gendarmerie or Police and Civil Protection authorities must be warned so that they can ensure safety.
In conjunction with other professionals in the sector it the following could be considered: - Recovery of the product using an empty specialised tank truck to transfer the product involved, or – Any other operation that can be performed given the condition of the vehicle.

3.2 If there is a leak (the tank metal is cracked and/or the valves are out of service and/or inaccessible). The following measures must be taken: - the Gendarmerie or the Police and Civil Protection authorities must be alerted so that they can ensure protection by forming a safety cordon at an adequate distance from the vehicle.

3.2.1 If the leak is not lit

3.2.1.2 If it is not a significant leak and the direction of the gas jet does not threaten the tank, or its environment
- Proceed as in 2.2.1.1.

3.2.1.2 If it is a significant leak and/or the direction of the gas jet threatens the tank and/or its environment.
- The gas jet should be sprayed with the aim of directing the gas cloud (using a nozzle for example) and to accelerate its dilution (using a water spray).

3.2.2 If the leak has ignited

3.2.2.1 If it is a significant leak and its direction does not threaten the tank or its environment
- it is preferable to extinguish it and to proceed as in 2.2.1.1.

3.2.2.2 If it is a significant leak and the flame direction threatens the tank and its environment.

- Evacuate the vicinity.
- To limit the heat rise, spraying the leaking container carrier vehicle may be attempted if necessary, but without needlessly exposing personnel.
- Move the non-derailed parts of the train away.

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Annex 2 Excerpt from the German Technical Rules for Pipeline Installations

TRFL - Technical Rules for Pipeline Installations
as of 19 March 2003
(German Federal Gazette No. 100a of 31.5.2003;:: ber. 2004)

Pipeline installations have to be state-of-the-art in their construction, installation and operation, so that the impairment of the greater public good will be avoided and that specifically man and environment will be protected against dangerous impact of the pipeline installation. Especially an impairment of the waters must not be worried about.

Therefore, the chemical, physical and water-polluting characteristics of the transported material have to be considered and the installation and operation of the pipeline installation have to be constructed in such a way, that the pipeline installation will safely resist the expected operational demands and will stay leak-proof. Depending on the characteristics of the transported material, accordant safety measures for people and environment have to be implemented.

Beside the pipelines, they contain all facilities which serve the pipeline operation, especially the pump stations, branch pipe stations, transfer stations, shut-off and release stations as well as the compressing, control and measurement plant.

3. Pipeline configuration

3.1. Choice of alignment in consideration of danger

The alignment of the pipeline must be chosen in such a way that the danger based on the pipeline as well as the impact on the pipeline, will be as small as possible in case of damage.

3.1.1. Avoidance of built-up areas

As far as possible, pipeline installations should neither be installed in a built-up area, nor in an area which is declared for development by a land utilization plan passed by the Federal Building Act, as long as the development serves the purpose of habitation according to the Land Use Ordinance. If this is impossible, specific safety measures have to be provided.

3.3 Specifically designated areas

3.3.1 Alignment in specifically designated areas

In order to save asset and operation the pipeline has to be laid in a specifically designated area, which must also guarantee easy maintenance of the pipeline.

3.3.2 Width of specifically designated areas

The specifically designated area, which should be centered to the axis of the pipeline, must have the following widths at certain nominal widths in a pipeline:

£ DN 150	at least 4m
> DN 150 £ DN 400	at least 6m
> DN 400 £ DN 600	at least 8m
> DN 600	at least 10m

In justified cases it is allowed to diverge from the aforementioned widths of the specifically designated areas.

4. Explosive areas, safety zones

4.1 Generalities

Aboveground outdoor system parts and stations (compressing, control and measurement plants) where emissions of gas or vapors might occur (e.g.: soluble compounds, sockets, discharging and pressure relief facilities) must be surrounded by a safety zone which, depending on the local ratio and the nature of the system part and substance, must be measured in such a way that endangerment of the surrounding area in case of leakage will be avoided.

4.3.1 Fire prevention

System parts which contain inflammable gases or liquids must be located according to possible fire hazard that far from the surrounding estate, that a possible fire on this estate will not reach the system parts. There must be enough vacant space around the pumps and compressors to ensure the unhampered realization of fire extinguishing measures.
The standards will be considered to be fulfilled, if there are no

a. basement doors
b. unsealed canal inlets and in case of inflammable gases or liquids no
c. inflammable substances or
d. ignition sources

in a distance up to 5m, measured from a wall opening surrounding the system parts.

5 Planning and assessment

5.1 Generalities

Pipeline installations must be resistant to positive and negative pressure which occurs under normal operating conditions as well as to internal and external strains and impacts and must stay leak-proof.

5.2 Planning of the pipeline installation facility

5.2.1 Laying

5.2.1.1 Pipeline installations must be laid rugged; and generally, they have to be laid underground.
5.2.1.2 In the case of underground pipeline installations, the height of the coverage must be adapted to the local circumstances. In general, it should be 1.0m. In justified cases, it can be reduced for specific locations only if and when special safety measures are taken.
5.2.1.3 In the case of surface pipelines, appropriate measures to protect the pipeline must be taken. In particular, arrangements must be made, which compensate elongation and prevent mechanical damage.

5.2.5 Areas with special protection requirements

In areas with special protection requirements, e.g. in important water management areas …, in built-up areas or in areas which are designated for development according to 3.1.1, and in areas of crossings with transportation routes or in areas which are exposed to additional impacts on the pipelines, specific arrangements should be made.

5.2.6 Safety measures in case of an impact on territory

In areas with potential impact on territory, which could impair the safety of the pipeline, e.g. in an area influenced by mining and in hillside situations, safety measures depending on the individual case are to be arranged.

5.4.2 Load assumptions

5.4.2.1 For the whole pipeline the highest and lowest internal pressure as well as the pressure gradients for the worst operational case, considering the delivery rate, the physical characteristics of the transported material as well as the trace profile, are to be measured.

7 Corrosion protection

7.1 Generalities

7.1.1 Necessity of corrosion protection
Pipeline installations which are influenced by corrosion and which are are made using corrosion-irresistant material, must be protected against corrosion. The necessity of corrosion protection with pipelines made of austenitic steel and other materials must be tested.

7.1.2 Protection against outer corrosion
The outwall of the pipeline must be protected against exterior corrosion.

8 Construction and laying

8.1 Generalities

8.1.1 Workmanship
Only companies which demonstrably have enough skills and appropriate devices to properly run the construction and installation works and particularly the welding, are permitted to run the construction and installation work and welding.
One has to provide evidence about it to the surveyor.

9 Inspection during the laying

9.1 Generalities

9.1.1 Scale of surveillance
Construction and installation work and welding are to be supervised by competent surveillance staff on the realisation of construction work according to construction plan as well as on appropriate execution. The surveillance particularly refers to the pipe transportation, the welding, the pipe cover, the pipe trench design, the pipe lowering, as well as the back-filling and compaction of the pipe trench. Details of the surveillance are to be arranged in a surveillance plan before the beginning of the work in consultation with the surveyor.

11.1.1 Required facilities
Pipeline installations have to be provided with facilities which ensure safe operation. In particular, it must be guarantied, that

a. the operating pressure can be measured and registered,
b. improper internal pressure cannot occur during operation or conveying break,
c. the volume of the substances to be discharged in the event of any damage can be limited,
d. losses can be detected and the source of the leak can be located and
e. liquids from the operating facility can be absorbed.

11.7.3 Emergency cut-out, stop of the feed pump and the compressor
Feed pumps and compressors must be provided with an emergency cut-out which stops the pumps and compressors and closes off the station from the pipeline. The emergency cut-out should be able to be operated from safe spots which should be reached fast and safely anytime. If a station is not permanently manned, additionally the operations of the emergency cut-out from the operating facility must be possible. After an emergency cut-out, the control system of the station should be locked in such a way, that restart is only possible after manual unlocking.

12.3 Measures for operations and control

12.3.1 Generalities
The operation of the pipeline installation is to be supervised permanently.

12.3.2 Operations control center

12.3.2.1 All facilities necessary for the safety of the pipeline installation (e.g. pump stations, compressors, branch and transfer stations, pressure measurement facilities, main stop valves) must be connected to an operations control center or an operations facility, in sections or on the whole. From there, all important facilities connected with the safety of the pipeline installation must be able to be supervised and operated. The operations control center/operations facility must be permanently manned, even during transport breaks. Operational faults must be permanently observable to the operating staff. If necessary, outstation facilities must be installed.

12.3.3 Inspection of the trace

12.3.3.1 The pipeline trace must be checked in regular intervals.
12.3.3.2 To conform the requirements …, the pipeline trace must be checked at least twice a month.
In case of pipelines containing acids and pipelines with gaseous substances, the pipeline alignment must be checked at least once a month.
Track sections in built-up areas or other areas with special protection requirements have to be inspected more regularly. If the alignment is checked by plane, accessible plant components will have to be locally inspected at least four times a year (quarterly).

12.3.4 Leak tightness and condition of the pipeline installation

12.3.4.1 The pipeline installation must be checked for leak tightness
a. in fixed time intervals
b. as soon as a leakage is assumed or
c. as soon as a leakage is repaired.

The inspections must come to a correct result within the determined regulations. The time frames and methods of the inspection must be appropriate to the chemical, biological and physical characteristics of the transported material. Here, built-up areas are to be considered in particular.

12.5.4 Pipeline for gaseous substances

If a leakage of the pipeline is suspected or determined and a hazardous volume of gaseous substances might discharge, all actions which are necessary to limit the discharge volume of gaseous substances and to prevent damage from discharging gaseous substances, will (have to) be implemented.

Conditions required

Rules and regulations of other member states of the European Union or the European Economic Area can be used instead of the mentioned German regulations, as long as they correspond to e.g. §4 Para. 2 VbF or similar regulations.

Attachment G: Information to authorities

Within the scope of the prevention of any damage, the designated authorities, the municipalities affected by the pipeline alignment, fire department, police and other organizations as appropriate have to receive information about:

a. name of pipeline operator and site description,
b. name and position of the person who provides the information,
c. generally understandable, brief description of type and function of the facility,
d. description of the transported material stating all the essential hazardous characteristics of the substance ,
e. general information about the type of hazard in case of damage, including possible impact on man and environment,
f. adequate information about how affected municipalities will be warned and informed about the procedures in case of damage,
g. adequate information about how the affected municipalities should react in case of damage.

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Annex 3 - Guidelines to 'Ship/Shore Safety Checklist'

International Chamber of Shipping, Oil Companies International Marine Forum
International Association of Ports and Harbors
"International Safety Guide for Oil Tankers and Terminals
4th edition; London 1996 Appendix A

Introduction
The IMO Recommendations on the Safe Transport, Handling and Storage of Dangerous Substances in Port Areas (Assembly Resolution A.435 (XI)) contain the requirement that:
The master of a ship and the berth operator should before liquid bulk dangerous substances are pumped into or out of any ship or into a shore installation:

1. agree in writing on the handling procedures including the maximum loading or unloading rates;
2. complete and sign the appropriate safety check list, showing the main safety precautions to be taken before and during such handling operations; and
3. agree in writing on the action to be taken in the event of an emergency during handling operations

Annexed to the Recommendations is a safety check list covering the arrangements and conditions under which the loading and discharging of bulk liquid dangerous cargoes and associated operations such as bunkering, ballasting or thank cleaning may be carried out safely.

Application
The checklist shall be used prior to the following operations:

1. the loading and discharging of dangerous substances in unpacked liquid or gaseous condition;
2. ballasting and de-ballasting of tanks which have not been cleaned and contained the substances indicated under1;
3. loading from the shore installation of fuel for the propulsion of the ship or handling stores on ships which contain the substances under 1 or on ships which are involved in operation under 1 and/or 2;
4. loading and discharging of substances other than those under 1 and 3 on board ships which contain the substances under 1.

If operations under 4 are carried out, a number of Questions on the checklist are not applicable; a note to that effect shall be inserted in the column "Remarks".
The list is divided into three parts which shall be used as follows:

Part A. general, for all tankships

Part B. additional for chemical tankers'

Part C. additional for gas tankers'

Consultation
The operations under items 1, 2, 3 and 4 of application may only be carried out if both parties, indicated as "Ship" and "Shore" on the checklist, have jointly ascertained that they can carry out these operations safely, as far as their own sphere of influence is concerned. This is possible only if all questions of the checklist are answered affirmatively or, if it has been mutually agreed that a question is nor applicable, a not to that effect has been inserted into the column "Remarks".
An exemption is made for the questions coded "P". The operation, may still be carried out, even if a negative answer is indicated provided the competent port authority has been informed and the subsequent conditions required are being met.

Although one of the parties may be the opinion that from his point of view the operations mentioned under items 1, 2,3 and 4 above can be carried out safely, it is possible that the other party does not share this opinion.
In such case no agreement can be reached when jointly completing the checklist. The operations cannot begin until both parties reach agreement over the measures necessary to ensure that the operation can be carried out safely.

Deviations
It is possible that changing conditions may effect the continuing safety of the operations once they have started. The party finding or having the opinion that there has been a change in conditions must take all necessary action to re-establish the safely of the operations. Where appropriate the other party shall assist. All operations shall be suspended immediately if the necessary actions cannot be taken.

Keeping of forms
The checklist and the forms required by certain items of the checklist shall be kept by the representative of the shore installation for a period of at least one month after the date of completion.
On board the ship the checklist and the associated forms shall be kept until at least 12 hours after departure from the Netherlands (or any other country where the checklist is used). At their request the checklist and forms shall be submitted to the competent port authority.

Itemised guidelines
The following part of the guidelines contains an itemised summing up of the conditions which, judged by the current state of the art, shall be established to ensure the safety of the operations.

Part A
Bulk Liquids - General

a1 *Is the ship securely moored?*
In answering this question, due regard shall be given to the need for adequate fendering arrangements.
Ships shall remain adequately secured in their moorings. Alongside piers or quays ranging of the ship shall be prevented by keeping all mooring lines taut; attention shall be given to the movement of the ship caused by currents or tides and the operation in progress.
Wire ropes and fibre ropes shall not be used together in the same direction (i.e. breasts, springs, head or stern) because of the difference in their elastic properties. Once moored, ship fitted with automatic tension winches shall not use such winches in the automatic mode.
Means shall be provided to enable quick and safe release of the ship in case of an emergency.
The method used for the emergency release operation shall be agreed, taking into account the possible risks involved.
Anchors not in use shall be properly secured.

a2 *Are emergency towing wires correctly positioned?*
Emergency towing wires shall be positioned both on the offshore bow and quarter of the ship.
The eyes of these wires shall be maintained about the waterline and regularly checked and adjusted if necessary during the operations. They shall be properly made fast on and adjusted if necessary during the operations. They shall be properly made fast on the ship's if necessary during the operations. They shall be properly made fast on the ship's bollards while having sufficient slack on deck.
Means shall be provided to prevent the slack from accidentally running into the water. These means shall be so arranged that they can easily be broken.

a3 *Is there safe access between ship an shore?*
The access shall be positioned as far away from the manifolds as practicable.
The means of access to the ship shall be safe and may consist of appropriate gangway or accommodation ladder.
It is advisable to fit and properly secure a safety not under the means o asses.
When terminal access facilities are not available and a ship's gangway is used, there shall be an adequate landing area on the berth so as to provide the gangway with a sufficient clear run of space and so maintain safe and convenient access to the ship at all states of tide and changes in the ship's freeboard.
Near the access ashore suitable life-saving equipment shall be available. A lifebuoy shall be available on board the ship near the gangway or accommodation ladder.
The access shall be safely and properly lit during darkness.
Persons who have no legitimate business on board, or who do not have the master's permission, shall be refused access to the ship.
The terminal shall control access to the jetty or berth in agreement with the ship.

a4 *Is the ship ready to move under its own power?*
The ship shall be able to move under its own power at short notice, unless permission to immobilise the ship has been granted by the competent port authority and the terminal manager.
Certain conditions may have to be met for permission to be granted.

a5 *Is there an effective deck watch in attendance on board and adequate supervision on the terminal and on the ship?*
The operations shall be under constant control both on ship and shore.
Supervision shall be aimed at preventing the development of hazardous situations; if however, such a situation arises, the controlling personnel shall have adequate means available to take corrective action.
The controlling personnel on ship and shore shall maintain an effective communication with their respective supervisors.
All personnel connected with the operations shall be familiar with the dangers of the substances handled.

a6 *Is the agreed ship/shore communication system operative?*
Communication shall be maintained between the responsible officer on duty on the ship and the responsible person ashore, in the most efficient way.
The ship is supplied by the agent with a portable VHF which has to be used only in case o emergency. Furthermore there is a telephone box given on board.
The selected system on communication together with the necessary information on telephone numbers and/or channels to be used shall be recorded on the appropriate form.
This form shall be signed by both ship and shore representatives.
The telephone and portable RT/VHF systems shall comply with the appropriate safety requirements.

a7 *Have the procedures for cargo and ballast handling been agreed?*
The procedures for the intended operation shall be preplanned. They shall be discussed and agreed upon by the ship and shore representative prior to the start of the operations. In setting up the procedures for the intended operation, the master or his representative shall pay due regard to the forces and stresses to which the ship may be subjected.
The agreed arrangements shall be recorded. The information which shall be contained in this form, shall be at least as indicated on that form which is attached to these guidelines.
Where deemed necessary this form may be used to record information related to the contents of the foregoing paragraph. (See annex 3 to these guidelines.) The form shall be signed by both representatives.
Any change in the agreed procedure that could affect the operation shall be discussed by both parties and agreed upon. After agreement has been reached by both parties substantial changes shall be laid down in writing as soon as possible and in sufficient time before the change in procedure takes place. In any case the change shall be laid down in writing within the working period of those supervisors on board and ashore in whose working period agreement on the change was reached.
The properties of the substances handled, the equipment of ship and shore installation, the ability of the ship's crew and the shore personnel to execute the necessary operations and to sufficiently control the operations are factors which shall be taken into account, when ascertaining the possibility of handling a number of substances concurrently.
The manifold area both on board and ashore shall be safely and properly lit during darkness. The illumination level shall be at least 20 lux.
The initial and maximum loading rates, topping off rates and normal stopping times shall be agreed, having regard to:

- the nature of the cargo to be handled;
- the arrangement and capacity of the ship's cargo lines and gas venting systems;
- the maximum allowable pressure and flow rate in the ship/shore hoses and loading arms;
- precautions to avoid accumulation of static electricity;
- any other flow control limitations.

Where applicable notes shall be inserted in the form mentioned in the second paragraph.
If the static electricity properties of the substance handled and the situation in the tank so require, no conducting object shall be inserted into that tank during loading and during a period of at least 30 minutes after the cessation of loading.
The operations shall be suspended on the approach of an electrical storm within a short distance of the handling location, except for operations with products having a flashpoint exceeding 55°C.
All openings in deck and vent lines shall be closed and kept closed during the electrical storm.

a8 *Has the emergency shut down procedure been agreed?*
An emergency shut down procedure shall be agreed between ship and shore and recorded on an appropriate form. The agreement shall designate in which cases the operations have to be stopped immediately.
Due regard shall be given to the possible introduction of dangers associated with the emergency shut down procedure.

a9 *Are fire hoses and fire fighting equipment on board and ashore positioned and ready for immediate use?*
Fire fighting equipment both on board and ashore should be correctly positioned and ready for immediate use.
Adequate units of fixed or portable equipment shall be stationed to cover the ship's cargo deck and on the jetty. The ship and shore main fire systems shall be pressurised, or be capable of being pressurised at short notice.
Both ship and shore shall ensure that their main fire systems can be connected in a quick and easy way where necessary utilising the international ship/shore connection.

a10 *Are cargo hoses/arms in good condition and properly rigged and, where appropriate, certificates checked?*
Cargo hoses and metal arms shall be in a good condition and shall be properly fitted and rigged so as to prevent strain and stress beyond design limitations. All flange connections shall be fully bolted. Other types of connections shall be properly secured.
It shall be ensured that the hoses or metal arms are constructed of a material suitable for the substance to be handled taking into account its temperature and the maximum operating pressure.
Cargo hoses shall be identifiable with regard to their suitability for the intended operation.

a11 *Are scuppers effectively plugged and drip trays in position, both on board and ashore?*
All scuppers on board and where applicable drainholes ashore shall be properly plugged during the operations.
Accumulation of water shall be drained off periodically.
Both ship and jetty shall ideally be provided with fixed drip trays; in their absence portable drip trays may be used.
All drip trays shall be emptied in an appropriate manner whenever necessary but always after completion of the specific operation.

a12 *Are unused cargo and bunker connections including the stern discharge line, if fitted, blanked?*
Unused cargo and bunker line connections shall be closed and blanked. Blank flanges shall be fully bolted and other types of fittings, if used, properly secured.

a13 *Are sea and overboard discharge valves, when not in use, closed and lashed?*
Experience shows the importance of this item in pollution avoidance on ships where the cargo line- and ballast systems are interconnected.
The security of the valves in question shall be checked.

a14 *Are all cargo and bunker tanks lids closed?*
Apart from the openings in use for tank venting (see a15) all openings to cargo tanks shall be closed gaslight.
Ullaging and sampling openings may be opened for the short period of ullaging and sampling.
Closed ullaging and sampling systems shall be used where required by international, national and local regulations and agreements.

a15 *Is the agreed tank venting system being used?*
Agreement shall e reached by both parties as to the venting system for the operation, taking into account the nature of the cargo and applicable regulations for ship and shore installation.
There are three basic systems for venting of tanks:
1. Open to atmosphere via open ullage ports, protected by suitable flame screens.
2. Fixed venting systems which include inert gas systems.
3. Suitable safe vapour return or handling system.

a16 *Are hand torches of an approved type?*

a17 *Are portable VHF/UHF transceivers of an approved type?*
Battery operated hand torches and VHF radio-telephone sets shall be of a safe approved* type. Ship/shore telephones shall comply with the requirements* for explosion-proof construction except when placed in a safe space in the accommodation.
VHF radio-telephone sets may operate in the internationally agreed wave bands only. The above-mentioned equipment shall be well maintained and damaged units, though operative, shall not be used.

a18 *Are the ship's main radio transmitter aerials earthed and radar's switched off?*
The ship's main radio transmitter shall not be used during the ship's stay in port, except for receiving purposes. The main transmitting aerials must be disconnected and earthed.
The ship's radar installation shall not be used unless the master, in consultation with the terminal manager, has established the conditions under which the installation may be used safely.

a19 *Are electric cables to portable electrical equipment disconnected from power?*
The use of portable electrical equipment on wandering leads is prohibited in hazardous zones.
The supply cables shall be disconnected and preferably removed from the hazardous zone.
Telephone cables in use in the ship/shore communication system, shall preferably be routed outside the hazardous zone. Wherever this is not feasible, the cable shall be so conditioned and protected, that no danger arises from its use.

a20 *Are all external doors and ports in the midships accommodation closed?*

a21 *Are all external doors and ports in the after accommodation leading onto or overlooking the tank deck closed?*
External doors, windows and portholes in the midship's accommodation shall be closed during the operations.
In the after accommodation external doors, windows and portholes facing or near the cargo zone shall be closed during operations. These doors shall be clearly marked, but at no time shall they be locked.

a22 *Are air conditioning intakes which may permit the entry of cargo vapours closed?*

a23 *Are window-type air conditioning units disconnected?*
Air-conditioning and ventilator intakes which are likely to draw in air from the cargo area shall be closed.
Air-conditioning units which are located wholly within the accommodation which do not draw in air from the outside may remain in operation.
Window type air conditioners shall be disconnected from their power supply.

a24 *Are smoking requirements being observed?*
Smoking on board the ship may only take place in places specified by the master in consultation with the terminal manager or his representative.
The smoking is allowed on the jetty and the adjacent area except in buildings and places specified by the terminal manager in consultation with the master.
Places which are directly accessible from the outside shall not be designated as places where smoking is permitted. Buildings, places and rooms designed as places where smoking is permitted shall be clearly marked as such.

a25 *Are the requirements for the use of galley and other cooking appliances being observed?*
Open fire may be used in galleys whose construction, location and ventilation system provides protection against entry of flammable gases.
In cases where the galley does not comply with the above, open fire may be used provided the master, in consultation with the terminal manager, has ensured that precautions have been taken against the entry or build up of flammable gases.

* Approved by or requirements of competent authorities such as Arbeidsinspectie (NL), PTB (BRD), Bureau of Mines (USA), BASEEFA (UK), U.L. (USA)

On ships fitted with stern discharge lines no open fire in galley furnaces and cooking appliances is allowed when these lines are used, unless the construction of the ship's accommodation allows for the safe use of open fire.

a26 *Are naked light requirements being observed?*
Naked light or open fire comprises the following: fire, spark formation, naked light and any surface with a temperature that is equal to or higher than the minimum ignition temperature of the products handled in the operations.
The use of open fire on board the ship - other than covered in questions a24 and a25 - and within a distance of 25m of the ship is prohibited, unless all applicable regulations have been met and subject to agreement by the competent port authority, terminal manager and the master.

a27 *Is there provision for an emergency escape possibility?*
In addition to the means of access referred to in question a3, a safe and quick emergency escape shall be available both on board and ashore.
On board the ship it may consist of a lifeboat ready for immediate use.

a28 *Are sufficient personnel on board and ashore to deal with an emergency?*
At all times during the ship's stay at the terminal, a sufficient number of personnel shall be present on board the ship and in the shore installation to deal with an emergency.

a29 *Are adequate insulating means in place in the ship/shore connection?*
Ship shore connections shall be fitted with electrically isolating means. They may consist of an isolating flange in every coupling or metal arm or a single length of non-conductive hose in the ship to shore connection. If insulating flanges are used, only one may be fitted in each of the lines or metals arms. The lines on the shore side of the insulating device shall be electrically continuous to the jetty system while the lines on the ship side shall be electrically continuous to the ship.
It shall be ascertained that the means of electrical discontinuity is in place and in good condition and that is not being by-passed by contact with external metal.

a30 *Have measures been taken to ensure sufficient pump-room ventilation?*
Ship's pump-rooms shall be mechanically ventilated and the ventilation shall be kept running throughout the operation. Ventilation shall be aimed at maintaining a safe atmosphere throughout the pump-room.

Part B
Additional Checks - Bulk Liquid Chemicals

b1 *Is information available giving the necessary data for the safe handling of the cargo including, where applicable, a manufacturer's inhibition certificate?*
Information on the product to be handled shall be available on board the ship and ashore before and during the operation.
This information shall include:
a. cargo stowage plan;
b. a full description of the physical and chemical properties, including reactivity, necessary for the safe containment of the cargo;
c. action to be taken in the event of spills or leaks;
d. counter measures against accidental personal contact;
e. fire-fighting procedures and fire fighting media;
f. procedures for cargo transfer.
When cargoes required to be stabilised or inhibited are to handled, information shall be exchanged thereon.

b2 *Is sufficient and suitable protective equipment (including self-contained breathing apparatus) and protective clothing ready for immediate use?*
Suitable protective equipment including self contained breathing apparatus, and protective clothing, appropriate to the specific dangers of the product handled, shall be readily available in sufficient numbers for operational personnel both on board and ashore.
Storage places shall be protected from the weather and clearly marked.
All persons directly involved in the operation shall utilise this equipment and clothing whenever the situation requires.
Personnel required to use breathing apparatus during operations shall be physically fit and trained in its safe use. Unit or untrained personnel shall not be selected for operations involving the use of breathing apparatus.

b3 *Are counter measures against accidental personal contact with the cargo agreed?*
Sufficient and suitable means shall be available to neutralise the effects and remove small quantities of spilled products.
However it is possible that unforeseen personal contact may occur. To limit the consequences sufficient and suitable counter measures shall be taken.
Information how to handle these contacts giving regard to the special properties of the products shall be studied and available for immediate use.
A suitable safety shower and eye rinsing equipment shall be fitted and ready for operations regularly take place.
Measures shall be taken to maintain the water at a safe temperature.

b4 *Is the cargo handling rate compatible with the automatic shut down system if in use?*
Automatic shut down valves may be fitted on the ship and the shore. The action of these is automatically initiated by a certain level being reached in the tank being loaded either on board or ashore. In cases where such systems are used, the cargo handling rate shall be so adjusted that a pressure surge evolving from the automatic closure of any such valve, does not exceed the safe working pressure of either the ship or shore pipeline system.
Alternatively, means may be fitted to relieve the pressure surge created, such as recirculation systems and buffer tanks. A written agreement shall be made between the ship and shore supervisors indicating whether the cargo handling rate will be adjusted or alternative systems will be used; the safe cargo handling rate shall be noted in this agreement and in the operation arrangement form (see a7).

b5 *Are cargo system gauges and alarms correctly set and in good order?*
Ship and shore cargo system gauges and alarms shall be regularly checked to ensure they are in good working order. Date and details of the last test shall be exchanged. In cases where it is possible to set alarms to different levels the alarm shall be set to the required level.

b6 *Are portable vapour detection instruments readily available for the products to be handled?*
The equipment provided shall be capable of measuring, where appropriate, flammable and/or toxic levels.
Suitable equipment shall be available to calibrate those instruments capable of measuring flammability.
Calibration shall be carried out before the operation commences.

b7 *Has information on fire fighting media and procedures been exchanged?*
Information shall be exchanged on the availability of fire fighting equipment and the procedures to be followed in the event of fire on board or ashore.
Special attention shall be given to any products which are being handled which may be water reactive or require specialised fire fighting procedures.

b8 *Are transfer hoses of suitable material resistant to the action of the cargo's*?
A transfer hose shall be indelibly marked so as to allow the identification of the products for which it is suitable, its specified maximum working pressure, the test pressure and the last date on which it was tested at this pressure, and if used at service temperatures other than ambient, its maximum and/or minimum service temperature.

b9 *Is cargo handling being performed with the permanent installed pipeline systems?*
During cargo operations where the use of portable cargo lines on board or ashore is inevitable, care shall be taken to ensure that these lines are correctly positioned and assembled so that no extra danger exists from their use. Where necessary, the electrical continuity of these lines shall be checked.
Non permanent cargo line systems shall be kept as short as possible.
Whenever cargo hoses are used to make connections within the ship or shore permanent pipeline system, these connections shall be secured and kept as short as possible and electrically continuous to the ship or shore line system respectively (see a29).
The use of non permanent equipment inside tanks in generally not permitted unless the competent port authority's approval has been obtained.

Part C
Additional Checks - Bulk Liquefied Gases

c1 *Is information available giving the necessary data for the safe handling of the cargo including, where applicable, a manufacturer's inhibition certificate?*
Information on the product to be handled shall be available on board the ship and ashore before and during the operation.
This information shall include:
a. cargo stowage plan;
b. a full description of the physical and chemical properties necessary for the safe containment of the cargo;
c. action to be taken in the event of spills or leaks;
d. counter measures against accidental personal contact;
e. fire-fighting procedures and fire fighting media;
f. procedures for cargo transfer;
g. special equipment needed for the safe handling of the particular cargo;
h. minimum cargo containment system temperature.
When cargoes required to be stabilised or inhibited are to be handled, information shall be exchanged thereon.

c2 *Is the water spray system ready for use?*
In cases where flammable and/or toxic products are handled, water spray systems shall be regularly tested.
Details of the last test shall be exchanged.
During operations the systems shall be kept ready for immediate use.

c3 *Is sufficient and suitable protective equipment (including self-contained breathing apparatus) and protective clothing ready for immediate use?*
Suitable protective equipment, including self-contained breathing apparatus, and protective clothing, appropriate to the specific dangers of the product handled, shall be readily available in sufficient numbers for operational personnel both on board and ashore.
Storage places shall be protected from the weather and clearly marked.
All personnel directly involved in the operation shall utilise this equipment and clothing whenever the situation requires.
Personnel required to use breathing apparatus during operations shall be physically fit and trained in its use. Unfit or untrained personnel shall not be selected for operations involving the use of breathing apparatus.

c4 *Are void spaces properly inerted where required?*
The spaces that are required by the IMO Gas Carrier Codes to be inerted shall be checked by ship's personnel prior to arrival.

c5 *Are all remote control valves in working order?*
All ship and shore cargo system remote control valves and their position indicating systems shall be regularly tested. Details of the last tests shall be exchanged.

c6 *Are cargo tank safety relief valves lined up to the ship's venting system and are by-passes closed?*
If the venting system is fitted with relief valve by-passes, the by-passes must be closed.
When different grades of cargo are carried simultaneously, independent venting systems must be available and segregation between systems shall be checked.
In cases where cargo tanks are permitted to have more than one relief valve setting, it shall be verified that the relief valve is set as required by the cargo to be handled and that the actual setting of relief valve is clearly and visibly displayed. Setting of relief valves shall be recorded.

c7 *Are the required cargo pumps and compressors in good order, and have the maximum working pressures been agreed between ship and shore?*
Agreement shall be reached upon the maximum allowable working pressure in the cargo line system during operations. The agreed pressure shall be entered in the operation arrangement form.

c8 *Is re-liquefaction or boil off control equipment in good order?*
It shall be verified that re-liquefaction and boil off control systems, if required, are functioning correctly prior to commencement of operations.

c9 *Is gas detection equipment set for the cargo, calibrated and in good order?*
Span gas shall be available to enable calibration of gas detection equipment. Fixed gas detection equipment shall be calibrated for the product to be handled prior to commencement of operations. The alarm function shall have been tested and details of last test shall be exchanged.
Portable gas detection instruments, suitable for the products handled and capable of measuring flammable and/or toxic levels shall be available.
Portable instruments capable of measuring in the flammable range shall be calibrated for the product to be handled before the operations commence.

c10 *Are cargo system gauges and alarms correctly set and in good order?*
Ship and shore cargo system gauges shall be regularly checked to ensure that they are in good working order. Date and details of last test shall be exchanged.
In cases where it is possible so set alarms to different levels, the alarm shall be set to the required level.

c11 *Are emergency shut down systems working properly?*
Ship and shore emergency shut down systems shall be tested regularly.
The test procedure shall include the testing of as many elements of the cargo transfer system as possible. Details of the last test shall be exchanged.

c12 *Does shore know the closing rate of ship's automatic valves; does ship have similar details of shore system?*
Automatic shut down valves may be fitted on the ship and the shore. The action of these is automatically initiated by a certain level being reached in the tank being loaded either on board or ashore.
In cases where such systems are used, the cargo handling rate shall be so adjusted that a pressure surge evolving from the automatic closure of any such valve, does not exceed the safe working pressure of either the ship- or shore pipeline system.
Alternatively, means may be fitted to relieve the pressure surge created, such as recirculation systems and buffer tanks. A written agreement shall be made between the ship and shore supervisor indicating whether the cargo handling rate will be adjusted or alternative systems will be used; the safe cargo handling rate will be adjusted or alternative systems will be used; the safe cargo handling rate shall be noted in this agreement and in the operation arrangement form (see a7).

c13 *Has information been exchanged between ship and shore on minimum working temperatures of the cargo system?*
Before operations commence information should be exchanged between ships and shore representatives on cargo temperature/pressure requirements.
This information shall be entered in the operation arrangement form.

Annex 1 to the guidelines

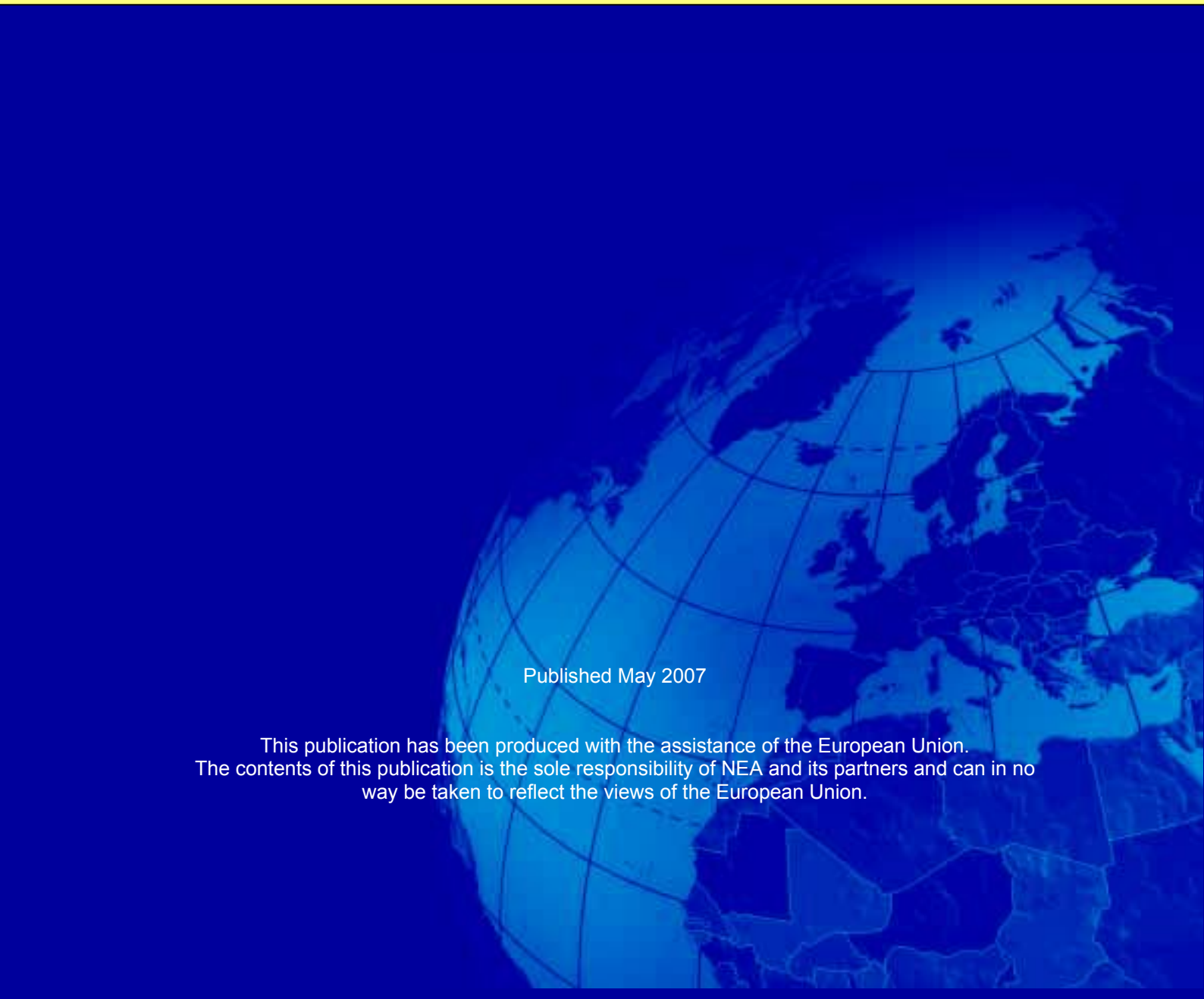
Description of dangerous substances
Dangerous substances in the context of the checklist are the substances of the following classes of the International Maritime Dangerous Goods Code,
2. Gases, Compressed, liquefied or dissolved under pressure
3. Flammable liquids
6.1 Poisonous substances
8. Corrosives

Note
European regulations for Class 3 liquids, designate products with flashpoints up to 100°C as flammable liquids.

Chemical tankers
Tankships handling substances as mentioned in chapters 6 and 7 of the Annex[22] of Resolution A212 (VII) of IMO as amended.
These substances are also mentioned in chapters 17 and 18 of the International Bulk Chemical Code.

Gastankers
Tankships handling substances as mentioned in chapter 19 of the Annex[23] of Resolution A328 (IX) or the Annex[24] of Resolution A329 (IX) of IMO, as amended.
These substances are also mentioned in chapter 17 of the International Gas Carrier Code.

[22] Bulk Chemical Code
[23] Gas Carrier Code
[24] Gas Carrier Code for existing Ships



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