European Commission
Directorate-General Environment

Assessing the case for EU legislation on the safety of pipelines and the possible impacts of such an initiative

Final Report
ENV.G.1/FRA/2006/0073

December 2011

COWI

ECORYS Research and Consulting

cambridge econometrics

COWI

COWI A/S

Parallelvej 2
DK-2800 Kongens Lyngby
Denmark

Tel +45 45 97 22 11
Fax +45 45 97 22 12
www.cowi.com

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Prepared	FHHE, MMS, Koen Rademaekers (Ecorys) and Hans Bolscher (Ecorys)
Checked	MMS, SHJ
Approved	Michael Munk Sørensen (COWI)

Table of Contents

List of abbreviations		**3**
Executive summary		**5**
1	**Introduction**	**15**
1.1	Background	15
1.2	Objective	16
1.3	Approach	16
1.4	Contents of the report	17
2	**Pipeline infrastructure, accidents and hazard potentials**	**18**
2.1	Data on pipeline networks	18
2.2	Accident potential	27
2.3	Accident statistics	36
2.4	Individual and society risk posed by pipelines	42
2.5	US Pipeline safety recommendations	43
2.6	Potential and accidents	44
3	**Existing legislation**	**45**
3.1	National Member State legislation	45
3.2	Industry perspectives	50
3.3	Existing EU legislation, other than Seveso	62
4	**Legislative gaps**	**65**
4.1	Legislative benchmark	65
4.2	Legislative gaps	66
4.3	Baseline	71
5	**Options for closing legislative gaps**	**76**
5.1	Baseline	77
5.2	Recommendations/guidelines	77

5.3	Include pipelines in Seveso Directive	78
5.4	Introduce a specific directive for pipeline safety	78
5.5	Other policy options	78
6	**Impact assessment**	**80**
6.1	Baseline	81
6.2	Non-legislative action: guidelines, recommendations and benchmarking	81
6.3	Legislative options	82
6.4	Comparison of options	90
6.5	Conclusions	91
7	**Data sources**	**92**

Table of Appendices

Appendix A	**Member State legislation**	**96**
Appendix B	**Questionnaire on national legislation**	**125**

List of abbreviations

APPE	Association of Petrochemicals Producers in Europe
bcm	Billion cubic metre
BEVB	External Safety of Pipelines Decree (the Netherlands)
CA	Competent Authorities
CBA	Cost-Benefit Analysis
CLP	Classification, Labelling and Packaging
CSR	Corporate Social Responsibility
EDCA	External Corrosion Direct Assessment
EFMA	European Fertiliser Manufacturers' Association
EGIG	European Gas Pipeline Incident Data Group
EIA	Environmental Impact Assessment
ELD	Environment Liability Directive
EPCIP	European Critical Infrastructure Protection Directive
EPDC	European Pipeline Development Company
E-PRTR	European Pollute Release and Transfer Register
FTE	Full-time Equivalents
GAO	General Accounting Office (USA)
GIS	Geographic Information System
HTL	High-pressure Network (the Netherlands)
IR	Individual Risk
ISPS	International Port and Ship Facility
JRC	Joint Research Centre
KLIC	Cables and pipeline information system (the Netherlands)

LPG	Liquefied Petroleum Gas
MAPCO	MidAmerica Pipeline System
MOP	Maximum Operation Pressure
MS	Member State
NEN	Dutch pipeline standard
NGL	Natural Gas Liquids
NMA	Netherlands Competition Authority
OSP	Operator Security Plan
PAS	Publicly Available Specification
PED	Pressure Equipment Directive
PIMS	Pipeline Integrity Management System
PK	Point Kilométrique
RIVM	National Institute of Public Health and the Environment (the Netherlands)
RTL	Regional Network (the Netherlands)
SMS	Safety Management System
SODM	State Supervision of Mines (the Netherlands)
SR	Societal Risk
TEPN	Trans-European Pipeline Network
TSO	Transmission System Operator
UNECE	UN Economic Commission for Europe

Executive summary

Aim of the study

The overall aim of this study was to provide the Commission with information and analysis that will enable it to determine the need for and the potential value added of Community legislative action on the safety of onshore pipelines.

Major industrial accidents are regulated through the Seveso II Directive, which excludes pipelines from its scope. While there is currently no comprehensive EU legislation on pipeline safety, the national legislation of Member States regulates the construction and operation of pipelines today.

On this background, the specific objectives of this study were to:

- review data on pipeline networks and pipeline accident history to assess the major accident hazard potential;
- assess the coverage of existing national and EU legislation and identify possible gaps in the legislative coverage;
- propose non-legislative and legislative initiatives to close identified gaps and to assess the impacts of the suggested initiatives.

Pipeline network and incident history and hazard potential

Network length

The onshore pipeline network conveying dangerous substances in the EU is predominantly natural gas pipelines.

Table 0-1 Pipeline network in EU - estimated length in km

	Length - km
Total gas	2,030,058
Transmission	250,942
Distribution	1,779,116
Oil & Petroleum Products	36,275
Olefin	≈6,000

	Length - km
Ammonia	≈200
CO_2	≈250
Hydrogen	≈1,500
Others	?
Total	**2,074,283**
Total excluding gas distribution	**295,168**

Source: Eurogas, CONCAWE APPE and own estimates

The gas distribution system accounts for 87 per cent of the total pipeline network. The majority of the distribution network is comprised of low-pressure pipelines (below 8 bar), which are of no relevance to a major accident hazard potential. If the distribution pipelines of the gas network are excluded, the total length of 'major accident hazard' pipelines is about 295,000 km of which the gas transmission pipelines account for the largest share - about 84 per cent.

Hazard potential

The major accident hazard potential has been demonstrated through international examples of major accidents. The only severe European pipeline disaster to date was the third-party caused pipeline rupture in a sparsely populated area in Ghislenghien (Belgium) in 2004. There were 24 fatalities and 132 injuries. The damage costs were estimated at 100 MEUR[1]. On a global scale, particularly in the USA, pipeline incidents with major consequences are more frequent, mostly because the pipeline networks are more extensive.

Accident and incident statistics

As major accidents with pipelines in Europe happen very rarely, it is not possible to resort to statistics to assess the development in pipeline safety management. Instead, the number of incidents, including minor incidents, can be used as indicator for the development in pipeline safety. Available incident statistics are based on data reported by industrial associations.

The incident rate for gas transmission pipeline is illustrated in the figure below.

[1] EEA (2010)

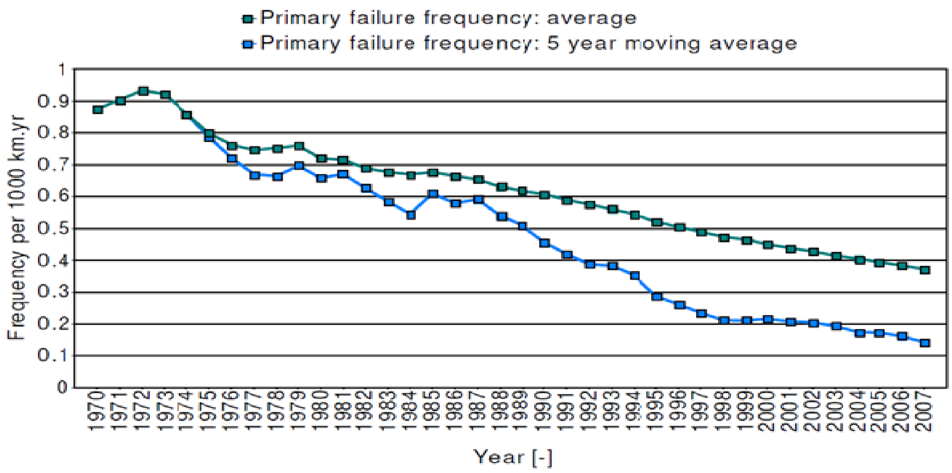
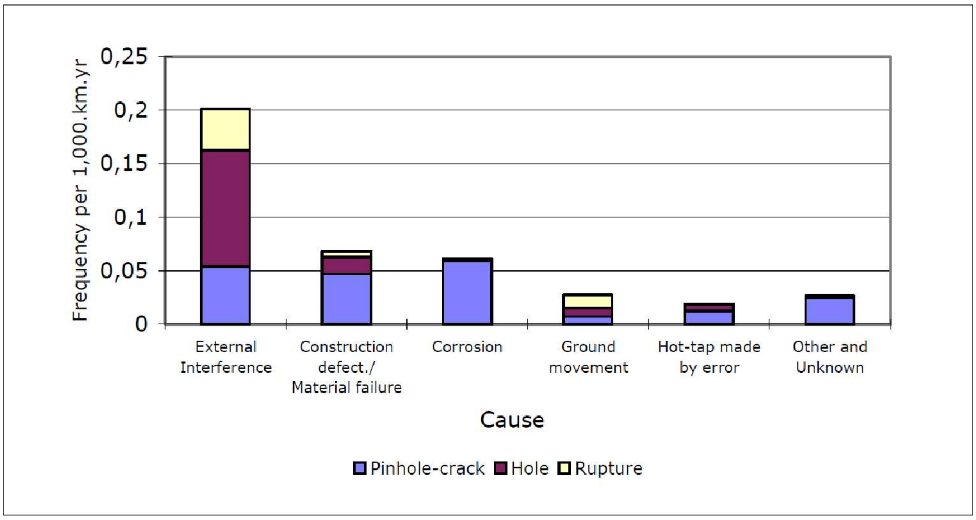


Figure 0-1 Development of overall and five-year moving average incident frequency in EGIG natural gas transmission pipelines

Source: EGIG (2008)

The latest five-year moving average incident rate for gas transmission pipelines is 0.14 incident per 1000 km/year. For oil pipelines, there is a similar trend where the latest five-year average is 0.28 incidents per 1000 km/year[2].

The below figure illustrates the relationship between the size of the leak and the causes of the pipeline failure. Assuming that the categories "hole" and "rupture" are potentially the ones causing the most severe accidents, third-party interference is the main cause. Hence, this identifies third-party interference as one of the most important elements to consider.



Source WG 2006:21

Figure 0-2 Relationship between cause and size of leak

[2] CONCAWE 2011

Though there are shortcomings in the statistics available[3], the main findings from the review of the onshore pipeline accident and incident history are:

- a decreasing incident rate for both gas and oil pipelines suggesting continued safety management improvements.

- third-party interference as one of the main causes of pipeline incidents - for gas pipelines it is about 50 per cent and for oil about 30 per cent.

If the available incident rates are applied to the total pipeline network length with a major hazard potential (excluding the gas distribution system), the expected annual number of incidents is around 40-50.

Damage costs were estimated based on data from the Netherlands where reported incidents are categorised according to the severity of the damage caused by the incidents. Applying the Dutch data to the costs of damage to health, the environment and third-party property, the average damage per incident is estimated to EUR 0.39 million. Accordingly, approximately 40-50 expected incidents annually would result in damage costs of about EUR 18 million. This is a rough indication of the average, annual damage costs, which exclude the costs to the pipeline operators.

Legislative benchmark

To assess the coverage of national legislation, a legislative benchmark was developed. The benchmark is based on a combination of the safety provisions applied to fixed installations and an assessment of the accident history and major accident hazard potential of onshore pipeline transport. The legislative benchmark includes the following general safety provisions:

- Prevention of accidents:

  - Safety management systems
  - Risk assessment
  - Technical safety management measures
  - Prevention of third part interference
  - Land use planning (will also have a mitigating effect).

- Mitigation of impact of accidents;

  - Information to the public
  - Emergency plans (authority's onus)

The assessment of the coverage of national legislation has included more detailed requirements within each of the main general safety provisions.

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[3] The main deficiency is that that incident data on the gas transmission network in terms of length covers around 50 per cent of the EU-27 gas transmission pipelines system.

Coverage of existing Member State legislation

The assessment of the current national legislation was derived from replies to a Member State questionnaire. The questionnaire is included as Appendix B, while the replies are presented in Appendix A.

Table 0-2 presents an overview of the coverage of national legislation regarding key safety elements based on an assessment of the replies of 17 Member States three candidate countries and one EFTA country[4].

The replies are from Member States that account for 90 per cent of the pipeline length. Hence, data are considered reasonably representative for assessing the overall coverage of national safety legislation on on-shore pipelines.

Table 0-2 Overview of current Member State legislative coverage[5]

Country	Safety management systems	Risk assessment	External emergency plans	Land use planning	Information to the public	Third-party issues	Technical safety requirements
Belgium	++	++	++	++	+	+++	++
Czech Republic	+	0	+++	++	+	+++	++
Denmark	0	++	++	+	0	++	+++
Estonia	0	++	0	+	0	++	++
Finland	+++	++	++	++	+	++	+++
France	+++	++	+++	++	+	+++	++
Germany	++	++	+++	++	+	+++	+++
Ireland	+++	++	+++	0	+	+++	0
Italy	+	++	0	+	+	++	+++
Netherlands	++	++	+++	+	+	+++	Duty of care
Poland	+++	+	0	+	+	+	+++
Portugal	+++	++	0	+	+	+++	+++
Romania	+++	++	+++	+	+	0	++
Spain[6]	+ +	+ +	+	+ + +	+	+	+ +

[4] Malta and Iceland also replied but have no legislation as there are no pipelines to be covered by national legislation and hence they are not shown in Table 0-2.

[5] There can be differences depending the substance being transported - typically coverage is most extenstive for gas pipelines.

Country	Safety management systems	Risk assessment	External emergency plans	Land use planning	Information to the public	Third-party issues	Technical safety requirements
Sweden	++	0	+	0	0	+	++
UK	+++	++	++	++	0	+	Duty of care
Croatia	++	+++	++	++	+	++	+++
Turkey	++	+++	+++	++	+	++	+++
Norway	++	+++	+++	++	+	++	+++

Legend: 0: no provision in place +: basic provision, ++ several provisions +++ many provisions

Source: Member State questionnaire replies

Legislative gaps

The assessment of existing Member State legislation found that:

- according to the data collected, there are few major gaps. As to external emergency plans and information to the public, there are a few examples of Member States with not very stringent requirements.
  - emergency plans are not mandatory in four of 16 Member States, and only six of those who have made provisions for emergency plans require testing and drills.
  - in terms of third-party interference, all Member States have various provisions, though only eight of 16 seem to have a single point of contact for contractors.
- the scope of legislation is implemented differs and the specific detailed requirements vary across Member States reviewed.
- none of the responding Member States has a major gaps in legislative coverage - only one or two elements are missing.
- most countries have made revisions or amendments to legislation during the last 10 years, and in most countries legislation is regularly revised.
- the assessment does not indicate to which extent existing legislation is adequately enforced.

Other potentially relevant EU legislation includes the EIA Directive, the Pressure Equipment Directive and the European Critical Infrastructure Directive[7].

[6] In Spain there is no safety legislation covering oil pipelines.

[7] Council Directive 2008/114/EC on the identification and designation of European critical infrastructures and the assessment of the need to improve their protection

The EIA Directive requires risk assessment of new pipeline projects, which in principle means that issues of protection against third-party interference etc should be covered. The Pressure Equipment Directive includes standards for equipment used as part of pipeline systems. In this manner, it supports the technical quality of the equipment. The Directive on designation of critical infrastructure requires Member States to identify pipelines that are critical (energy supply perspective) and develop Operator Security Plans (OSPs) for the identified infrastructure. These plans will cover protection measures against intentional third-party interference for the designated pipelines.

Policy options and impacts

Irrespective of whether a decision is made to take any further EU level action on the safety of onshore pipelines, potential alternative policy options could be defined and considered. Hence, the following set of relevant policy options was assessed:

- Develop recommendations/guidelines (not legally binding) and introduce benchmarking;
- Amend the Seveso III Directive to include pipeline transport;
- Adopt a specific pipeline safety directive.

Guidelines and benchmarking

While effect of additional guidance might not be significant, introducing more benchmarking could be relevant. Currently, industry associations collect data on incidents for gas and oil pipelines, and in some Member States there are national incident statistics. The criteria for inclusion of incidents vary making comparison and benchmarking difficult.

Benchmarking would imply costs of developing a useful system and of operators reporting incidents. It could have a positive impact on the overall protection level by increasing and maintaining focus on pipeline safety, including increasing the attention of relevant CAs (Competent authorities) to preventing third-party interference.

New directive or part of Seveso

Including pipelines in the Seveso III Directive or making a specific pipeline safety directive will lead to many of the same impacts. The specific provisions for pipelines could in principle be made in the same way, so when comparing these alternatives, it is mainly a question of the 'practical' aspects of either modifying the Seveso Directive or developing, transposing and implementing a new directive that determine the preferred alternative.

Table 0-3 Comparison of specific pipeline safety directive or inclusion as part of Seveso

	Advantages	Disadvantages
Separate directive	Scope has to be defined differently compared with fixed installations covered by the current Seveso II Directive. Several safety provisions have to be tailored to pipeline safety. Measures to prevent third party interference are specific to pipelines.	Potentially more costly to introduce a new directive (depend on whether pipelines could be included in the ongoing revision of the Seveso Directive). If not, probably no major differences in transposition costs.
Include in Seveso III Directive	More complete coverage of industrial accidents (though other forms of transport still separately).	Different CAs involved in pipeline safety issues, which will make implementation of the Seveso III Directive more complicated and costly. An amended Seveso Directive would become more complex with new elements only relevant to pipelines.

The comparison suggests that a specific pipeline safety directive could be the best option.

Impacts of legislative option

It is difficult to estimate the impact of additional legislation without specifying the detailed requirements. Given that the gaps found in national legislation were few, the impact on the protection level will be moderate unless additional requirements are proposed and included in a legislative option. Similarly, the administrative costs to operators of a legislative option would also be limited, as they are already required to comply with national legislation covering most of the 'legislative benchmark' elements.

Comparison of options

The impacts of the options are presented in the below table. Though some illustrative costs are presented, the available information does not allow for a detailed quantified impact assessment.

Table 0-4 Impacts of policy options - preliminary assessment

Policy option	Impact on protection level	Cost of implementation
Recommendations and benchmarking	Benchmarking might support the current trend of decreasing incident rates	Cost of developing recommendations could be in the order of 0.5MEUR Reporting and benchmarking could cost around 0.5 MEUR annually

Policy option	Impact on protection level	Cost of implementation
Extend Seveso Directive	As there are few gaps in national legislation, new EU legislation cannot be expected to have major impacts.	Possible additional administrative costs to operators - uncertain estimate in the order of 2 MEUR annually If more inspection and maintenance of pipelines are required, it could lead to high costs to operators (1% additional inspection and maintenance could cost 6 MEUR) Additional measures to prevent third-party interference could lead to higher costs to CAs Transposition and implementation could be in the order of 1 MEUR for MSs Differences in specific provisions for pipelines and different CAs being involved could incur additional administrative costs to CAs
New Directive	As there are few gaps in national legislation, new EU legislation cannot be expected to have major impacts.	Possible additional administrative costs to operators - uncertain estimate in the order of 2 MEUR per year If more inspection and maintenance of pipelines would be required it could lead to high costs for operators (1% additional inspection and maintenance could cost 6 MEUR) Additional measures to prevent third-party interference could lead to high costs for CAs Transposition and implementation could be in the order of 1 MEUR for MSs

In the presentation above, the effects of the option "New Directive" and the option "Extend Seveso Directive" are almost similar. This is based on the assumption that the same safety requirements can be included in both options.

A separate pipeline directive would make it easier to draw up provisions that address appropriately pipeline safety issues. Pipeline safety also involves CAs different from those involved in enforcement of the Seveso Directive. Hence an amended Seveso III Directive would require the involvement of additional CAs and higher administrative costs for CAs.

Conclusions

The main objectives of this study were to assess need for and the value added of EU-level legislation targeting onshore pipeline safety.

The assessment found that:

- onshore pipeline conveyance of dangerous substances has a major hazard potential, which is demonstrated by several case examples;
- the number of major accidents involving pipelines in the EU is limited;

- there is a decreasing incident rate for both gas and oil pipelines based on the incident data as recorded by EGIG and CONCAWE. If this incident rate is used as indicator for the level of safety management, it suggests that operators are improving their safety management;

- based on information from Member States covering around 90 per cent of the pipeline network, there are some but not many gaps in national legislation compared to the legislative benchmark.

This points to limited value added of additional EU legislation. The reservations to this conclusion are:

- The EGIG database on gas incidents covers a network of a little more than 50 per cent of the total gas transmission network. Data are not published annually, as it is the case for CONCAWE's incident report on onshore oil pipelines. Accordingly, the understanding of the level and development of gas pipeline incidents are not complete.

- Third-party interference is one of the main reasons for incidents. Further reduction of third-party interference will require additional efforts from relevant CAs. Additional legislation may be necessary to improve enforcement of rules designed to prevent contractors from starting excavation work without knowledge about pipeline location.

Given the shortcomings of existing incident statistics, introducing reporting and benchmarking at EU level could improve the decision basis for future considerations of pipeline safety and help maintain focus on safety on the part of operators and CAs.

1 Introduction

This is the Final Report for the study on *"Assessing the case for EU legislation on the safety of pipelines and the possible impacts of such an initiative"* under the Framework Contract for Economic Analysis of Environmental Policies and of Sustainable Development (ENV.G.1/FRA/2006/0073).

1.1 Background

The safety aspects of pipelines conveying dangerous substances are not covered specific EU legislation. While the Seveso II Directive aims to prevent major accidents at industrial facilities, pipeline transport is not included. Other EU legislation such as the Pressure Equipment Directive (PED) also excludes pipeline safety.

During the discussion and co-decision process on the Seveso II Directive, the Parliament was keen to see pipelines included and the Commission was asked to look into the matter. Previous work on this subject was done almost 15 years ago. At that time, the conclusion that emerged from the studies pointed to certain gaps in national legislation[8]. A draft proposal for "stand alone" regulation was prepared, but did not materialise, primarily because of lack of resources and not so much because of specific results indicating a non-existent need for such regulation.

Since the last assessment of how pipeline safety was incorporated into national legislation, there have been a number of new developments in pipeline transport and pipeline safety. These developments include:

- New Member States;
- Increased pipeline networks;
- New national legislation.

In the remit of the UNECE, an initiative for pipeline safety was taken,, which led, in 2008, to the publication of a set of recommendations for pipeline safety[9].

Against this background, the objective of this study is to follow up on these developments and assess the current situation regarding legislation on the safety of pipelines.

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[8] JRC 1999, *Pipeline Safety Instrument*, MAHB May 1999

[9] UNECE 2008 *Safety Guidelines and Good Practices for Pipelines*

1.2 Objective

Purpose of study

The purpose of this study is to assess how pipeline safety is covered by current national and EU legislation and in the light of an increasing use of pipeline networks across the EU to investigate the potential added value of additional EU safety legislation.

Overall objective

The overall objective of this study is to provide the Commission with a basis for determining the need and potential added value of Community legislative actions regarding the safety of pipelines.

Immediate objectives

This overall aim leads to following immediate and operational objectives:

1. Review pipeline accident history and assess the major accident hazard potential from pipeline transport of dangerous substances;

2. Define a legislative benchmark for general safety measures related to onshore pipeline transport of dangerous substances;

3. Identify the gap between the existing legislative coverage (national and EU) and the "benchmark" level of coverage; and

4. Identify and assess the impacts of alternative policy options to close the legislative gap.

The policy options to be considered in this study include non-mandatory actions, inclusion of safety of pipelines in existing EU legislation and development of specific EU safety of pipeline legislation.

1.3 Approach

The hazard potential was described using example of past major accidents. Many of these accidents have taken place outside of the EU but they still demonstrate the hazard potential associated with pipeline transport of dangerous substances.

The accident history was further described using incident statistics from European Gas Pipeline Incident Data Group (EGIG) and the oil companies' European association for environment, health and safety in refining and distribution (CONCAWE).

The main element in the approach to the study was the collection of data on existing national legislation through a Member State questionnaire. Additionally, selected industry associations and operators were consulted.

The questionnaire on the national legislation is included in Appendix B. The questionnaire was submitted to all EU Member States and candidate countries.

Answers were received from 17 Member States, three candidate countries and Norway.

The Member States that have replied account for around 90% of the EU-27 on-shore pipeline network. Hence, replies are considered sufficiently representative for assessing the current situation regarding pipeline safety in the EU.

The following industry associations have been consulted:

- Marcogaz
- CONCAWE
- APPE
- Euro Chlor

The purpose of the industry consultation has been to get additional data on pipeline network and incident statics and to get information about operator's safety management practices and experience with the current legislation. In addition to the industry associations, two gas operators have been consulted and have provided more detailed input on use of safety management systems and costs of safety management.

The description of the results of the interviews and consultation with the selected industry associations are presented in Chapter 3, Section 3.2.

1.4 Contents of the report

The Final Report includes the following sections:

- Chapter 2: pipeline network, accident history and accident potentials
- Chapter 3: description of existing national and EU legislation
- Chapter 4: assessment of legislative gaps
- Chapter 5: options for closing gaps
- Chapter 6: impact assessment of options
- Appendix A: Detailed reporting of existing national legislation based on Member State replies to questionnaire
- Appendix B: The Member State questionnaire

2 Pipeline infrastructure, accidents and hazard potentials

A discussion on the inclusion or exclusion of pipelines in Seveso-type legislation would naturally comprise considerations on:

- the extent to which pipelines present a hazard potential comparable to that of Seveso establishments, and,

- the extent to which the hazard is adequately controlled, i.e. how often the hazard potential is realized.

A review of selected past accidents may serve to illustrate the extent to which existing pipelines have been able to cause harm, i.e. the extent to which they present a hazard potential comparable to that of industrial establishments.

A review of the accident statistics could provide information on the second issue, the extent to which the existing hazard control measures have been effective.

2.1 Data on pipeline networks

In this section, an overview is provided on available data on pipeline networks and their length in the EU-27 region.

2.1.1 Gas pipelines

The enlargement of the European Union from EU-15 to EU-27 led to the inclusion of ex-eastern European gas and oil networks.

The most extensive pipeline network is for transmission of natural gas from the producer to local distribution networks. The European high-pressure gas transmission grid has grown to a length of over 250,000 km in addition to more than 1.7 million kilometres of low-pressure distribution lines, which today distribute over 300 billion cubic metres (bcm) per year. The outlook for natural gas demand in the EU indicates growth to a level of 530 bcm in the year 2020 (Papadakis 2003). A large part of the existing networks (~2/3) was constructed between 1964 and 1983.

The European Gas Incident Group (EGIG) represents 14 major natural gas transmission network operators in the EU (Austria, Denmark, Spain, Belgium, Czech Republic, Finland, France, Germany, Italy, Ireland, the Netherlands, Portugal, Sweden, and UK). Nearly half of the EGIG system is in the 5-16″ diameter range and almost a quarter of it in the uppermost range of over 30″ up to 48″ diameter. The total length of the EGIG networks was estimated to be 130,000 by 2007[10]. A large part of the networks (~2/3) was constructed between 1964 and 1983 (Papadakis 2003).

The below table is based on Eurogas (2007) and it shows the network in EU by Member State and divided on transmission pipes and distribution pipes.

Table 2-1 Gas pipelines in km 2007 data

Country	Natural gas pipelines, total length (km)	Length of transmission pipelines	Length of distribution pipelines
Total	**1,807,131**	**263,715**	**1,195,452**
Austria	36,000		
Belgium	65,834	3,316	62,518
Bulgaria	4,000	1,800	2,200
Cyprus			
Czech Republic	74,437	3,650	70,787
Denmark	18,439	1,439	17,000
Estonia	2,274	879	1,395
Finland	2,800	1,140	1,660
France	229,950	36,620	193,330
Germany	420,000		
Greece	5,315	1,076	4,239
Hungary	86,613	5,278	81,335
Ireland	12,373	2,311	10,062
Italy	261,923	32,381	229,542
Latvia	5,830	1,281	4,549
Lithuania	9,300	1,800	7,500
Luxembourg	2,365	405	1,960
Malta			
Netherlands	147,700	12,000	135,700
Poland	120,723	15,976	104,747
Portugal	12,452	1,431	11,021
Romania	46,047	12,258	33,789
Slovakia	33,807	2,270	31,573
Slovenia	3,610	1,010	2,600
Spain	63,139	9,344	53,795
Sweden	2,800	650	2,150
UK	139,400	7,400	132,000
Non-EU countries			
Turkey	9,798	7,150	2,648

Source: Eurogas 2007

[10] EGIG (2008)

The above data are the latest publicly available data by Member States which include the split between transmission and distribution. The latest Eurogas data cover 2009, and the total network length has increased to 2,030,058 km, which is an increase of 4 per cent annually from 2007 to 2009[11].

There may be some inconsistencies in the breakdown on transmission and distribution networks as different criteria are in use by Member States. The transmission backbone grid is made of steel; it often operates at a pressure of 80 bar and may have compressor booster stations to compensate for pressure drop caused by flow friction. From the backbone grid, regulator stations may supply 40 bar or 20 bar pipeline systems made of steel, which have no booster stations. The distribution pipeline system is usually made of polyethylene thermoplastics and typically operated at 4 bar or less. For historical reasons, there is considerable variation amongst Member States; some operate transmission pipelines at 19 bar of pressure, and some operate distribution networks at 8 bar or more. A group of European gas experts has offered a simple classification based on maximum operating pressure; above 16 bar it is a transmission pipeline, otherwise it is a distribution pipeline (WG 2006). Early British Gas data presented failure rates for transmission lines, defined as those with a design pressure greater than 7 bar (HSE 1995).

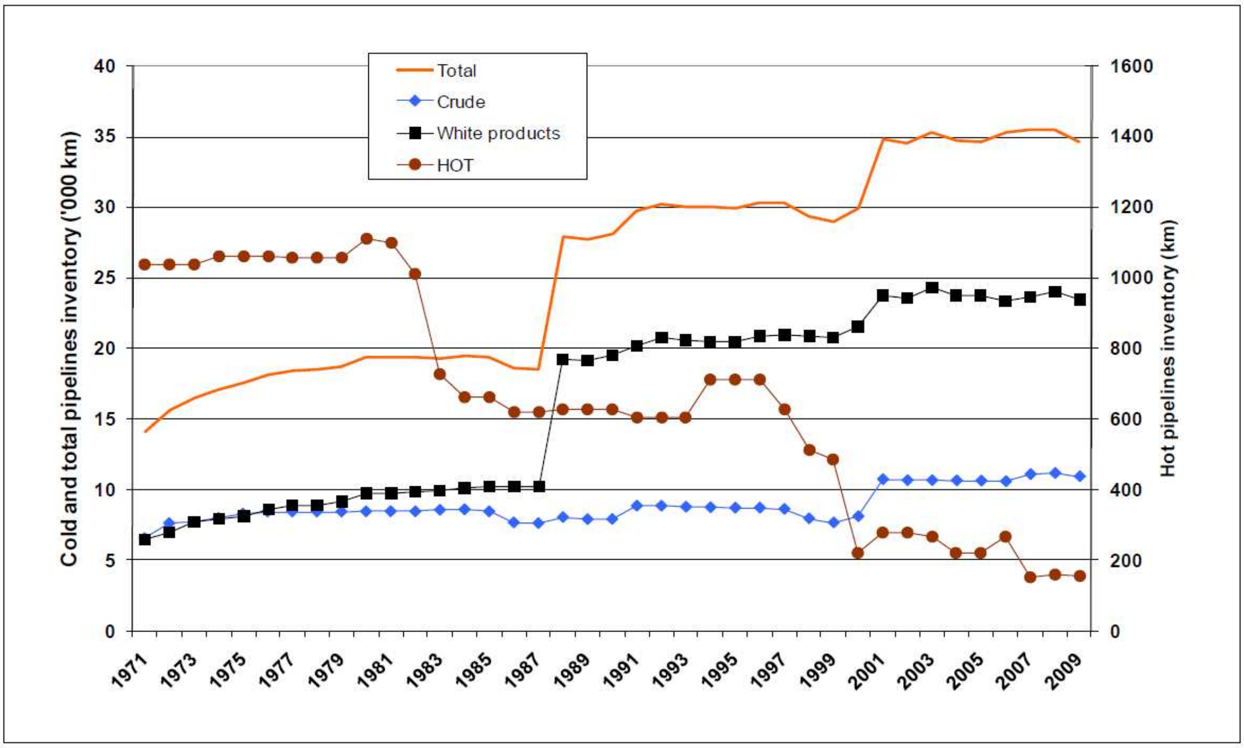
2.1.2 Oil

Apart from natural gas, other hazardous substances transported in pipelines include crude oil, oil products and other chemicals for example ammonia or chlorine. Crude oil and oil products are the main fluids extensively conveyed in European networks. There is an extended onshore network throughout the EU used for the carriage of crude oil and refined products, including gasoline, kerosene, diesel and heavy fuel oils. The major EU traffic of crude oil and oil products takes place in France, Germany, Italy, Spain and the UK.

The last CONCAWE report for 2009 (CONCAWE 2011) in a series of reports that cover 40 years of pipeline data describes the EU oil pipelines and petroleum product pipelines as follows, divided on total, crude, white products and hot products. The term "white products" refers to oil distillate fractions, typically gasoline, diesel or home heating oils. Hot products generally refer to high-viscosity residual oils that can be pumped only if heated.

The total length of the oil pipelines accumulates to approximately 35,000 km of pipeline, of which the share of hot pipelines is less than 200 km.

[11] Eurogas 2010 Eurogas Statistical Report 2010



Source: *Performance of European cross-country oil pipelines - statistical summary of reported spillages in 2009 and since 1971, CONCAWE 2011, Report no. 3/11*

Figure 2-1 Oil pipeline composition, 1971 - 2009

As the figure displays, there has been a change in the composition of types of oil that is being transported, and the use of pipelines for hot oil has gone down. The share of pipelines for white products has almost doubled since the mid 1980s, while crude oil pipelines have been quite steady.

The majority of cross-country oil pipelines are in the 8-12" (200-300 mm) diameter range. Crude oil cross country pipelines are generally in the 20-30" (500-750 mm) diameter range or larger. Pressures ratings vary greatly. For crude oil and multi-products (white product) pipelines, pressures in the range 75-100 bar are common. Smaller systems may operate in the 20-40 bar range. Cross-country pipelines typically have capacities in the 500-2,000 m^3/h range.

2.1.3 Olefin pipeline

Olefins, mainly ethylene and propylene, are high-volume feedstocks to the chemical industry. Very large amounts of ethylene are used in the production of polyethylene (PE) plastics. Ethylene is also the starting material in the production of styrene, which in turn is converted to e.g. polystyrene plastics. In Western Europe, the 2003 production of ethylene and propylene amounted to 20.7 and 14.7 million tons with annual growth rates around 3 per cent. About 60 per cent is consumed locally. The remainder is moved by pipe (70%), ship (20%); and barge or rail (10%).

The industry is organised in APPE, the Association of Petrochemicals Producers in Europe. Based on their data, we estimate the length of the olefins pipeline network in Europe to approximately 6,000 km, of which the majority (90%) is in ethylene service. Pipeline diameters are typically in the 8-12 inch (200-300 mm) range with operating pressures up to about 100 bar, i.e. somewhat above the 80 bar encountered in the natural gas transmission grid. Olefins are highly flammable. The hazard characteristics of olefins are comparable to those of liquefied petroleum gases (LPG), in particular the ability to produce denser than air flammable clouds, which can drift for considerable distances before being diluted to safe concentrations.

The existing olefins pipelines in Europe are shown in Figure 2-2. The length of the longest pipeline system is approximately 900 km.

Source APPE (adopted from homepage: http://www.petrochemistry.net/map-refineries-pipelines-and-crackers-in-europe.html)

Figure 2-2 Olefins pipelines in Europe: The large majority are for ethylene (red) with only a few propylene (green) pipelines. There are plans to interconnect the pipeline systems

APPE proposed in 2004 to develop a Trans-European olefins Pipeline Network (TEPN), which would link existing olefins pipelines by building new connector lines, and expand pipeline capacities where necessary, in order to accommodate the expected future growth in olefins transportation needs. An integrated olefins pipeline infrastructure, connecting clusters and regions, is seen as an essential condition to remain competitive against the US Gulf Coast, Middle East and the Far East regions. The financial setup was completed in 2004 for the first of the proposed pipelines, the 420 km EPDC propylene pipeline connecting The Netherlands, Belgium and Germany. Various governments along to route provided some subsidies. The project was halted in 2007 due to cost increases, but according to APPE it is now back on track. Feasibility studies for other pipelines are in progress.

2.1.4 Ammonia transport

Ammonia is a toxic gas. It is produced in large quantities, with typical plant capacities being in excess of 1,000 tons per day, which need to be transferred or transported to the user plants, such as nitric acid, ammonium nitrate, urea and other chemical plants. Much of this transfer between sites as well as within integrated complexes takes place by pipelines. In a significant number of cases, these pipelines are close to public roads or other areas of population,

Ammonia is transported by pipelines, either as a refrigerated liquid, close to the atmospheric boiling temperature of -33°C, or warm (that is, at ambient temperature) pressurized liquid ammonia. Practices of design, inspection and leak detection with respect to liquid ammonia pipelines are not uniform within the EU. They differ from Member State to Member State. The industry is organised in The European Fertilizer Manufacturers' Association (EFMA), which has published guidance on these topics (EMFA 2008).

Very large ammonia pipeline systems can be found in the USA and Russia/Ukraine. The main pipeline systems are:

- The 3,057 km Gulf Central pipeline (USA) is the longest system and connects the major producers along the Texas and Louisiana Gulf coast with terminals in Arkansas, Iowa, Illinois, Indiana, Nebraska and Missouri.

- The MidAmerica Pipeline System (MAPCO) extends from Northern Texas, across Oklahoma, Kansas, Nebraska and Iowa, and ends in Minnesota, all intensive agricultural areas. The total length is 1,754 km.

- The Tolyatti-Odessa ammonia pipeline, which connects the TogliattiAzot production facilities in Tolyatti (Togliatti) with the Black Sea (Ukraine). The total length is about 2,420 km

In comparison, the European system is very limited with a combined length of less than 210 km. Details are provided in Table 2-2.

Table 2-2 Ammonia pipelines in the EU

Location	Distribution function	Above-/under-ground	Length (km)	Operating pressure (barg)	Operating temp (°C)	Diameter (mm)
Belgium						
Pipeline 1	to onsite customers	above	10	22	10-15	100 and 150
Pipeline 2	to offsite customers	under	12	22	10-15	100 and 150
Germany						
Pipeline 1	to onsite customers	above	24	21	5-40	50-200
Pipeline 2	harbour to storage	above	2.8	11	5-40	150
Pipeline 3	to offsite customer	under	12	10-15	1-5	275
Italy						
Pipeline 1	to offsite customer	under	74	17	10	200
Netherlands						
Pipeline 1	to onsite customers	above	5.8	16	5	100-200
Pipeline 2	harbour to storage	above	1	10	-32	80
Poland						
Pipeline 1	plant to storage	above	1.2	10-15	-30	200
Pipeline 2	storage to plant	above	1.5	13	-7 to 0	75, 100, 150
Pipeline 3	storage to harbour	above	6	8-13	-33 to -15	350
Pipeline 4	storage to harbour	above	5.9	8-13	-33 to -15	100
Pipeline 5	plant to storage	above	1.2	8-13	-5	150
Portugal						
Pipeline 1	plant to harbour	above	1.9	13	-30	100
Spain						
Pipeline 1	to offsite customer	65% under	10	14.5	13	150 and 350
Pipeline 2	harbour to tank	95% above	1.5	3.5-4.5	-33	300
Pipeline 3	harbour to tank	90% under	2.4	6	-33	300
Pipeline 4	tank to plant	above	4.2	15-18	8-15	100
UK						
Pipeline 1	harbour to storage	above	8.8	30	-32	100 and 150
Pipeline 2	harbour to plant	above	6.9	21	-33 to +25	150
Pipeline 3	plant to harbour	above	6.8	21	-28	150
Pipeline 4	to offsite customer	above	2.2	14	-29 to ambient	100
Pipeline 5	to offsite customer	above	1.6	14	-29 to ambient	100
Pipeline 6	harbour to storage	above	2	2-5	-32	300
Pipeline 7	harbour to storage	above	2	2-5	-32	75

Source: EFMA (2008)

The Seveso II threshold quantities for ammonia are 50 and 200 tonnes. All storage sites would therefore be Seveso II installations. Harbour areas or offsite customers would likely not be covered by the Seveso II Directive.

2.1.5 Chlorine transport

Chlorine is a toxic gas. The annual chlorine production in Europe amounts to about 10 million tonnes (2010). The majority of this chlorine is moved by short distance pipeline, with rail and road transportation accounting for a little more than 5 per cent of production (Euro Chlor 2011). The biggest applications for chlorine are the manufacture of polyvinyl chloride (PVC), polyurethane and polycarbonate plastics, representing about two thirds of the chlorine consumption. Producers and consumers of large-volume bulk chemicals are often located in relative proximity, to minimize transportation costs. Most movement of chlorine by pipeline therefore takes place within company premises, or between different companies within an industrial complex. In the latter case, the pipeline may follow or cross public roads.

The industry is reportedly in a process of reorganisation in which chlorine movement is progressively decoupled from production through supplier-customer relocations. Consequently, the amount of chlorine transported by rail and road has decreased over the last decade. This achievement has to some extent led to an increased use of local pipelines for chlorine transport (Euro Chlor 2011). Supplier-customer relocations and the use of local pipelines are indicative that chlorine is mostly transported by pipeline over relatively short distances.

In 2011, Euro Chlor had 127 members comprising 39 chlorine producers representing about 99 per cent of the chlorine production capacity in the EU-27 and EFTA regions. Euro Chlor informs that most of the chlorine is transported locally, as gas, in very short pipelines (from a few tens of meters to a few kilometres) inside production units. Liquid chlorine pipelines are used for local transportation inside production units but also, in a limited number of cases, to supply a nearby consuming unit by passing through public domain in large industrial areas, like the Rotterdam and Antwerp harbours, and some German highly industrialised areas. A typical liquid chlorine pipeline has a diameter of 4 inches or less connecting a producing unit to a consumer's unit. There is no distribution network. Excluding pipelines of less than 100 m, the average length of a liquid chlorine pipeline is about 6 km. There are no cross-country chlorine pipelines in the EU.

Euro Chlor cannot provide a detailed breakdown on length and capacity of chlorine pipeline systems per Member State but informs that there might be between 5 and 10 of the pipelines in the EU, which at some point extend into public land with a combined length of 50 km (upper estimate).

The Seveso II threshold quantities for chlorine are 10 and 25 tons. Production and storage sites would therefore likely be covered by the Directive, but consumers may not be.

2.1.6 CO_2 Transport

Two countries have pipelines for CO_2 transport. France has one pipeline of 29 km; the Netherlands has a transport pipeline of around 90 km and 130 km of pipeline for distribution (OECD Working group 2010).

2.1.7 Hydrogen

There are approximately 1500 km of hydrogen pipelines in the EU. The largest operator, Air Liquide, has around 1300 km of hydrogen pipeline, mainly located in France, Belgium, the Netherlands and Germany.

Other industrial gases such as oxygen and nitrogen are conveyed by pipelines but due to their non-dangerous nature, they are not relevant for this assessment.

2.1.8 Total pipeline network

Based on the sources discussed above, the total network length is presented in Table 2-3.

The network for distribution of gas accounts for 86 per cent of the total network length. The network with the major accident potential excludes the gas distribution network. If gas distribution is excluded, the total length of the network is approximately 295,000 km, and the gas transmission pipelines accounts for 85 per cent.

Table 2-3 EU-27 pipeline network for transport of dangerous substances

	Length - km
Total gas	2,030,058
Transmission	250,942
Distribution	1,779,116
Oil & Petroleum Products	36,275
Olefin	≈6,000
Ammonia	200
CO_2	250
Hydrogen	≈1,500
Others	?
Total	**2,074,283**
Total excluding gas distribution	**295,168**

Source: Estimates based on above sources

2.2 Accident potential

2.2.1 Introduction

Pipelines are generally considered a safe way of transporting dangerous substances, both in absolute terms and in comparison with other modes of transport. Since the 1960s, the reliance on pipeline transport in Europe has increased substantially, both in terms of the number of countries relying on pipeline transportation of essential substances, in terms of total length of installed pipelines and quantities moved, in terms of interconnectedness of pipeline networks, and in terms of the number of different hazardous substances transported. This trend is expected to continue.

For some dangerous substances, like natural gas, there are hardly any viable or realistic alternatives to pipeline transportation considering the very large quantities transported. US data on different methods used to transport petroleum indicate that pipelines are the safest overall method. Only rail appears to be safer in terms of the number of injuries per ton-mile, and only barges are safer in terms the number of deaths per ton-mile. The rate of fatalities, injuries, and fires and explosions per ton-mile of oil transported for all other modes is typically at least twice - and in some cases more than 10 times larger than the equivalent rate for pipeline transport. Trucks appear to be, by far, the most dangerous method for transporting petroleum (TRB 2004).

The scope of the EU Seveso II legislation is defined in terms of *hazard.* In risk terminology, hazard is defined as the potential ability to cause harm. The Seveso II Directive uses threshold quantities of dangerous substances that can be present at an industrial establishment as a proxy for quantifying the amount of hazard that brings an industrial establishment within the scope of Seveso II directive. Industrial establishments for which the Directive applies must then demonstrate that all necessary precautions have been taken, i.e. that the *risk* is low.

It is difficult to set similar threshold criteria for pipelines because the quantity of a dangerous substance that can be released in case of an accident is not readily available. The amount released depends both on the inventory of an isolatable pipeline segment and on difficult assumptions of the time required to shut down the pipeline and isolate the affected pipeline segment.

In the next section, a number of major accidents are presented. They are from different regions and some took place several years ago. They are presented to illustrate the potential irrespective of whether current European safety standards have in fact reduced the risk of such accidents.

2.2.2 Examples of major accidents

Below a number of accidents are presented. They cover:

- Gas

- Oil
- LPG
- Other chemicals

Natural gas pipeline, Carlsbad (USA), 2000

On August 19, 2000, a 30-inch diameter underground natural gas transmission pipeline ruptured adjacent to the Pecos River near Carlsbad, New Mexico (USA). The released gas ignited and burned for 55 minutes. The height of the flames was estimated at 150 m. The operating pressure at the time of the rupture was 675 psig (47 bar).

Twelve persons who were camping were killed. The victims were camped about 675 feet (200 m) from the rupture site, between the river and the rupture site. Their three vehicles parked by the river were destroyed. Six victims were found at the camping area; six others had gone into the river, presumable to escape the intense heat radiation. The causes of death were extensive thermal burns, carbon monoxide poisoning and smoke inhalation.

The rupture was caused by internal corrosion in a part of the pipeline where liquids condensing out of the natural gas could accumulate. The liquids had water concentrations ranging from trace amounts (less than 1 per cent) to 10 per cent. Corrosion product samples taken from this line were analysed and found to contain high levels of acid-producing bacteria. (NTSB 2003).

Natural gas pipeline, Ghislenghien (Belgium) 2004

On July 30, 2004 a 1.0 m diameter underground high-pressure natural gas pipeline ruptured in an industrial area near Ghislenghien, Belgium resulting in 24 deaths and over 132 injured. It was the Zeebrugge-Blaregnies-2 transit pipeline laid in 1992 with a burial depth of 1.1 m, wall thickness of 13 mm and nominal flow rate of 1.6 million m^3/hr at 80 bar. The accident pipeline was laid about 7 m from the 80 bar 0.9 m diameter Zeebrugge-Blaregnies transport pipeline, which was only slightly damaged in the incident. The operating pressure of the pipeline at the time of the accident seems to have been about 60 bar.

A gas leak was reported to fire fighters and a loud hissing, a tremor and a sudden creation of a cavity in the ground was observed. About 15 minutes later fire fighters requested the assistance of the gas utility crew and set up a safety perimeter. The leak increased in intensity, forming a whitish spray shooting about fifteen metres up. About 45 minutes after onset of the leak, the pipeline failed catastrophically. Technicians were able to isolate flow to the affected pipeline segment 47 minutes after onset of the first leak.

An explosion was reported, throwing several individuals tens of meters, and an 11-m pipeline segment weighing in excess of a tonne was ejected and thrown 150 m. The gas cloud ignited, producing a fireball several hundred meters high that subsequently transformed into a long flame with an estimated height of 150-200 m, which kept burning for about 20 minutes, until the fuel in the damaged pipeline segment was exhausted. The heat radiation was extreme, and total devastation was reported within a radius of 200 m. Fire fighters stayed close to their vehicles some 150 m from the scene while sprinkling their polyester water tank, which deformed due to thermal radiation. Vehicles at 150-200 m caught fire, the roofs of nearby premises melted, and plastic components at a gas reducing station located at distance 200 m melted, causing a secondary fire that set six vehicles ablaze. The heat was felt 2 km away. The ejected pipeline segment had multiple deep gouges. Heavy equipment damage to the pipeline during soil and road works in the preceding weeks or months is suspected.

Seven year after the worst natural gas accident in Europe, a number of important issues remain poorly addressed. Pipeline vibration caused by the forceful ejection of high-pressure gas is reported to have propagated along the pipeline for about 10 km, weakening distant flanged connections and causing secondary gas leaks, some of which ignited, but the extent is unclear. It is unclear why automated shutoff mechanisms, if installed, were not triggered, and why it took technicians more than 45 minutes to isolate flow to the damaged pipeline segment. It is remarkable that the complete pipeline rupture took place 45 minutes after the first gas leak, but open literature on the fracture causation is extremely sparse. It has been speculated if auto-refrigeration due to expansion of the high-pressure gas cooled the pipeline below the steel's ductile-brittle transition temperature; a hypothesis which could potentially have substantial impact on steel grades for future transmission pipelines. According to some accounts, there was significant confusion about the number, nature and location of underground pipelines in the accident area, and if pipeline markers were located correctly (DGPR 2009 , Mahgerefteh and Atti 2006, FLUXYS 2004).

Natural gas pipeline, San Bruno (USA) 2010

On Sept. 9, 2010, a 30-inch natural gas pipe ruptured in the residential area of San Bruno, south of San Francisco, California (USA), killing nine people and destroying nearly 40 houses. The accident is still under investigation and data are preliminary. The operating pressure of the pipeline was 386 psig (27 bar) at the time of the rupture. The specified maximum operating pressure (MOP) for the ruptured pipeline was 375 pounds per square inch gauge (psig). According to the utility, the maximum allowable operating pressure for the line was 400 psig.

The pipeline was laid around 1956 and was cathodically protected. Records kept by the utility showed that the pipe was seamless, but the failed pipeline segment had welding seams, some of which were faulty. Interim reports issued by the safety board indicate the possibility of computer problems. Technicians were working on the power supply system of a control centre 39 miles away, and power was cut to the control system. The loss of the electrical signal resulted in the regulating valve moving from partially open to the full open position as designed. The pipeline pressure then increased to 386 psig. The utility maintains that the pressure did not exceed the allowable maximum. However, the safety board has not concluded that, and has said that with the misinformation about the type of pipe, establishing a safe maximum operating pressure may be impossible.

Utility workers reached the scene in San Bruno quickly but were not qualified to operate the pipeline's valves. It took 90 minutes to shut off the gas to the rupture site. The utility decided in June 2006 not to equip many pipelines with expensive automatic shutoff valves that the federal government said could limit damage from pipeline failures. A utility memorandum from 2006 concluded that automatic shutoff valves would not provide additional safety to people or prevent property damage because damage would occur before valve closure could have an effect. That view has been contested. (NTSB 2010, NYT 20110121, NYT 20110228).

Crude oil pipeline, Bouches-du-Rhône (France) 2009

On August 7, 2009, a 40-inch underground cross-country pipeline ruptured and spilled 5,400 m^3 of crude oil into the Coussoules de Crau (Bouches-du-Rhône) nature reserve. The nature reserve reportedly holds the last dry-steppe in Europe, a fragile ecosystem and habitat for endangered species (L'EXPRESS 2009). The leak did not ignite, and there were no casualties.

By chance, a park ranger on patrol observed the rupture from distance, what he described as a geyser of black oil, see picture (**Error! Reference source not found.**). Three pipelines run through the nature reserve. He alerted the pumping station located at a port terminal only 10 km away, but the pumping station could not take mitigating action without specific information about the damaged pipeline's point kilométrique (PK) milepost marker. Eventually valves were closed, but reportedly the wrong valves, which intensified the leak (personal communication).

The event is registered in the CONCAWE system as Event 472. The description there indicates that the pipeline is of the fully welded type, i.e. not the seamless type. The origin of the rupture is considered a fatigue crack initiated in the heat affected zone of a weld, slowly growing through pressure cycles.

During cleanup operations, 60,000 tons of polluted soil were excavated and sent to biological treatment. Conservationists expressed concern over the impact to the ecosystem caused by the traffic of 2,000 heavy earth moving trucks (DD 2009). In total, the number of trucks doubled, because a similar quantity of fresh soil was moved in (personal communication).

Figure 2-3 Ruptured pipeline and crude oil spill in the Coussoules de Crau nature reserve 2009. (Photo courtesy Guillaume Paulus, CEN PACA)

There is very little information about this spill in the public domain. Important questions why prior intelligent pig inspection activities (if any) failed to reveal weld defects and early stages of fatigue cracks cannot be answered. Questions about the performance of automatic leak detection equipment and the handling of emergency shut down procedures are also unanswered. Technical investigations were carried out but they are reportedly locked by court order.

Earlier spills of crude oil have affected the area. The same pipeline spilled 4,000 m^3 in 1980 and a nearby 34-inch pipeline spilled 2,000 m^3 in 1978 (CONCAWE events 124 and 150). The nature reserve was founded in 2001, when the pipelines were already there.

LPG pipeline near Ufa (USSR) 1989

On June 3, 1989, a leaking liquefied petroleum gas (LPG) pipeline led to the formation of a large flammable gas cloud near the cities of Ufa and Chelyabinsk in the former Soviet Union. According to sources, engineers noticed a sudden drop in pressure at the pumping end of the LPG pipeline. Instead of investigating the trouble, the engineers responded by increasing the pumping rate in order to maintain the required pressure in the pipeline. The pipeline was located about a half mile from the Trans-Siberian Railway. The escaping liquefied gas drifted for a distance of 5 miles and formed two large pockets in the low-lying areas along the railway line.

Two approaching trains, both filled to capacity with more than 1100 people on board approached the gas cloud in opposite directions. One of the trains ignited the cloud. Several explosions took place in quick succession followed by a ball of fire approximately 1 mile wide, which raced down the railway track in both directions. Trees were flattened within a radius of 2.5 miles of the epicentre of the explosions and windows were broken as far away as 8 miles. The explosion thrust a pillar of fire into the night-time skies that was visible to observers more than 60 miles (100 km) away. The accident resulted in 462 to 600 fatalities; the precise number is not known, since many bodies were incinerated by the fireball (Energy Library 2011, NYT 1989)

LPG pipeline Port Hudson (USA) 1970

On December 9, 1970, a leaking liquefied petroleum gas (LPG) pipeline led to the formation of a large flammable gas cloud near Port Hudson, Missouri, USA. An abnormality occurred at a pumping station, and pumps were automatically shut down. 13 minutes later, the pipeline ruptured releasing liquid propane that formed a plume of white fog, which drifted and accumulated in a valley. About 750 barrels (88 m^3) of liquid propane escaped during the first 24 minutes. At that time, four families had evacuated their homes; the cloud exploded in a sudden flash and produced an immediate pressure pulse. In the seconds following the detonation, a firestorm was observed to roll from east to west.

People were knocked off their feet at 800 meters, and a state trooper driving 24 km away reported that his car swerved. Severe building damage was observed within 2,000 ft (600 m) and window breakage was observed 12 miles (19 km) away. A red glow in the sky was reported at Kansas City, 200 miles (320 km) to the west, probably caused by the continued burning of propane at the pipeline break. The total loss of propane was 4,538 barrels (532 m^3).

The accident represents a “worst-possible” sort of case history for the assessment of the hazards of fuel transportation (Burgess and Zabetakis, 1973).

Petroleum pipelines near Houston (USA) 1994

Between October 14 and October 21, 1994, some 15 to 20 inches of rain fell on the San Jacinto River flood plain near Houston, Texas. Due to the flooding, eight pipelines ruptured between 20-21 October, and 29 others were undermined both at river crossings and new channels created in the flood plain. More than 35,000 barrels (4,100 m^3) of petroleum and petroleum products were released into the river. A series of explosions, fires and fireballs erupted on the river. Ignition of the released products within flooded residential areas resulted in 547 people receiving (mostly minor) burn and inhalation injuries.

Ruptured pipelines included an 8-inch LPG pipeline, a 40-inch gasoline pipeline, a 36-inch diesel pipeline, a 12-inch natural gas pipeline, and a 20-inch crude oil pipeline. Some of the ruptured pipelines were in operation throughout the flooding emergency and shut down, only after ruptures had occurred and some manual isolation valves could not be reached by response crews because they were under water.

Because so many pipelines were damaged during this flood and such large volumes of petroleum and petroleum products were released - requiring a massive environmental response in terms of personnel and equipment - the US Safety Board undertook a special investigation. The investigation observed that although pipeline transportation is one of the safest means for transporting petroleum, it poses a great risk potential to the environment because of the large volumes of hazardous liquids that can be released when a rupture occurs. (NTSB 1996).

Ammonia pipeline in Algona (USA) 2001

Less extensive spills of ammonia can lead to even larger consequences. On December 14, 2001 a valve on an 8-inch-diameter ammonia pipeline in Algona, Iowa, USA, was damaged during maintenance work carried out by contractors. Over nine hours more than 150 tonnes leaked into a creek and killed an estimated 1.3 million fish in downstream rivers, which could amount to the State's worst fish kill. The plume reportedly drifted over a 6-mile area (about 10 km) leading to evacuations (KCCI 2001, UKOPA/02/0035). It deserves mention that the company responsible for the pipeline had received multiple safety and environmental awards for that year, including Excellence Achievement Award (company-wide) and Perfect Safety Record (Ammonia Division), National Safety Council; Outstanding Achievement Award (Ammonia Division), Region 7, U.S. Environmental Protection Agency (Koch Annual Report 2002).

Ammonia pipeline near Kingman (USA) 2004

On October 27, 2004, an 8-inch-diameter ammonia pipeline ruptured near Kingman, Kansas, USA, and released approximately 580 m^3 (400 tons) of anhydrous ammonia. Nobody was killed or injured due to the release. The rupture site was in an agricultural area that is home to several threatened and endangered species of fish and wildlife. The anhydrous ammonia leaked into a creek a couple of kilometres away and killed more than 25,000 fish including some from threatened species.

Three minutes after the pipeline rupture a passing motorist called 911 to report a huge vapour cloud on the north side of the highway that he believed was a pipeline release. The sheriff's office immediately started telephoning residents in 35 houses; eventually four families were evacuated; no residents were home at 28 houses. Due to a series of misinterpretations of alarms in the control room, the pipeline operator first responded by increasing the flow to the rupture site. Only after more than half an hour when the control room was alerted over telephone about the rupture, the pump feeding the pipeline was shut down. About two hours after the rupture, manual block valves were closed isolating the ruptured pipeline segment. The Safety Board concluded that heavy equipment damage to the pipeline during construction or subsequent excavation activity had initiated metal fatigue cracking, which led to the eventual rupture of the pipeline (NTSB 2007).

EFMA (2008) presents a list with various incidents with liquid ammonia pipelines above 75 mm diameter.

Chlorine pipeline, Champagnier (France) 2005

On May 21, 2005, an 8-inch above-ground chlorine pipeline exploded. The 3.6 km long pipeline conveyed chlorine gas at 4 bar between a chlorine manufacturer and a consumer site producing chloroprene, a precursor of synthetic rubber. Both sites are upper-tier Seveso II installations. The pipeline is mainly located on company premises except for the crossing of a public road. The accident led to blast damage and heavy fragments were thrown up to 200 m away. There were no casualties.

The explosion was caused by the accumulation of an explosive mixture of hydrogen and chlorine gas, which ignited and detonated. Hydrogen had been produced by an unexpected chemical reaction set in motion due to water ingress into the pipeline four years earlier and overheating caused by a recent failure of the pipeline's heat tracing system (Aria 2007).

2.2.3 Natural gas, BAM study on consequences (2009)

The German BAM institute carried out a study on the reported consequences of natural gas pipeline accidents (BAM 2009).

They found a correlation between the diameter of the pipeline, i.e. the mass flow rate, the collapse pressures and the hazard radii. In some cases, damage resulting from thermal radiation has occurred at distances of 350 to 1000 m. The height of the flame can approach 150 m, and there have been reports of cases of the thermal radiation being clearly felt over even greater distances. Results are summarized in Figure 2-4.

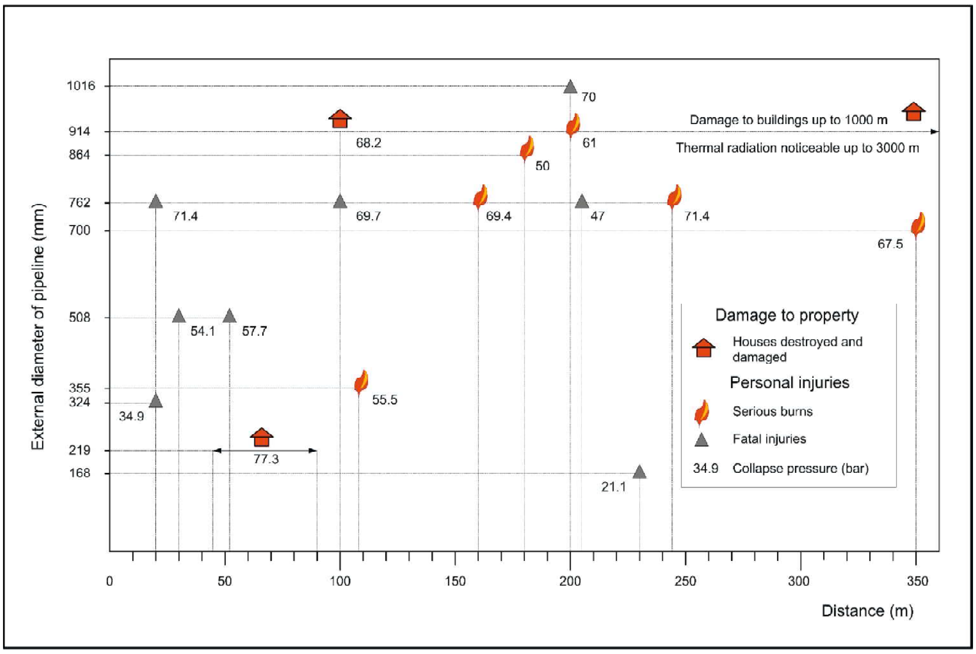


Figure 2-4 Reported hazard radiuses resulting from thermal radiation in natural gas pipeline failures

The BAM study also lists explosion and blast wave as a possible consequence of accidental releases from natural gas pipelines but offer no observed blast damage distances.

Damage may also result from flying debris from pipeline segments, pieces of equipment or soil that is thrown up (stones, boulders). From the accidents investigated, the BAM study reports a maximum trajectory range of 350 m and finds a correlation between pipeline working pressure and trajectory range. The correlation is shown in Figure 2-5.

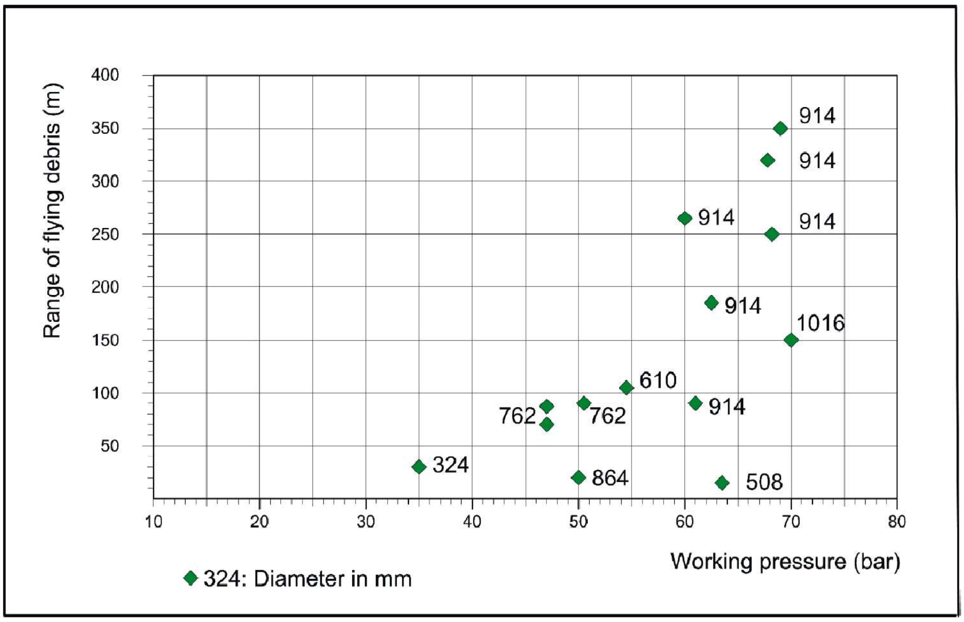


Figure 2-5 Reported ranges of flying debris for natural gas pipelines

2.3 Accident statistics

2.3.1 Introduction

A number of data sets could be used in reviewing various components of pipeline safety. In practice, however, the use of the data is complicated. Reporting criteria, definitions, incident causation classifications, and other categories differ from one database to another and within a database across time (TRB 2004).

Accidents or unintentional releases above certain threshold values are often reportable to public authorities, but meaningful statistical overviews of safety performance expressed as failure frequencies can only be produced if the pipeline population (broken down on size, operating pressure, wall thickness etc) is known. The most comprehensive failure databases are often maintained by industry associations, which decide on the scope of the database and the level of detail provided in published reports.

Common scope differences in various databases relate to the fact that some databases register only unintentional releases from the pipeline itself, whereas others also include releases from components and equipments such as valves, flanges, compressors etc. that together with the pipeline make up the pipeline system (Moosemiller 2006).

There is no European Authority keeping pipeline incident data. Longstanding incident statistics are kept voluntarily by industry. A study by the European Commission's Joint Research Centre concluded that in contrast to the USA, there is no European incident reporting or analysis system based on widely accepted and approved reporting criteria from which the safety status and trends could be evaluated (JRC 2004).

2.3.2 EGIG data on natural gas pipelines

The European Gas pipeline Incident data Group (EGIG) maintains a database of unintentional gas releases from pipelines since 1970. Participation is voluntary. When the group was formed in 1982, it comprised six pipeline operators. At present 15 major gas transmission companies in the western part of Europe participate in the survey covering about half the length of the European gas transmission network.

The objective of setting up the EGIG was to provide a broad basis for statistical use, giving a more realistic picture of the frequencies and probabilities of incidents than would be possible with the data of each company considered separately. The creation of the pipeline-incident database has helped pipeline operators to demonstrate the safety performance of their pipeline systems.

Criteria for reporting are: the incident must result in an unintentional gas release from a transmission pipeline; the pipeline must be made of steel, have a maximum operating pressure higher than 15 bar, be onshore and outside the fences of gas installations. Incidents on production lines are not reported in the EGIG database, nor are releases from equipment or components in the transmission pipeline system, such as valves and compressors.

By 2007, companies participating in the survey had accumulated 3.15 million kilometres-years (km.yr) with an overall incident frequency of 0.37 incidents per 1,000 km per year; the average incident frequency for the last five years was 0.14 incidents per 1,000 km per year

The main conclusions of EGIG data are (EGIG 2007 and WG 2006)):

- Over time, the overall incident frequency exhibits a downward trend (see Figure 2-6) but with the rate of reduction levelling off;
- Third-party damage remains the main cause of gas pipeline incidents involving gas leakage; accounting for about half of all incidents, followed by construction defects / materials failure (16%) and corrosion (15%), see Figure 2-7;
- Third-party damage often results in potentially large gas releases (holes and ruptures) with severe consequences;
- For the incident causes 'corrosion' and 'construction defects/material failures' no ageing effect could be demonstrated;
- From 1970 to 2003, no incident on a high-pressure transmission steel pipeline caused fatalities or injuries to the public. This trend was broken with

the natural gas transmission pipeline disaster in Ghislenghien, Belgium, in 2004, which was caused by third-party damage.

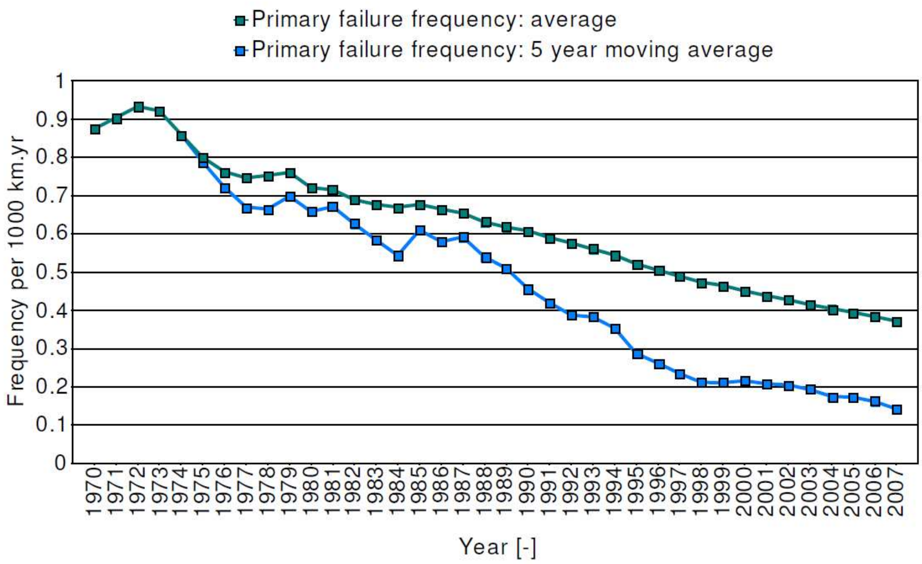


Figure 2-6 Development of overall and five-year moving average failure frequency in EGIG natural gas transmission pipelines (EGIG 2008)

External interference, which remains the main cause of gas pipeline incidents involving gas leakage, is the main contributor to 'holes and ruptures', according to EGIG data (Figure 2-7). Ground movement is also a main contributor.

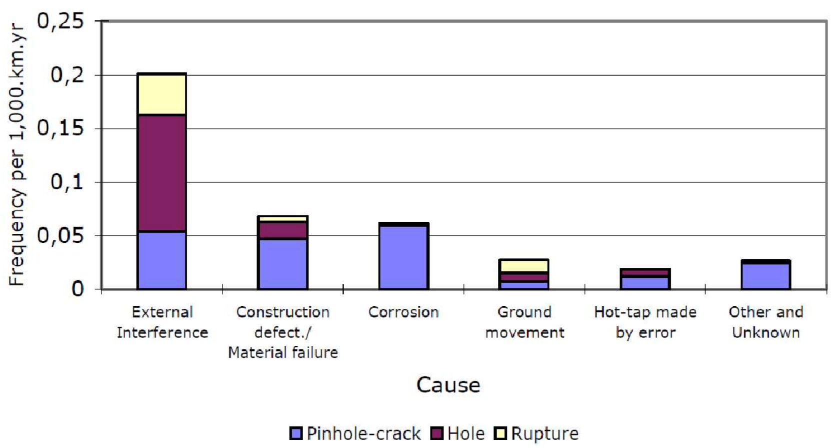


Figure 2-7 Relation between cause and size of leak (source WG 2006:21)

EGIG data demonstrate the effect of commonly used safety measures such as depth of soil cover and increased wall thickness. Figure 2-8 indicates that the effect is significant but levels off beyond 0.8 m of cover, although it is unclear whether further resolution of the >1 m class would support a different conclusion.

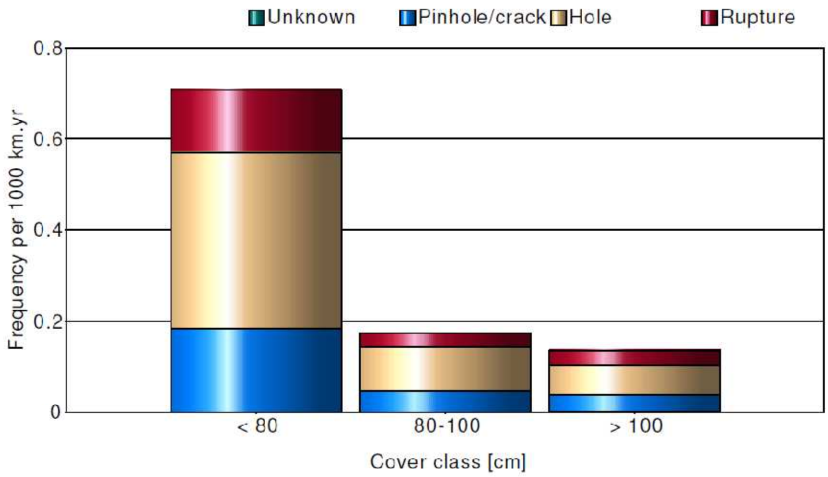


Figure 2-8 Frequencies of incidents caused by external interference for different classes of depths of soil cover (source EGIG 2007)

Figure 2-9 shows that the probability of external interference decreases (strongly) with pipe wall thickness and pipe diameter. Indeed, that beyond a wall thickness of 15 mm, the incident rate levels off to very low levels. Thicker pipe walls are in use in densely populated areas and at locations where the pipeline surfaces (e.g. valve stations).

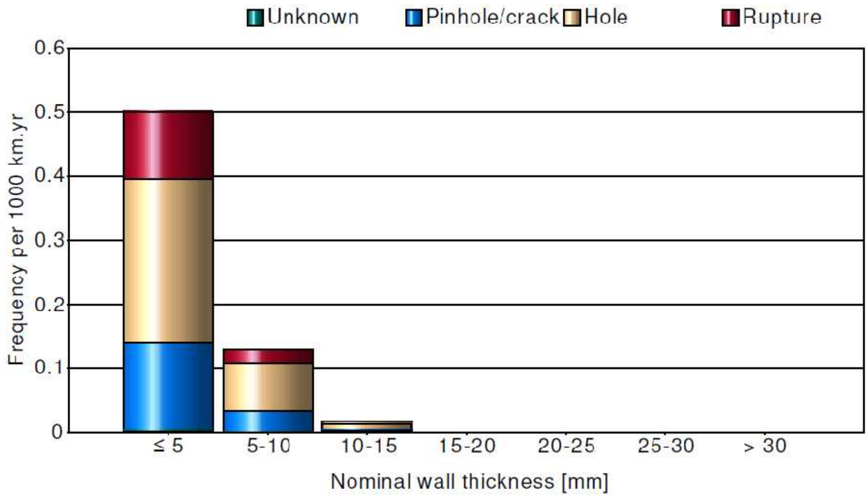


Figure 2-9 Frequencies of incidents caused by external interference for different wall thickness classes (source EGIG 2007)

The most obvious shortcomings of EGIG data relate to scope limitations, that it mainly comprises companies in Western Europe and that it excludes common components in the pipeline system such as valves. The extent to which EGIG data are representative of all Member States in EU-27, in particular new Member States from the former east block is unclear.

While the positive trend of EGIG overall failure frequencies is laudable, it is important to keep in mind that the potential danger to the public and the environment is caused by major gas releases. An aggregate number of overall pipeline incidents will be heavily influenced by the number of frequent minor leaks, which pose no or only limited danger to the public. It is certainly possible that the incidence of large gas releases of relevance to the public is decreasing, but this cannot be verified from publicly available data.

The EGIG database is intended to give an overview of the average safety level of European gas transmission pipelines. Published information provides breakdowns of incidents on pipeline pressure, wall thickness, diameter, etc. However, it does not offer the possibility of conducting detailed statistical correlation analysis, for instance if pipelines of certain diameters and wall thickness are more incident prone than others.

2.3.3 CONCAWE data on pipelines transporting oil products

CONCAWE, the Oil Companies' European Association for Environment, Health and Safety in refining and distribution, collects data on the safety and environmental performance of cross-country oil pipelines. It was originally focused on European OECD countries (excluding Turkey), but the database is gradually being extended to include the new EU Member States. Currently, the Czech Republic, Hungary and Slovakia are included. Participation is voluntary. Currently, about 65 companies take part in the survey, with a combined network of 36,000 km. It is believed that most pipelines operated in the reporting countries are included (WG 2006, CONCAWE 2011).

Database inclusion criteria are: pipelines must transport crude oil or refined oil products, the length in public domain must exceed 2 km, pipelines must be onshore, pumping stations and intermediate storage facilities associated with the pipeline system are included, storage terminals are excluded. The spill reporting threshold is 1 m^3. Within the last decade, there have been about 10 reportable incidents per year. Several reportable incidents are caused by theft of refined product from improvised line tappings. Third-party damage, including theft, is the leading cause of incidents.

The overall incident frequency is about 0.55 per 1,000 km per year, the average incident frequency for the last five years was about 0.3 incidents per 1,000 km per year. Data exhibit a downwards trend as illustrated in Figure 2-10.

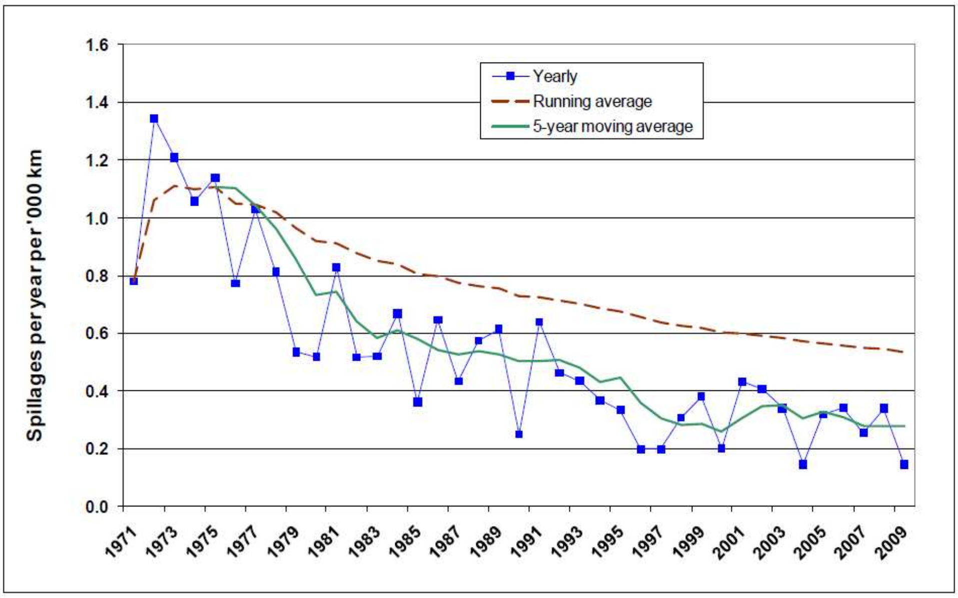


Figure 2-10 Development of overall, five-year moving average and yearly spillage frequency in all oil pipelines (CONCAWE 2011 Figure 5)

The database also includes data on the average spillage from each incident. This allows assessing whether there is a trend in the severity of the incidents. The CONCAWE (2011) data show that there is no clear trend in the average spillage per incident.

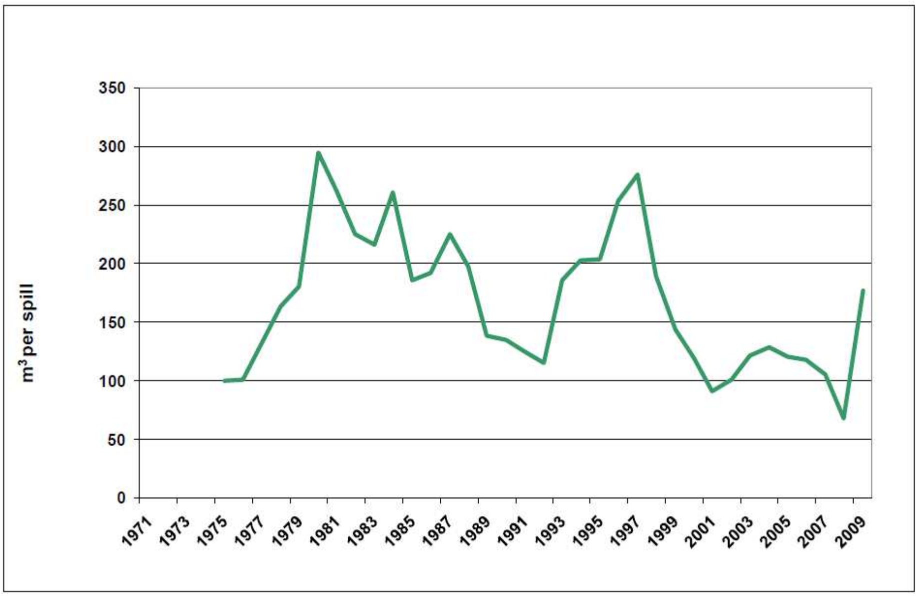


Figure 2-11 Yearly gross spillage volume per event (five-year moving average) (CONCAWE 2011 Figure 13)

CONCAWE reports hold summary descriptions of reported spills and are in this respect more detailed than EGIG reports.

2.3.4 Olefins pipelines and other chemical pipelines

The industry association APPE does not collect data on the safety and environmental performance of olefins pipelines.

No data have been collected on other pipelines, such as hydrogen pipelines. There might be data, but the network is too limited for computation of incident statistics.

2.4 Individual and society risk posed by pipelines

A report published by the UK Health and Safety Executive in 1995 (HSE 1995) observed that pipelines in most European countries are not subject to risk assessment or safety studies by government regulation. This lack of control had led to considerable debate on the need for additional safety requirements. The study examined fifteen UK pipelines conveying both liquid and gaseous substances with a toxic or flammable hazard. The pipelines examined conveyed gasoline, ethylene, oxygen, NGL, spiked crude, and ammonia. NGL refers to natural gas liquids; these are highly volatile substances including ethane, propane and butane that are extracted during the processing and refining of raw natural gas. NGLs can either be transported as compressed liquids, essentially similar to LPG, or be dissolved in and transported with crude oil, known as spiked crude.

The study assumed that only one pipeline (Ø = 24 inch natural gas) ran through a Class II area with residential properties, schools and shops and a population density of 50 persons per hectare. The remainder ran through countryside designated as Class I.

Computed distances from the centre line of the pipeline to an individual risk of death of 1×10^{-6} per year, a common assessment criterion, are shown in Table 2-4.

Table 2-4 Distances from the centre line of a pipeline to an individual risk of death of 1×10^{-6} per year (HSE 1995)

Pipeline	Distance to 1 x 10-6 per year
Natural gas, Ø = 6-inch 70 bar	60 m
Natural gas, Ø = 42-inch diameter 70 bar pipeline	230 m
Natural gas, small diameter low pressure	Risk level not exceeded
Gasoline	30 m
Ethylene	200 / 260 m
Ammonia	530 m

Pipeline	Distance to 1 x 10-6 per year
Spiked crude	100 m
NGL	180 m

The study presented computed societal risk results using f-N diagrams. The pipeline showing the greatest likelihood of one or more fatalities is ammonia, at a frequency exceeding 1 x 10^{-4} per km.year. The remaining pipelines show one or more fatalities occurring at a frequency of about 1 x 10^{-5} per km.year. Invariably, large parts of the f-N diagrams clearly exceed the Dutch recommended acceptability limits for society risk as defined in VROM (2005), the most recent criteria available but may satisfy older UK criteria. This is particularly true for the 24-inch natural gas pipeline traversing a residential area.

The results of this study therefore indicate that the risks posed by pipelines, expressed both as individual risk and society risk, are significant, at least at par with the risk from land-based installations, and exceeding the society risk criteria proposed by the Netherlands.

2.5 US Pipeline safety recommendations

The US General Accounting Office (GAO) was asked to review the Office of Pipeline Safety's (OPS) performance in regulating pipeline safety. The review was requested following a pipeline accident involving the rupture of a gasoline pipeline in Bellingham, Washington State. At least 250,000 gallons (1,000 m^3) were spilled into a nature park area and entered a creek, a salmon habitat, where it ignited, and killed three persons, injured eight, destroyed the banks of the creek over a 1.5-mile (2.4 km) section and severely damaged several buildings adjacent to the creek.

The pipeline had been damaged during earthworks on new water lines crossing the pipeline years earlier. After the rupture, control systems shut down the pipeline. However, operators restarted the pipelines some 45 minutes later, and pumped gasoline into the damaged segment for 17 minutes.

The national transportation safety board investigated certain accidents and issued recommendations, which the OPS did not always implement. Many of the Safety Board's recommendations deal with recurring issues, such as the use of valves to rapidly shut down pipelines after a rupture, the need for periodic internal inspections of pipelines, and the need to ensure that pipeline operators are adequately trained to respond to emergencies.

Major differences exist between the agencies on whether and how to implement the recommendations. The Safety Board continues to recommend that OPS require the use of automatic or remotely operated valves on high-pressure pipelines in urban or environmentally sensitive areas. The OPS has resisted this because several cost/benefit studies showed that the costs to the industry of installing valves are generally greater than the expected benefits. The Safety

Board has also called for the OPS to require operators to conduct periodic internal inspections (running so-called pigs, internal inspection tools), to identify weaknesses or defects. The OPS partly implemented this recommendation, only in areas with the highest risk of harming people or the environment.

The Safety Board issued recommendations urging the OPS to ensure that operators are adequately trained. The OPS issued a proposed rule, but it was negatively received by industry and subsequently modified, which left the Safety Board dissatisfied (GAO 2000).

2.6 Potential and accidents

The review of the accident history for pipeline operations shows that pipeline releases of dangerous substances beyond doubt have a major accident potential, comparable to or exceeding the hazard from Seveso industrial establishments.

High-pressure natural gas pipeline operators that participate in the EGIG survey report 20-30 incidents annually. Most accidents have limited consequences, but one incident in Belgium in 2004 resulted in mass casualties and became Belgium's worst post-war disaster. Oil product pipelines operators that participate in the CONCAWE survey report 10-20 incidents annually. There have been no disasters in the EU from these pipelines, but evidence from the USA, which has a far more extensive network, clearly demonstrates that such installations have major accident potential.

The number of major accidents is so small that it is not possible to calculate statistics and time trends. The best available indicator is the rate on incidents, which includes also minor incidents. The recorded incident data for gas transmission and oil pipelines show a decreasing incident rate.

It is difficult to benchmark the overall level of protection and conclude whether the risks are adequately controlled. Differences in definition of incidents prevent comparison of absolute levels of incidents. Overall, the number of major accidents in the EU has been very limited, and the incident rates have been constantly decreasing over the last years.

Despite shortcomings in the coverage of the collection of incident data at the EU level, the available data point to the risks of pipeline accidents being reasonably well controlled.

The only recent major accident is a reminder of the hazard potential. The review of development of accidents also suggests that preparedness and response could be improved.

3 Existing legislation

3.1 National Member State legislation

The analysis of the existing national Member State legislation is based on responses to a questionnaire submitted to all Member States and candidate countries.

The questionnaire itself is attached as Appendix B. It includes questions about the coverage of national legislation regarding the safety of onshore pipelines that convey dangerous substances.

The key results are presented under the following headings:

- Overall assessment of national legislation
- Scope of legislation
- Safety management systems and risk assessment
- Third party interference issues
- Emergency plans
- Technical safety measures.

A detailed presentation and discussion of the results is included in Appendix A.

3.1.1 Overall assessment of the national legislation

Replies to the questionnaire were received from 17 Member States, three candidate countries and Norway

Malta and Iceland replied that they do not have any relevant legislation as they do not have pipeline transporting dangerous substances. In the following presentation, only EU Member States are included; for the countries; see Appendix A. The 16 Member States with pipeline networks that have provided information cover 90 per cent of the EU27pipeline network and therefore, the results can be considered reasonably representative of the safety situation in the EU-27.

The following two illustrations present whether pipeline safety is covered by one piece or separate pieces of legislation regarding different types of pipelines. If legislation is separate, it usually means that gas pipelines are covered by separate legislation.

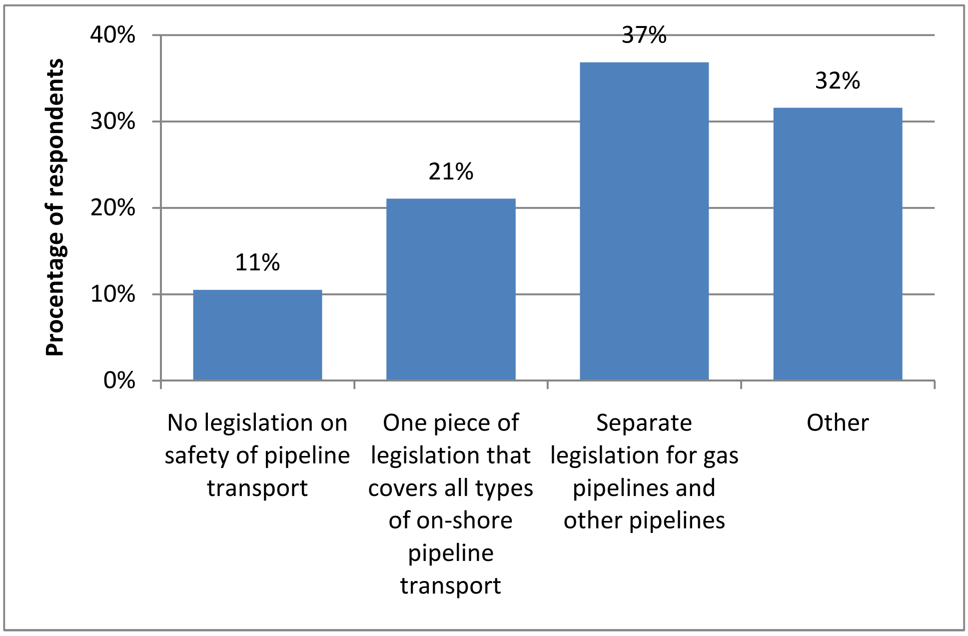


Figure 3-1 Separate or common legislation for different type of pipelines

Member States were asked to describe their national legislation in terms of completeness of current coverage of key safety requirements. The results indicate that the majority of Member States consider national legislation adequate.

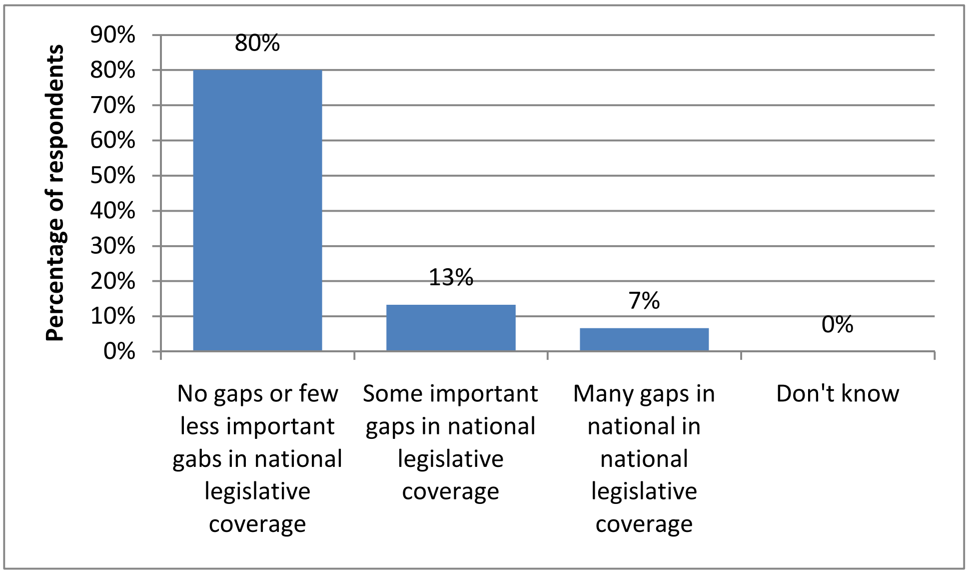


Figure 3-2 Completeness of current legislative coverage

3.1.2 Scope of legislation

There are large variations in the definition of scope across Member States. This regards the definition of pressures and diameters. There is generally no lower limit on pipeline length. Also with respect to substances covered, the majority of Member States includes all dangerous substances. See Appendix A, Section A.2.1 for more details.

3.1.3 Safety management systems and elements

Specific safety management systems for pipeline integrity are required in slightly more than half of the responding Member States. Most countries require some form of safety management system

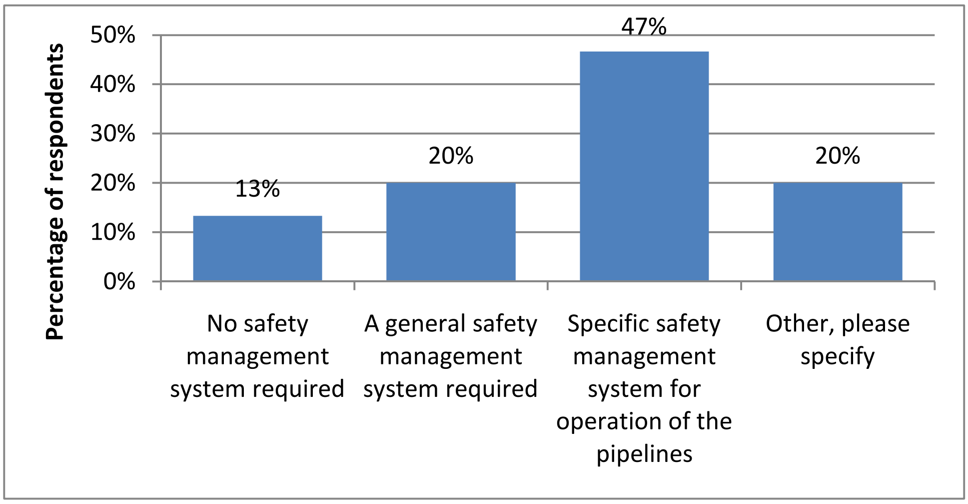


Figure 3-3 Requirements for safety management systems

Member States with no requirements for a safety management system still demand compliance with certain elements of safety management. Inspection and maintenance plans are for example required by almost 90 per cent of the responding Member States.

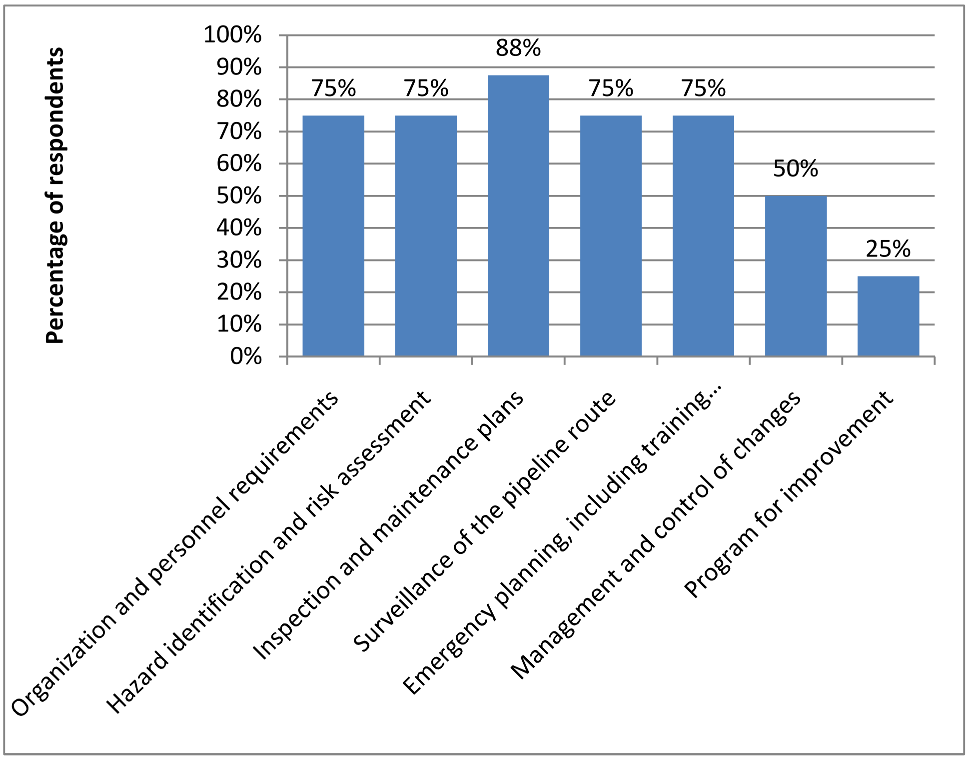


Figure 3-4 Requirements for safety management systems

3.1.4 Protection against third party interference

Protection against third-party interference is specifically included in the national legislation of most responding Member States. Additionally, the risk of third-party interference can be mitigated through land use planning. The availability and easy access to information about the location of pipelines can be important to avoid damage caused by excavation work. See Appendix A for more details.

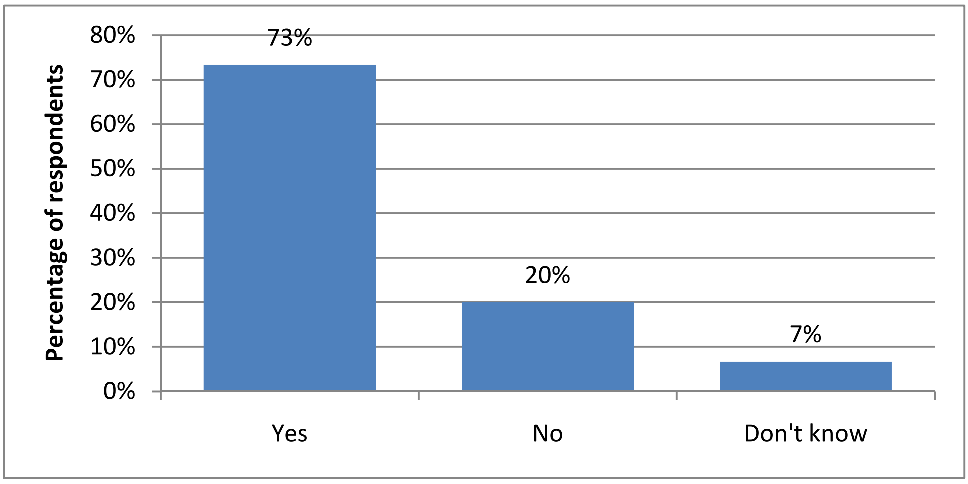


Figure 3-5 Measures against third-party interference

3.1.5 Emergency plans

External emergency plans drawn up by the relevant authorities are mandatory in most Member States.

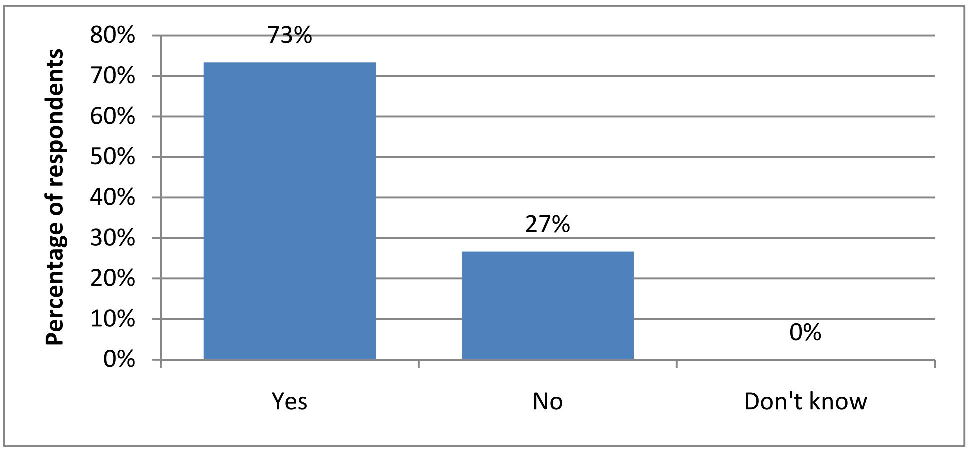


Figure 3-6 Requirements for external emergency plans

3.1.6 Technical standards and technical safety measures

In most cases, national legislation stipulates certain technical standards for construction and operation of pipelines to be observed, though in some Member States rules are only intended as a guide.

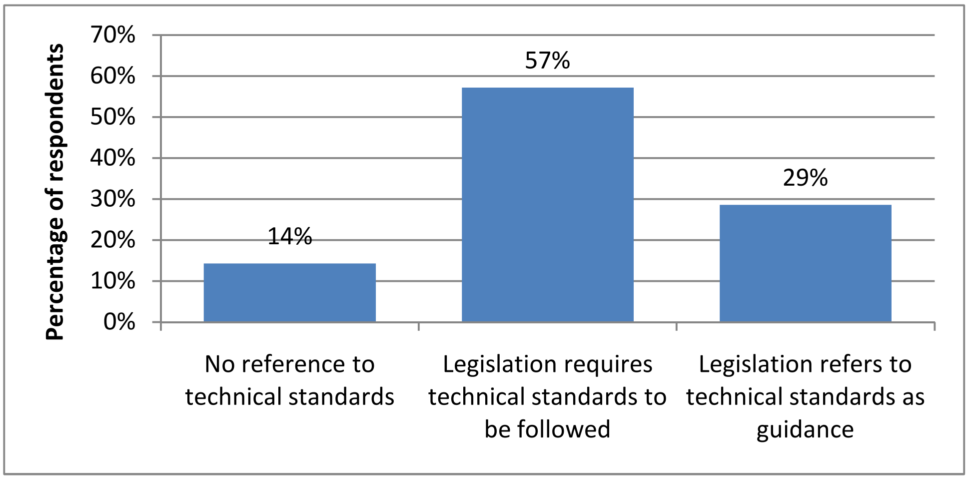


Figure 3-7 Requirements regarding technical standards

Legislation also specifically requires the implementation of various technical safety measures.

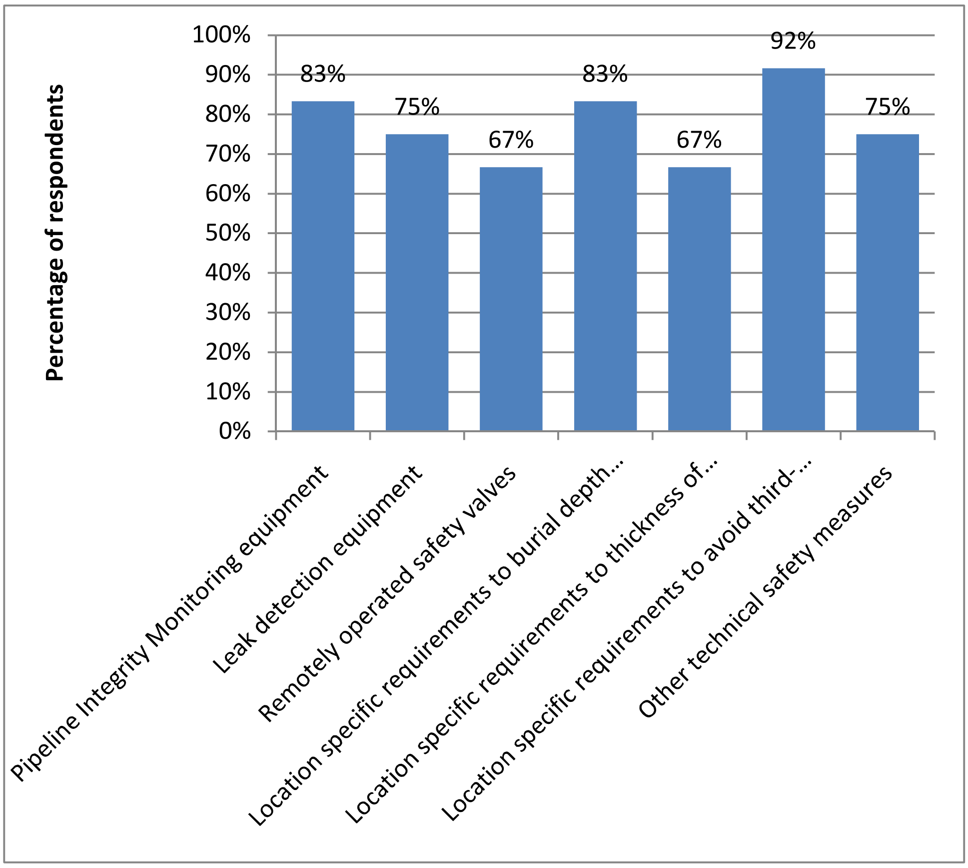


Figure 3-8 Requirements for technical safety measures

3.2 Industry perspectives

The main industry associations regarding gas and oil pipelines have been consulted. This includes Marcogaz and CONCAWE. Also two gas operators have interviewed and the key findings from the all the interviews are presented below. It should be noted that the presented opinions regarding safety legislation etc are those of the interviewed organisation.

3.2.1 Marcogaz[12]

Marcogaz

MARCOGAZ is the Technical Association of the Natural Gas Industry in Europe. 27 Members from 22 Countries are represented in Marcogaz, which accounts for about 90 per cent of the European pipeline network.

The main objectives of Marcogaz are to:

- promote safety, reliability, cost effectiveness and environmental advantages of natural gas systems and appliances;
- identify, monitor and take action on technical legislation at EU level;

[12] Based on an interview with Marcogaz.

- promote with the EU institutions fair European legislation reflecting the industry's high safety record and respecting subsidiarity;
- actively monitor standardisation activities related to natural gas conducted by CEN, ISO, OIML and others;
- identify appropriate levels of competence for a safe and effective operation of gas systems.

Technical safety measures

Member State requirements differ widely. The interesting point is that everything is cost driven: If the regulator does not allow pipeline operators to incorporate certain cost elements in the tariffs, operators will not meet requirements.

European Transmission System Operators (TSOs) spend much money on monitoring pipelines, walking on or driving by the pipeline route with gas detectors and monitoring pressure drops from control centres, still a leak is sometimes detected by a landowner reporting having observed something unusual. For that reason, the TSO emergency number is listed everywhere on information boards on the pipeline markers.

Depth of pipelines: it is better to lay pipelines at a depth of 80 cm or more, but costs increase drastically such regulation is enforced.

Pipeline wall thickness: there are more than 100 different products (most are of Indian (Tata Steel) or South Korean origin. German production continues to decrease.

Safety management systems

Currently, discussions are ongoing about the application of the asset management system PAS55. To this end, Marcogaz has investigated the use of environmental and health standards among its members. 12 to 13 gas operators filled in the Marcogaz questionnaire:

- 9 out of 12 respondents have adopted ISO 14001 for management of environmental issues;
- 12 out of 13 respondents have adopted ISO 9001 for management of quality;
- 9 out of 12 respondents have adopted OHSAS 18001 for the management of health and safety at work;
- 9 out of 12 respondents also use other standards to measure the management of the environment, health and safety and quality.

Information about PAS55

With the objective of providing optimal management of physical assets, the PAS 55 - is a Publicly Available Specification offered by the British Standards Institution. The PAS provides guidance and a 28-point requirements checklist of good practices in physical asset management. Typically, such an application would be relevant to gas, electricity and water utilities, road, air and rail transport systems, public facilities, process, manufacturing and natural resource industries. It would equally be applicable to public and private sectors, regulated or non-regulated environments. The PAS 55 has attracted much attention and it holds great promise as a de facto worldwide specification for any organisation seeking to demonstrate a high level of professionalism in the whole life cycle management of physical assets.

The standard is split into two parts:

- Part 1 - Specification for the optimised management of physical infrastructure assets;
- Part 2 - Guidelines for the application of PAS 55-1.

The application is accompanied by a comprehensive Competencies Framework for asset managers.

It is interesting to note that 50 per cent of their members are working on PAS55, with 40 per cent being opposed. In the Netherlands, the PAS55 became compulsory for the GAS TSOs.

Generally, Marcogaz considers the inclusion of gas transmission pipelines with a MOP (Maximum Operating Pressure) above 16 bar in the Seveso Directive unnecessary for the following considerations:

- Safety of pipelines is constantly improving, as demonstrated by EGIG statistics (European Gas Pipeline Incident data Group). The trend of incidents (gas leakages) is **constantly decreasing**. This finding clearly demonstrates that the safety of gas installations is managed efficiently.
- The very good results in terms of safety are also due to the efforts made by the Gas Industry in developing, for more than 40 years, tailor-made **European and International standards**. These standards are adopted for the design, construction, maintenance and operation of the infrastructure thus creating a harmonized safety level and a sound basis for common operations throughout Europe. In particular, European standards for Safety Management Systems (SMS) and Pipeline Integrity Management Systems (PIMS) are available for the infrastructure operators.
- In 2006, the Directorate General on Energy and Transport (DG-TREN) organized in industry expert working group. The result of the assessment done by the working group is included in a report on pipeline safety "*Safety of oil & gas pipelines in the EU*"[13] concluding that oil & gas pipelines safety was improving through improved maintenance, operations and R&D investments. Considering this background, the report does not mention the need for improving pipelines safety legislation. This report can be provided on request.

[13] WG (2006)

- The main problem (more than 50% of incidents) of transport pipelines is caused by **third-party interference,** i.e. incidents caused by unreported works made by contractors in the proximity of the pipelines. This problem is often beyond the control of pipelines operators who are unaware of work ongoing close to pipelines (despite regular monitoring). The previously mentioned DG TREN report suggests that this problem be addressed by **specific legislation** towards contractors to increase awareness and liability for excavation works.

- In addition to the previous remarks, Marcogaz has pointed out that the Seveso Directive and its requirements would be difficult to apply to the pipeline network, which extends (in Europe) about 234,000 km. The application of Seveso II requirements to high-pressure pipelines would incur very high additional costs to the operators without yielding clear benefits in terms of safety improvement. It should be noted that pipelines are excluded, for instance, from the scope of the EPCIP Directive (European Critical Infrastructure Protection Directive 2008/114/EC) dealing with security issues. Therefore, Marcogas believes that the Seveso Directive can be applied only to fixed installations.

- The possible inclusion of security in the revision of the Seveso Directive could create **overlapping** with other regulations already in force for some Seveso II industrial establishments. For instance, LNG Plants are covered by the ISPS Code (International Ship and Port Facility Security). Therefore, Marcogas suggests not mixing up safety issues as for Seveso Directive requirements with security issues, which are of complete different nature.

3.2.2 Interview with Gasunie14

Gasunie

Gasunie operates the gas transmission network on behalf of the Dutch government. It is a fully state-owned corporation but run commercially. Gasunie operates some 12,000 km transmission pipelines in the Netherlands and an additional network in Germany (about 3,500 km). Further, it is involved in major offshore pipelines such as Northstream and BBL. Gasunie operates more than 99 per cent of all transmissions gas pipes in The Netherlands.

The network is split roughly in 50 per cent HTL (high pressure; 66.2/80 bar) and 50 per cent RTL, regional transport at 40 bar. The HTL diameter is typically from 18” to 48” and RTL diameter is from 4” to 16”. Gasunie operates until the GOS centre (gas reception centres) where the gas is reduced in pressure and transferred to the distributor's network or directly to the industry.

- 6,000 km at 40 bar, 5000 km at 66.2 bar and 1,000 km at 80 bar

- 6,500 km 4”-16” , 5,500 km 18” – 48” (mainly 36”, 42” and 48” divided evenly)

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[14] Interview 27th June with Gasunie

Incident data	Extensive and state-of-the-art recording on severity and cause (comparable to EGIG guidelines) is compulsory under the incident registration programme. Furthermore, regular reports are sent to OVV (the Dutch Safety Board) and Velin (Dutch Pipeline Association) as stipulated by new act on pipelines (Besluit Externe Veiligheid Buisleidingen, BEVB). Moreover, all incidents are recorded at a more aggregated level in the CSR (corporate social responsibility) annual report and in the EGIG reporting In the last 13 years, no major ruptures or accidents have occurred and to date there has never been a rupture to the HTL.
Technical safety measures	All mentioned technical safety measures are systematically implemented. Some pipelines cannot be inspected by intelligent pigs[15], the HTL network is inspected by means of intelligent pigs, the RTL, due to smaller diameter, only partially (according to risk ranking). Where pigging is not possible, ECDA methodology is in place (External Corrosion Direct Assessment). This programme provides statistical analysis of the results of catholic measurements, location specific data and inspection results to get a best estimate of the condition of the network. In a high-pressure system, leak detection is less relevant and is not done systematically (contrary to the distribution grid). However, the necessary equipment and staff are available whenever needed. There are remotely controlled safety valves in the HTL (all controlled from Groningen). Disruption of the gas flow to a major region has a strong impact on safety, for which reason it will only be done when necessary. Construction specifications are prescribed by several (inter)national standards. Especially for pipelines, NEN 3650 (Dutch pipeline standard) prescribes the methodology for construction, commissioning and maintenance. BEVB refers to this standard. Above, the combination of the thickness, burial depth, pressure, material and location-specific adjustments form the basis for a probabilistic determination of the risk, which can lead to mitigating measures. The overall risk pattern is the main guiding principle, and the construction is determined by the risk analysis. Under the former act (circulaire '84), construction obligations consisted of a simple deduction based on pressure, material, diameter and surroundings. Today, a much more elaborate risk analysis has to be made when applying for a permit. The advantage is improved flexibility on the part of the gas company and local governments in adapting the risk profile and the construction work to the locality in question (ideally resulting in lower cost to the network company, enhanced possibility of using a nearby area for the local governments without increasing the overall risks). The drawback of the present

[15] Pipeline pigs are devices that are inserted into and travel throughout the length of a pipeline driven by a product flow

scheme is the need for more elaborate calculations making it more complicated than the former design.

Different standards apply for burial depth depending on the type of soil, community soil or agricultural soil. The lower limit for in community soil is minimum 80 cm, while in open land the lower limit may be only 60 cm. There are historic cases of less depth of cover, and specific measures are required in these situations. However, Gasunie is operates with 120 cm as the minimum depth for any new construction, and in most cases even 150 cm are used. Existing 'near-surface' pipelines are being monitored, and case-by-case tailor-made solutions are implemented. As the burial depth can change over time, it is part of the overall monitoring scheme.

Under the BEVB, the risk has to be calculated both for individual risks (IR) and for societal risks (SR). The distance to vulnerable dwellings (risk contour) is set at 10-6. The RIVM (Dutch National Institute for Public Health and the Environment) has drawn up a list of risk-reducing measures and their calculation method.

The technical construction standards are still covered by NEN 3650/3651. These standards ‘only’ provide an indication about the construction part (is it built sufficiently solid to withstand intended practical use?) but they do not indicate or include safety issues.

In addition to the safety requirements stipulated by the BEVB, Gasunie has adopted a policy on marking which includes several ways of informing and warning the public about pipeline locations. Information includes signposting at water crossings, buried ribbons, panels on land, etc.

Safety management system

Gasunie uses the PIMS (Pipelines Integrity Management System) and other SMS (safety management) tools for the overall safeguarding of operations. Next to PIMS, the NTA 8620 and the NTA 8000 are the guiding safety management systems (as required under BEVB/BRZO (implementation of Seveso). In addition, Gasunie has an ISO 14.001certification.

Internally, Gasunie has prepared a ‘handbook for safety and environment’, which stipulates carefully all necessary steps according to the above-mentioned SMS. Specific, additional issues include:

- Helicopter surveys of all HTL pipelines and selected parts of the RTL pipelines every second week;

- On-foot inspection of all HTL and RTL pipes, including check of burial depth and site-specific conditions.

The KLIC system (Dutch Cables and Pipelines Information Centre) is very important to avoid third-party interference. Every mechanical digging in the subsoil must be reported to a central place and all network operators are immediately informed on any activity near their pipes. Proper implementation and execution of KLIC has reduced incidents strongly.

Gasunie assumes that all industry best practice is being implemented, in several cases they believe to be leading the path and to be setting the standard for the industry.

Safety legislation

The most relevant was the switch from the former 'circulaire '84' to the recently implemented BEVB (1-1-2011, Besluit Externe Veiligheid Buisleidingen). This new and innovative act is, as already mentioned, moving away from construction description and towards a risk/safety analysis as the basis for decision-making and safety management. This means that probability (chance for lethality below 10^{-6}) has become an additional demand.

The basic elements are:

1. Analyse both IR (Individual Risk) and SR (Societal Risk) and maintain overall risk contour below 10-6;

2. Implement an SMS;

3. Reporting.

The Ministry of Infrastructure and the Environment is responsible for evaluations and inspections. Installations are visited and inspected at regular intervals. The pipelines are evaluated based on the yearly managerial reports. New pipelines are subject to a permission procedure, including environmental impact assessment, public comments/hearings and safety analysis.

According to the "Registratiebesluit Externe Veligheid" (Dutch External Security Registration Decision), all pipelines above 8 bar must be registered in a specific risk register. This is publicly available on the internet (www.risicokaart.nl). Any changes must be reported within three weeks.

According to Gasunie, there are no major gaps in the existing legislation. The new legislative system has changed the practice (no more hard prescriptions and more complex risk analysis), but this improves flexibility. There is no redundant regulation since pieces of legislation have recently been reviewed and integrated into an amending act..

Legislatively and otherwise, the Dutch approach distinguishes itself clearly from other Member States. However, despite being active in other countries, Gasunie has no problem handling differences.

A related issue is the 'crowded' underground in the Netherlands where the interference of different networks increasingly causes problems. There is no regulation (apart from KLIC and the registration map) that can address this specific issue.

Another distantly related issue concerns the issue of gas quality, which has until now mainly been regulated by bilateral contracts between countries. When biogas will cover a more important part of the gas market, this issue may deserve some more attention as different quality of gas could impact pipelines differently with respect to safety.

Costs

As most of the systems have developed gradually over time or have been in place already for a long time, it is hard to provide specific cost estimates. However, e.g. introducing the PIMS needed roughly 10 full-time equivalents (fte) for one year plus the costs of programme design (equals roughly EUR 4.5 million).

The implementation of safety measures is far more expensive. Pigging, checks, data collection and management, screening of (new) construction works, preventive repair etc. are expensive and labour intensive. More than 200 fte are directly involved in this part of Gasunie operations resulting in annualised costs of above EUR 30 million. Concerning the SMS, software and yearly implementation of requirements are the most costly elements.

3.2.3 Interview with Kiwa Gas Technology[16]

Kiwa

Kiwa Gas technology is the company in specialising in the distribution network in the Netherlands. Kiwa advises, controls and certifies network companies, regulators and inspection bodies. Kiwa does not own or operate its own network. However, the association of network companies has asked Kiwa to operate the 'Expert Centre for Gas grid management', which is specific to the distribution network (8 bar and lower). All data on incidents, accidents etc. are collected by the Centre.

In the Netherlands, the SODM (State Supervisory for Mines) and NMA (Netherlands Competition Authority) are the regulatory bodies for safety and tariff/competition issues respectively.

Other relevant companies with activities in the pipeline sector are TNO (equipment), Deltares (soil physics) and Kema. All are former public companies.

Data

The gas distribution network in the Netherlands comprises the following materials and pressures:

Table 3-1 Length of distribution network in the Netherlands by pressure

Material	Pressure (bar)	Length (km)
PE	0.03-0.1	11,296
u-PVC	0.03-0.1	21,405
HI-PVC	0.03-0.1	52,855

[16] Interview Kiwa Gas technology 27th June

Material	Pressure (bar)	Length (km)
Steel	0.03-0.1	5431
Cast iron	0.03-0.1	6355
Nodular cast iron	0.03-0.1	1,209
AC	0.03-0.1	1,759
PE	1-4	7,099
Steel	1-4	1,033
Cast iron	1-4	163
Nodular cast iron	1-4	326
PE	8	847
Steel	8	12,795
Nodular cast iron	8	256
Total length		122,829

Source: Kiwa

Most data can be found in the following reports:

- Delivery problems: ‘Nestor Gas’ annual report. Publicly accessible at the Netbeheer Nederland website. All general data on pipeline system are included here.
- Incidents and accidents: ‘Veiligheids indicator’ (safety indicator). All data are specified by severity and cause. This report bundles all reports to the OvV, (Onderzoeksraad voor de Veiligheid, Research Council for Safety issues). This is not publicly available but can be made available on request.
- In the latter report a systematic link between delivery issues and safety is investigated and all network companies are benchmarked and ranked.
- With over 7 million consumer connections, only 1 casualty per 10 year is reported. This very low rate makes prediction difficult, precaution and statistic analysing of incidents are considered important instruments.
- The most incident prone location in the Netherlands distribution system is the point were the gas piping enters the house/building. Almost all incidents are because of gas building up in and under buildings.

Technical safety measures

All technical safety requirements are regulated under NEN 7244 and NEN 1059, norms related to CEN 12001/12007. These standards partly also describe required management instructions.

For pipeline integrity, monitoring a 'leak inspection procedure' is in place. Every five years, every part of the network is checked (external gas detection, no internal pigging).

Remotely operated valves are still in operation, but are increasingly replaced (in the piping network). At gas stations with pressure regulators, automated systems are in operation.

Burial depth is everywhere at least 80 cm. In specific situations, exceptions are possible if additional measures are taken.

Pipeline thickness is strictly regulated (and implemented) by the NEN standards. Pipeline material is also regulated but in this field the discussion about old pipelines and their manufacturing is ongoing. Especially, grey cast iron piping (still some 5,000 km) and the asbestos cement piping are subject to discussions and replaced.

Location-specific technical requirements to avoid third-party damage are mostly situation specific and sometimes voluntary (e.g. a sign when a pipeline crosses a small water stream,). The KLIC management system (see below) provides third parties and utility owners the signal for such location specific actions.

An important and specific measure is the odorisation of gas when shifting from transition network to distribution network. The added THT is considered a basic safety instrument.

SMS

In general, network operators in the distribution sector do not use PIMS. They do, however, have other safety management systems in place, as required by NEN and NTA 8120 (NTA = Nederlandse Technische Afspraak, a Dutch norm). Overall asset management is regulated by these standards.

The KLIC system is a safety system requiring all mechanical digging/soil disruption (graafwerkzaamheden) to be reported to network operators. This is a very significant contribution to avoid third-party incidents. However, roughly one third of all incidents still originate from third-party interference (soil movement being the second most common cause).

Pigging is not used for the distribution network. However, all Dutch gas distribution network operators participate in a programme where Kiwa investigates, on a regular basis, samples of pipelines being brought to surface in order to evaluate deterioration. Data collected are used for statistical forecasts of corrosion, lifetime, etc.

Every 5 years, every part of the distribution network undergo a leakage check. This is typically done manually using gas detection equipment. Companies and employees involved in this work must be specially trained and certified. This is provided centrally by Kiwa.

Safety legislation

In theory, legislation is rather complete and well developed. In practice, there are still some minor issues relating to execution that need attention:

- Registration of all pipelines, including information about diameter, pressure, length, material, etc. is not always complete and/or digitally available. Previously, sketches were made, but these do not always satisfy today's requirements. Work in ongoing to remedy this, but is still fully completed

- A relatively new issue is pipeline crossings with other underground activities, such as electricity, water or glass fibre cables. This is not sufficiently regulated yet.

Information about the distribution network is not publicly available; however, the KLIC system can provide anyone who needs information about pipeline locations.

Improvements can still be achieved by translating constructive requirements into functional requirements.

Pressure equipment used in gas distribution systems is not regulated by the PED (Pressure Equipment Directive). In many cases, however, equipment nevertheless meets PED requirements, and over time all equipment will be manufactured to PED standard. This could be included in legislation.

Other Member States

Comments about technical and legislative differences:

- There are wide variations in pressures used across the EU. This renders data and safety strategy comparison difficult. However, this is probably not sufficient to justify new EU regulations in the field.

- The same goes for the different points of handing over the gas supply to the consumer. In France, Italy and some other countries, distribution ends by the house/building. In the Netherlands, distribution enters the house and ends by the meter. Practices differ, but do not pose any major problems.

- The requirements for fire/heat resistance vary across Europe. To exemplify this, Germany has stricter requirements than the Netherlands, but Kiwa does not see any need for EU coordination.

Costs

No specific data are available. The general perception is that lack of data organisation and safety measures is much more expensive than a properly organised SMS, the payback time of which is short. There is, however, an initial investment to be made. If pipeline registration is not properly organised, an incident may become very costly case of changes. By way of example, the costs incurred by one company from organising registration were EUR 60 million, however, savings generated were more than EUR 200 million over the lifetime of the assets.

Reporting requirements are a significant additional burden. Still, it is generally limited compared with overall turnover.

Using certified material, certified staff and certified procedures add to costs; typically in the order of 10-20%

A rough indication of overall costs is given in the following. The distribution network in the Netherlands extends 120,000 km. One man-hour is required to inspect one kilometre. Every metre of pipeline has to be inspected every five years, which adds up to 24,000 man-hours/year. 24,000 x EUR 60 = EUR 1,440,000. The additional costs of materials, repair, analyses and reporting will roughly double this amount to EUR 3 million a year. Additional costs are the required 24/7 telephonic guard for public leak reports and the associated repairs. This increases the cost of safety management at least by an additional factor 2.

Other comments

Third-party incidents and ground soil movement are the main safety triggers. A good third is the wide variation in technical connection solutions between the central street pipe and individual houses. Some standardisation in this area could increase safety.

The use of grey cast iron in old piping is a specific issue in the Dutch situation. Still, some 5,000 km is in operation and needs to be replaced. Specific network operators have committed themselves to replacement plans as required by the SodM.

3.2.4 CONCAWE[17]

Safety management

CONCAWE indicates that its members already endeavour to prevent and reduce incidents and spillages. They believe that CONCAWE member have implemented very good safety management systems that are based on a thorough understanding of their pipeline grid (GIS systems + oil pipelines are digitalised), which, due to the implementation of the strategic infrastructure directive[18] cannot always be made public.

By using advanced technology (intelligence pig), CONCAWE inspects between 15 and 20 per cent of the total actual length of oil pipelines annually, which means that the full network is inspected at least once every five years. The findings of these inspections are always followed by preventive maintenance..

It has been noted that the frequency of mechanical failures has had an increasing trend over the last decade. However, an in-depth study of these incidents

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[17] Interview with CONCAWE

[18] Council Directive 2008/114/EC on the identification and designation of European critical infrastructures and the assessment of the need to improve their protection

revealed that failures are not associated with aging lines. Therefore, there is no evidence that the ageing of the pipeline system poses a larger spillage risk. The development and use of new internal and external inspection techniques support the prospect that pipelines can continue reliable operations in the foreseeable future.

In 2009, four of the five incidents were caused by mechanical failures, while one was related to third party interference.

Opinion on safety legislation

CONCAWE is not in favour of EU legislation, as there are too any differences in the current oil pipelines. The proposal to introduce minimum standards is neither a good idea, as it believes that the majority of its members have currently higher standards. The introduction of common minimum standards would impair the safety system, as some will choose to lower safety standards.

CONCAWE is of the opinion that existing legislation is sufficient to ensure the safe operation of oil pipelines, including the ELD and E-PRTR.

CONCAWE believes that the E-PRTR provides an appropriate framework that forces its members to operate prudently as mention in the E-PRTR report could be detrimental to business.

Further, CONCAWE indicated that the European environmental liability directive already provides a certain framework, which de facto obliges pipeline operators to prevent incidents, as the consequences to business and their reputation are already well regulated.

3.3 Existing EU legislation, other than Seveso

The existing EU legislation that could be of relevance includes the EIA Directive and the Pressure Equipment Directive.

3.3.1 EIA Directive safety of pipelines

The EIA Directive (85/337/EEC) as amended aims to ensure that projects that are likely to have a significant impact on the environment are identified and assessed before the project can proceed.

All projects listed in Annex I to the EIA Directive are considered to have significant impacts on the environment and must therefore undergo an EIA. Annex I (16) lists pipelines with a diameter of more than 800 mm and a length of more than 40 km:

- for the transport of gas, oil, chemicals, and,
- for the transport of carbon dioxide (CO_2) streams for the purposes of geological storage, including associated booster stations.

Projects for those types of pipelines are always subject to an EIA assessment.

For projects listed in Annex II, it is up to the national authorities to decide whether an EIA is needed. The decision is made by means of a 'screening procedure' taking into account the criteria laid down in Annex III. The screening procedure determines the effects of projects based on thresholds/criteria or a case-by-case examination. Annex I (i) lists oil and gas pipeline installations and pipelines for the transport of CO_2 streams for the purposes of geological storage (projects not included in Annex I). Projects involving those types of pipelines *may* be subject to an assessment procedure.

The assessment procedure in accordance with Articles 5 to 10 of the EIA Directive comprises the following stages. At the scoping stage, the developer may request the competent authority to indicate the contents of EIA to be provided by the developer. Pursuant to Article 4, the developer must supply information on the environmental impact as stipulated by Annex IV. The environmental authorities and the public, as well as affected Member States must be informed and consulted pursuant to Articles 6 and 7. When the competent authority has decided to grant or refuse development consent based on, the results of consultations, the public must be informed of the decision, which may be challenged before the courts, as stipulated in Articles 8 to 10.

The EIA Directive is general in scope in that it requires a generic assessment procedure to apply to a wide range of projects, including those involving pipelines. Although the EIA Directive requires that risks of incidents should be considered, it does not provide any details on how they should be taken into account. Neither does it contain a set of measures to be applied to mitigate such risks.

3.3.2 Pressure Equipment Directive

The Pressure Equipment Directive covers certain components used in the pipeline transmission system. The Directive reads:

3. The following is excluded from the scope of the Directive:

3.*1 pipelines comprising piping or a system of piping designed for the conveyance of any fluid or substance to or from an installation(onshore or offshore) starting from and including the last isolation device located within the confines of the installation, including all the annexed equipment designed specifically for pipelines. The Directive applies to* ***standard pressure equipment*** *such as may be found in pressure reduction stations or compression stations*[19].

The accompanying guideline explains, in Guidance 1/17, the meaning of standard pressure equipment in relation to pipelines:

[19] Pressure Equipment Directive (97/23/EC) Article 1 on Scope and definitions

A standard pressure equipment is not specially designed and manufactured for a specific conveyance pipeline, but is intended for use in a number of applications, including other conveyance pipelines or, for example, industrial piping.

Typical examples of standard pressure equipment annexed with pipelines, pressure reduction stations or compression stations may include: measuring devices, valves, pressure regulators, safety valves, filters, heat exchangers, vessels.

Such equipment is covered by the directive[20]*.*

Hence, it does not include overall safety measures in relation to the pipeline network.

3.3.3 European Critical Infrastructure Directive[21]

The Directive on designation of critical infrastructure requires Member States to identify pipelines that are critical (energy supply perspective) and develop Operator Security Plans (OSPs) for the identified infrastructure. These plans will detail protection measures against intentional third-party interference for the designated pipelines.

For major transmission lines and in particular cross-border lines, the increased protection against intentional third-party interference would also lead to better protection against the unintentional third-party interference. Hence, this Directive provides some additional safety measures.

[20] Guidelines related to the Pressure Equipment Directive 97/23/EC (PED)

[21] Council Directive 2008/114/EC on the identification and designation of European critical infrastructures and the assessment of the need to improve their protection

4 Legislative gaps

The section describes the preliminary findings regarding the existence of major legislative gaps in the current national legislative frameworks for safety of onshore pipelines.

4.1 Legislative benchmark

To identify any legislative gaps in Member States' current legislation, it is necessary to define what should ideally be covered by the legislation. This has been termed the "regulatory benchmark" for pipeline safety.

The "legislative benchmark" has been investigated previously. The elements are general safety provisions similar to those that are part of the Seveso requirements plus a few additional aspects relevant for pipeline safety. The definition of the legislative benchmark includes:

- Safety management systems;
- Safety reports or similar describing the risk scenarios and the mitigation measures;
- External emergency plans;
- Land use planning measures;
- Information to the public;
- Prevention of third-party interference (this element was not previously included in the benchmark, but studies have identified it as an important element given that a large share of pipeline failures are due to third party interference);
- Potentially specific requirements regarding technical safety measures.

Pipeline transport is fairly standardised so in principle one could define a best practice regarding which technical safety measures should be applied. This is different from the Seveso Directive where only a general safety provision is applied as the types of installation covered by the Directive are very different.

The above general safety elements are all important in preventing and mitigation of major accidents. The questionnaire on Member State legislation has included more detailed questions within each of the general categories. The following more specific elements could be considered as very important for the overall safety level.

- Prevention of accidents
  - Inspection and maintenance to ensure mechanical integrity of pipelines;
  - Special requirements for safe working in close proximity to high pressure pipelines and availability of pipeline location GIS data;
  - For carefully selected high-vulnerability surroundings, restricted access to pipeline route to reduce probability of inadvertent third party damage.
- Mitigation of impact of accidents
  - Ensure adequate distance to population concentrations to reduce severity of accidents (vulnerability);
  - Rapid leak detection capability and efficient means to stop flow to the damaged pipeline (operator onus);
  - Emergency plans (authority's onus).

4.2 Legislative gaps

This section presents a comparison between key legislative elements and current coverage as reported by Member States. The discussion is organised around the "legislative benchmark" headings.

4.2.1 Safety management system

Safety management systems could come in various forms. The questionnaire covered the use of a general SMS and more specific management systems tailored to the pipelines. PIMS are Pipeline Integrity Management Systems, and they specifically address pipeline operation and maintenance to achieve safe and reliable pipeline operation.

All the Member States that have replied so far have some form of SMS requirement, only in the Czech Republic is it voluntary for the operators. About half of the responding Member States require specific pipeline safety management systems, such as PIMS, to be in place.

As discussed above, inspection and maintenance of pipeline integrity is vital for prevention of accidents. 13 out of 16 Member States have specific requirements regarding inspection and maintenance and they all require documentation for the inspection.

As part of the investigation on safety systems, the question of risk or hazard assessments was covered. This element is included for the majority of countries as in 12 out of 16 Member States[22]; the element is covered by current legislation. Half of those with requirements to do risk assessments require i a quantitative analysis of the risks.

Other key safety elements covered include emergency plans and definition of roles and responsibilities for relevant staff. 10-12 of the responding Member States include these elements.

Overall, there seems to be a good coverage regarding the use of safety management systems and the key individual safety elements.

4.2.2 External emergency plans

A few Member States have no legislative requirements for the preparation of external emergency plans by the relevant authorities. Four respondents indicated that external emergency plans are not a mandatory requirement. Of the 12 Member States requesting external emergency plans, only seven include testing and drills as a requirement of the plans.

Overall, this might suggest a gap in the current legislative coverage.

As discussed above, most responding Member States require operators to draw up their own emergency plans.

4.2.3 Third-party interference prevention

Prevention and mitigation of third-party interference can be achieved by different types of measures. These include technical measures such as wall thickness, burial depth of pipelines and marking of pipeline location.

Other measures attempt to ensure that contractors get updated information about the location of pipelines before starting any excavation work.

Finally, land use planning measures with requirements to the location of pipelines and safety zones around pipelines also contributes to reducing the risk of third party interference.

Many Member States have requirements to technical measures such as location, specific burial depth and wall thickness.

[22] Note that though 17 Member States have responded, only 16 of those have pipelines and therefore relevant for this assessment.

12 of 16 Member States include prevention of third-party interference in legislation, and the two Member States without legal requirements have made provisions for other measures. This includes updated maps and a single contract point for contractors to obtain information about pipeline locations.

13 of 16 have updated maps, and eight of 16 have one single contract point for third-party contractors.

Based on the replies received, there seems to be no cases of major gaps in national legislation concerning prevention of third-party interference.

Land use measures are discussed on the next section.

4.2.4 Land use planning

Land use planning is related to the protection of human health and the environment but also links to the prevention of third-party interference.

The EIA Directive requires that an EIA be made for new pipelines longer than 40 km and with a diameter above 800 mm. Some Member States have reported that an EIA is required for other pipelines as well. This is the case for four Member States.

12 out of 16 Member States have replied that they have land use requirements in place. One of the specific land use requirement is the application of safety zones around new pipelines which are reported as a requirement by 10 out of 16 Member States.

There seems to be some gaps in terms of specific land use requirements.

4.2.5 Information

Most Member States require that the public potentially affected by a pipeline is informed, but there are a few exceptions.

It is obvious that households who receive gas should know about the risk involved, and hence all Member States require operators to inform the public. The data need to be analysed in more detail identify whether the information obligations extend to other types of pipelines.

All Member States require that incidents are reported.

There might be gaps relating to the requirement to inform the public living near transmission pipelines.

4.2.6 Technical safety measures

There are several international standards for construction and operation of pipelines, and all Member States have some form of reference to these technical standards.

Overall, the technical standards that national legislation refers to (typically EN, ISO, DIN and BSI) provide similarly levels of technical safety, but in principle it would be possible to harmonise the requirements.

While the general reference to technical standards does not guaranteed that these are fully implemented, the majority of Member States require the application of various specific technical measures. They are listed in Table 4-1.

Table 4-1 Required technical safety measures

Type of measure	Number of Member States (out of 16)
Pipeline Integrity Monitoring equipment	11
Leak detection equipment	10
Remotely operated safety valves	9
Location specific requirements to burial depth of pipeline	11
Location specific requirements to thickness of pipeline wall	9
Location specific requirements to avoid third-party damage	12

Industry interviews have disclosed that, due to natural gas is often supplied by either a public utility or tightly regulated companies; operators are not free to choose the cost elements that can be included in the user tariffs. This means that if the cost of certain safety measures cannot be included in the user tariffs, the operator will not implement these safety measures.

Overall, there seems to be no major gaps in terms of technical safety requirements.

4.2.7 Overall assessment

Table 4-2 presents an overview of the coverage of national legislation regarding key safety elements.

It presents the results of the replies from 17 Member States. Malta is not included in the table, due to lack of pipelines that need coverage by national legislation.

Replies from three candidate countries and Norway have been included. Similar to the case of Malta, Iceland has not any pipelines that need to be covered by national legislation.

Table 4-2 Overview of current Member State legislative coverage

Country	Safety manage-ment systems	Risk assessment	External emergency plans	Land use planning	Information to the public	Third-party is-sues	Technical safety requirements
Belgium	++	++	++	++	+	+++	++
Czech Republic	+	0	+++	++	+	+++	++
Denmark	0	++	++	+	0	++	+++
Estonia	0	++	0	+	0	++	++
Finland	+++	++	++	++	+	++	+++
France	+++	++	+++	++	+	+++	++
Germany	++	++	+++	++	+	+++	+++
Ireland	+++	++	+++		+	+++	0
Italy	+	++	0	+	+	++	+++
Netherlands	++	++	+++	+	+	+++	Duty of care
Poland	+++	+	0	+	+	+	+++
Portugal	+++	++	0	+	+	+++	+++
Romania	+++	++	+++	+	+	0	++
Spain[23]	+ +	+ +	+	+ + +	+	+	+ +
Sweden	++	0	+	0	0	+	++
UK	+++	++	++	++	0	+	Duty of care
Croatia	++	+++	++	++	+	++	+++
Turkey	++	+++	+++	++	+	++	+++
Norway	++	+++	+++	++	+	++	+++

Legend: 0: no provision in place +: basic provision, ++ several provisions +++ many provisions
Source: Member States questionnaire replies

[23] The legislation does not cover oil pipelines.

According to the collected data, there are a few major gaps. In terms of external emergency plans and information to the public, there are a few examples of Member States with less stringent requirements.

None of the responding Member States has wider gaps in legislative coverage[24]. One or two elements are missing at the most.

Most countries have made revisions or amendments to the legislation during the last 10 years, and in most countries legislation is regularly revised.

4.3 Baseline

In order to assess the value added of additional EU legislation, the baseline needs to be assessed.

Growth in pipeline network

The pipeline network is growing, and this trend is expected to continue. The natural gas network will most likely continue to expand, and the increasing use of LPG may trigger a need for additional transmission lines from new LPG terminals. According to APPE, there are plans to expand the olefin network. Also for other substances, such as hydrogen and CO_2, network expansions are foreseen.

Development in risks

Safety statistics indicate a decrease in the rate of pipeline incidents. Overall, this trend is expected to continue. It is not possible to isolate the specific causes of the decrease. There may be several contributory factors, such as.

- Increased awareness about safety among operators and in society in general;
- Technological progress leading to new and better equipment and systems for pipeline integrity management;
- Higher value of gas and oil products leading to increased financial loss in case of an incident, which, in turn, leads to improved maintenance

As discussed in previous sections, the data available on gas incidents do not allow for a more detailed assessment of the risks. For oil pipelines, the available incident data show for example that there is no clear trend in the average spillage per incident.

The lack of more comprehensive data prevents proper monitoring of the risk situation.

Applying current incident rates to the whole pipeline network can provide a rough indication of the level of damage at the current level of incidents.

[24] There are cases where the legislation has the most extensive coverage of gas pipelines. In Spain for example, there is no legislative coverage of oil pipelines.

The gas network covered by the study includes only pipelines defined as transmission pipelines in the Eurogas data. The distribution network might include pipelines, which could have a major hazard potential.

Table 4-3 Estimated annual number of incidents

	Length - km	Incident rate per '000 km	Number of incidents per year
Gas transmission	250,942	0.14	34
Oil	35,522	0.28	10
Olefin	6,000	0.28*	2
Ammonia	200	0.28*	0
Hydrogen	1500	0.28*	0
Others	?	0. 28*	0
Total	295,168		47

Note*: Assumed to more or less the same rate as for oil
Source: EGIG 2008 and CONCAWE 2011

Cost of incidents

The table gives a rough indication of the level of incidents. In order to estimate the possible costs to society of such incidents, more details are required.

The CONCAWE database includes information about each incident, and there is reason to believe that Member States possess more specific data. This is for example the case for the Netherlands. In the Netherlands, data on incidents are collected, including information about the severity of the damage caused by the incidents[25].

In the Dutch registration system, each reported incident is classified according to three categories. Category 3 includes near misses and very minor incidents and it is assumed that Category 3 are incidents not reported in the EGIG and CONCAWE incident data and therefore only Category 1 and 2 are used to estimate the damage costs.

To be included in Category 1, the following incident criteria must be met:

- A fatality(s) or a serious injury
- Damage to property of third parties in excess of EUR 0.5 million.

The definition of Category 2 incidents include:

[25] VELIN 2010; *Registratie en analyse van pijpleidingincidenten 2009*

- Injury or minor injuries (note: consultation with a physician is required)
- Fire, explosion or serious threat due to the outflow of gas or liquid
- Need to enable emergency services
- Damage to property of third parties in excess of € 250,000 and less than € 500,000
- Social unrest
- Serious risks to soil contamination, (ground) water pollution, air pollution or contamination of surface due to an outflow.

The costs of fatality or serious injury can be valued based on the direct costs of a fatality or injury plus the loss of welfare using willingness-to-pay estimates. For traffic accidents, estimates include these cost components to assess the cost of fatalities and serious injuries. Even though the method is subject to uncertainty, the costs for traffic safety give an indication of the order of magnitude for the monetary valuation of fatalities caused by all kind of accidents.

Across the EU-27, the costs of a fatality vary between EUR 0.5 million and EUR 2.0 million, and the costs of a severe injury vary between EUR 0.07 million and EUR 0.3 million.[26]

Comparing the two Category 1 criteria used in the Dutch registration of incidents, the estimated damage is likely to be above EUR 0.5 million irrespective of which of the criteria that triggered the registration. A similar analysis of Category 2 suggests that the damage to third-party property can be used as indicator for the monetary significance of all incidents irrespective of the criterion that prompted the reporting of the incident.

Table 4-4 presents the damage cost values included in each category based on the above assessment where the damage to third-party property is used as the indicator for each category.

The column indicating frequency is based on the number of incidents within the three categories reported in period from 2005 to 2009.

[26] SafetyNet (2009) Cost-benefit analysis, retrieved 15.11.2011

Table 4-4 Data on "unit" damage costs from incidents

Type of incident	Damage costs in million EUR per incident			Frequency
	Minimum	Maximum	Average	
Category 1	0.50		0.50	10%
Category 2	0.25	0.50	0.38	90%
Overall average			0.39	

Source: VELIN 2010 and own calculations

The assumption to use the average damage costs for Category 2 might overestimate actual damage costs. Given that the number of incidents is highest for the less severe incidents, the true average for Category 2 is likely to be close to the minimum value. A sensitivity assessment would be to apply the interval from EUR 0.25 to EUR 0.50 million.

Table 4-5 Estimated damage costs from incidents in pipeline network (EU pipelines excluding gas distribution)

Type of incident	Expected number of incidents per year	Cost per incident	Annual damage costs in million EUR
Low	47	0.28	13
Average	47	0.39	18
High	47	0.50	24

Source: Own calculations based on Tables 4-3 and 4-4

Applying these data, the average damage per incident is assumed to be EUR 0.39 million, which with around 47 expected incidents annually adds up to approximately EUR 18 million in damage costs. This is a rough indication of the average annual damage costs. The sensitivity assessment suggests damage costs to be between EUR 13 and 24 million.

A study from 1998[27] on costs and benefits of EU pipeline safety instruments estimated the annual damage costs at EUR 11 million. This estimate is in the same order of magnitude as the estimate in Table 4-5 above considering the effect of inflation from 1998 until now and also considering that the estimate was for EU-15 only.

[27] Seaman (1998)

It should be emphasised that the estimate of damage costs covers pipelines with a major accident potential and that it excludes costs to the operator following from the incidents.

Costs of current safety management

The study has not systematically collected data on current expenditure on pipeline safety.

For the operators, one could assume that they have optimised their safety management effort. If that is the case then the benefits of additional safety measures would be outweighed by the costs of these additional safety measures.. However, a prerequisite for this is detailed risk assessments and a pipeline integrity management system. Some examples suggest that safety management systems have a short payback period.

The main cost element is likely to be inspection and subsequent maintenance of the pipeline network.

Cost of inspection and maintenance

Data from one operator of gas transmission pipelines can be used to give an indication of the order of magnitude of the inspection and maintenance costs.

Gasunie data suggest annual costs including repair and maintenance of EUR 30 million for a network of about 15,000 km of gas transmission lines (see Section 3.2.2 for more details). EUR 30 million annually for a network of 15,000 km means that the unit cost for inspection and maintenance. is about EUR 2,000/km.

Using these data, it is possible to estimate the annual inspection and maintenance costs for the major hazard potential pipelines (approximately 295,000 km). The result is an estimate of the total annual costs in the order of EUR 600 million.

5 Options for closing legislative gaps

The assessment of the national legislative coverage and the comparison with a "legislative" benchmark has identified cases where certain safety elements are missing in some Member States. This section presents alternative policy options for an EU level initiative that could be used to close these gaps.

As part of assessing the case for EU level legislation, the subsidiarity and the proportionality principles should be considered.

In relation to the subsidiarity principle, the key issues are considerations about transboundary environmental and health impacts and competition and internal market issues.

In principle, there are health impacts that could have cross-border impacts. This could be the case for the transport of toxic chemicals, but for the majority of the network, any major accident is likely to affect only the area sourcing the failed pipeline. Regarding the environmental impacts, oil spills could in principle impact international water bodies.

Lack of harmonised EU legislation can in principle affect the functioning of the internal market for example through distortion of competition. In case of pipeline transport, this is unlikely to be a significant issue as the location of pipelines will not be affected by differences in safety legislation. The location of pipeline will be determined by the supply source and the demand area. Any operator wanting to construct a new pipeline would therefore face the same legislation crossing different countries. Though there might be limited additional administrative costs due to different safety legislation across EU, this would not impact of the functioning of the internal market.

This means that, overall and compared to industrial fixed installations covered by the Seveso II Directive, pipeline transport is not a cross-national issue of the same importance.

Concerning the proportionality principle, there is already national legislation covering the safety of pipelines, so it would be proportional to consider further legislative action in cases where the current legislation would be insufficient.

In addition to considering legal initiatives, development of guidelines and similar non-mandatory initiatives should be considered. Hence, the set of relevant policy options that has been assessed include:

- Development of recommendations/guidelines (not legally binding);
    - General safety provision recommendations
    - Inclusion of specific technical safety measures in recommendation;
    - Inclusion of reporting obligations that would allow safety benchmarking across Member States
- Amendment of the Seveso III Directive to include pipeline transport
- Adoption of a Pipeline Safety Directive
    - Directive with general safety provisions similar to the Seveso Directive
    - Directive also including specific technical requirements.

Including pipelines as part of Seveso III or drawing up a specific pipeline safety directive will lead to many of the same impacts. The specific provisions can be made identically. Consequently, a comparison of the two alternatives, the important issues are mainly concern the "practical" aspects of modifying the Seveso Directive and the transposition and implementation processes in the Member States that determine the preferred alternative.

5.1 Baseline

The baseline is the present situation without any EU-level initiative, but a continuation of Member States' own legislative efforts in the field, including expected revisions. Most of the responding Member States indicated that they have made recent changes or amendments to the safety legislation. A few Member States also indicated that there are plans for future amendments.

5.2 Recommendations/guidelines

An EU initiative could be non-legally binding recommendations and guidelines for ensuring pipeline safety.

Recommendations and guidelines could have alternative levels of detail from the general safety measures included in the above discussion of the "legislative benchmark" to specific technical recommendations.

Furthermore, the recommendations/guidance initiative could be combined with a reporting element so that it would be possible to monitor progress and maybe introduce benchmarking across Member States as a "soft" incentive to improve national legislation for those with gaps in their current coverage.

It should be noted that the UNECE has issued a set of recommendations of what should be included in pipeline safety legislation[28].

The UNECE guidelines include the following headings:

- Design and construction
- Construction and testing
- Pipeline management system
- Emergency planning
- Inspection
- Hazard/risk assessment and land use planning.

The UNECE guidance would be a useful starting point for any development of guidance.

5.3 Include pipelines in Seveso Directive

One option would be to include pipelines in the Seveso Directive. The current version (and the proposal for the next version) excludes pipelines and other transport activities from the scope of the Directive.

It should be noted that only one Member State[29] has reported that safety of pipelines is part of the national implementation of the Seveso Directive.

5.4 Introduce a specific directive for pipeline safety

A specific directive on pipeline safety issues is another alternative worth considering. Such a directive may take various forms, which means that have several sub-options are feasible.

In line with the discussion on the recommendation/guidance option, the most relevant sub-options to consider would be to draw up a directive on only general - duty of care -type of safety provisions similar to what is included in the Seveso Directive or to issue a directive with requirements for more specific technical safety measures.

5.5 Other policy options

In principle, there are a number of other options. These include other directives into which pipeline safety can be integrated, such as the Pressure Equipment Directive. As explained in Section 3.3.2, the PED does not include pipelines, even though it includes standard pressure equipment used in pipeline systems.

The PED could be extended to include pipelines but, again, it would mainly address the technical characteristics of the pipeline. Given that most of the key

[28] UNECE (2008)

[29] Poland has indicated that pipeline safety is part of its national implementation of the Seveso II Directive.

safety provisions concern operational procedures and prevention of third-party interference, amending the PED would not be an appropriate way to cover these elements. Hence, this option is not considered further in this study.

6 Impact assessment

This section includes the impact assessment of each option. The impact assessment considers the potential costs associated with introducing each option and the possible effect on the protection level.

It should be emphasised that the assessment is not a full impact assessment as required for new EU legislative proposals. This study aims to provide the basis for the decision on whether to pursue any policy option and therefore, the objective of the impact assessment is to give an initial assessment of possible policy options.

The impacts to be considered include the economic, environmental and social effects of the policy options. The discussion in this section is organised under two main headings:

- Costs of the option;
- Benefit of the option.

The costs and benefits of the options include economic, environmental and social impacts. They are related as presented in Table 6-1.

Table 6-1 Relationship between costs and benefits and economic, environmental and social impacts of alternative policy options

	Economic impacts	Environmental impacts	Social impacts
Costs	Costs of options (compliance costs and administrative costs)		
Benefits	Reduced costs from fewer incidents	Reduced risk to the environment	Reduced risk to human health

The environmental and social impacts are first of all benefits related to the improvement of the protection level, and hence they are closely linked to how the protection level might be affected.

6.1 Baseline

The baseline is described in more detail in Section 4-3. Overall, the number of incidents seems to be decreasing, so even with a continued growth in the pipeline network the expected number of incidents would not increase.

6.2 Non-legislative action: guidelines, recommendations and benchmarking

6.2.1 Description of option

The United Nations Economic Commission for Europe issued a guidance document in 2008.

These guidelines and best practice recommendations include most of the "legislative benchmark" elements. It would be a natural starting point for developing more specific guidelines and best practice examples. In order to add value compared to the existing national legislation, more specific examples of how to address the risks of third-party interference should be included.

Recommendations that would focus on key elements such as maintenance of existing pipelines and prevention of third party interference including best practices could be supportive both in Member States' enforcement of existing legislation as well as in future revisions of the legislation.

A benchmark system with reporting of incidents and potentially other safety performance indicators would create additional focus on safety and hence lead to improvements. The reporting of incidents should be built on the existing reporting, for example, to the EGIG and the CONCAWE databases. Many Member States also have systems for recording incidents.

The isolated effect of additional guidelines and recommendations would most likely not be substantial; however, in combination with a system of benchmarking it could improve safety management by keeping focus on safety issues.

6.2.2 Cost of option

The costs of developing and implementing guidelines depend on the specific scope of the guidelines and the effort in dissemination of the guidelines.

Preparation of guidelines could cost up to EUR 0.5 million, including workshops with relevant stakeholders both to develop the recommendations and to disseminate the results.

A benchmarking system would require an organisation to receive and host the data. The number of operators will depend on specific definition of pipelines to be covered by the reporting system. Most likely it will not include gas distribution, and then the number of operators across EU is in order of a few hundred. If it is assumed that operators already record incident data, there would be limited costs associated with reporting these data. Assuming one to three days per operator and one man-year at the hosting organisation to compile and publish the data, the total costs would be in the order of EUR 0.5 million[30].

Reporting and benchmarking would only affect the safety performance if it leads to changed behaviour of operators and competent authorities (CA). It is not possible within the scope of this study to estimate the effects and the derived costs. If a reduction of the risk of major accidents entails additional inspection and maintenance, it could be costly, while additional efforts towards training and increasing awareness for relevant staff might be less costly.

Additional prevention of third-party interference would require relevant CAs to introduce measures or increase enforcement of existing systems. The costs of such actions have not been estimated.

6.2.3 Impact on protection level

The impact of this option relies on its ability to change the behaviour of operators and CAs as mentioned above. The impacts on behaviour could be related to the costs of improvement. If low performance is due to operational management issues, the costs of improvement might be moderate. If it is due to low maintenance of the pipelines, it could be more costly to improve performance, and the effect would be less significant. In relation to third-party interference, the operator might not be able to do more, and it is a question of enforcing more rigidly existing legislation requesting contractors to check pipeline locations before starting excavation work.

It is difficult to quantify the impacts on the protection level. There are no statistics on the major accidents that have occurred and their limited number makes it difficult to estimate the expected frequency of major accidents.

Assuming costs of up to EUR 1 million for the implementation of guidelines and benchmarking and using the above estimate of annual damage in the order of EUR 18 million, the number of incidents should be reduced by around 5 per cent to balance costs and benefits of this option. This does not, however, take into account the possible cost to operators and CAs of reducing the number of incidents and the benefits to operators of fewer incidents.

6.3 Legislative options

The two main legislative options are:

- including pipelines within the scope of the Seveso III Directive; or
- developing a new specific directive for onshore pipelines.

In terms of content of the legislation, both alternatives could include many of the same elements, and hence the impacts might not vary significantly.

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[30] This is an order of magnitude estimate assuming a unit cost per man-day of EUR 500.

The assessment of a legislative option includes:

- a discussion of alternative scope definitions
- a discussion of the type of safety provisions to be included
- costs of a legislative option
- benefits of legislative option.

The advantages and disadvantages of each alternative are discussed in the next sections.

6.3.1 Separate directive or part of Seveso III Directive

The Seveso II Directive specifically excludes pipelines from its scope. Currently, the Seveso Directive is being revised to consider the CLP regulation and it could be part of the revision to include pipeline transport.

Given that the definition of scope in Seveso is based on qualifying quantities of dangerous substances present at an industrial site, inclusion of pipelines would require specific criteria as to the types of pipelines to include.

In addition, the requirements to operators would in most cases have to be amended to take into account the specifics of pipeline transport. The risk assessment for example is to focus on pipeline integrity, and there is less need for a detailed internal emergency plan.

Specific to pipelines is the importance of preventing third-party interference. This element would require action on the part of CAs, which is not included in the existing Seveso II Directive.

As the Seveso II Directive is currently being revised, it means that Member State will have to amend national Seveso legislation so the additional costs of including pipelines will not create major, additional transposition costs. There will be additional costs to verify that the requirements are part of national legislation. In Member States where, for example, an impact assessment has to be made before any new legislation can be adopted, additional analyses need to be made.

Table 6-2 Comparison of specific pipeline safety directive or inclusion as part of Seveso III Directive

	Advantages	Disadvantages
Separate directive	Scope has to be defined differently compared to fixed installations included in the current Seveso II Directive. Several safety provisions have to be tailored to pipeline safety. Measures to prevent third party interference are specific to pipelines.	Potentially more costly to introduce a new directive (depends on whether pipelines could be included in the ongoing revision of the Seveso Directive). If not, probably no major differences in transposition costs.
Include in Seveso III Directive	More complete coverage of industrial accidents (though other forms of transport still separate).	Different CAs may be involved in pipeline safety issues, which will make the implementation of the Seveso III Directive more complicated and costly. An amended Seveso Directive would become more complex with new elements only relevant for pipelines.

Only one Member State has indicated that pipeline safety is covered by the national implementation of the Seveso Directive. This speaks in favour of a specific pipeline safety directive.

6.3.2 Scope of legislation

The issues related to the specific scope are the following dimensions:

- Substances covered
- Length
- Diameter
- Pressure.

Substances

The most relevant substances include gas, oil and olefin products. Also chemicals classified as flammable, toxic or harmful to the environment should be included. As indicated in the replies from Member States - see Appendix A - current legislation typically includes all hazardous substances. The specific CLP classifications and possible, specifically named substances would require additional analysis as part of developing a legislative proposal.

Pipe characteristics

Even though some Member States only consider pipelines of a certain length, it is difficult to justify any cut-off point. Even a very short ammonia pipeline connecting two industrial facilities but crossing public area - e.g. a public road - should be included, as it has a major accident hazard potential.

Diameter and pressure definition is mostly a question of how much of the gas network should be included in the scope. This calls for definition of what can be considered as a potential major hazard pipeline.

Member States have different definitions of high-pressure pipelines and low-pressure pipelines. Often, the definition of a distribution pipeline is covers pipelines with a pressure below 8 bar absolute, though for example the incident statistics from EGIG include only incidents from pipelines with maximum operating pressure above 15 bar.

Depending on how the threshold is defined, a certain share of the distribution network could be included.

6.3.3 Type of safety provisions

Specific or general safety provisions

The Seveso II Directive includes only general safety provisions. The industrial installations covered vary significantly, and therefore more specific requirements cannot easily be formulated. For pipelines, it is in principle possible to set more detailed requirements, as, technically, pipeline systems are relatively standardised.

It should be noted that the major part of current national legislation includes general safety requirements. More specific requirements are included by reference to national/international technical standards of construction and operation of pipelines.

In case EU legislation were to be developed, it would be more feasible to follow a similar approach focusing on the general safety requirements while including references to technical standards. This would incorporate certain flexibility in terms of accommodating differences across Member States and allow technological progress to take place without required legislative amendments.

Definition of general requirements

In case EU legislation on pipeline safety were to be developed, it should include the following types of requirements:

- Operators:
  - Safety management system - preferably a pipeline integrity management system (PIMS)
  - Risk assessment including input to external emergency plans
  - Requirement to report on pipeline inspection and maintenance
  - Reporting of incidents

- Competent Authorities:

  - Third-party interference prevention measures
  - External emergency plans
  - Reporting of incidents.

The impacts of a legislative option, including the above provisions, consist of the cost of implementing the option and the expected effects of the safety provisions.

6.3.4 Costs of legislative option

A legislative option includes the following cost elements:

- Preparation/revision of directive and national transposition and implementation;
- Costs to operators (administrative cost, additional operation and investment costs);
- Costs of CAs of (public safety measures and enforcement).

Preparation and implementation of directive

Whether the legislative option involves amending the Seveso III Directive or drawing up a pipeline safety directive, the development and national implementation will lead to costs for Member State CAs and relevant ministries.

The costs of the legal transposition and possible national impact assessments are difficult to estimate. It might involve several man-months in each country. In larger Member States and in Member States where national impact assessment and stakeholder consultations are required, the costs could be higher. In total the costs could be in the order of EUR 1-2 million for EU-27.

Cost to operators

The operators would face different types of costs:

- Introduction and operation of a SMS
- Hazard/risk assessments
- Reporting
- Additional inspection and maintenance
- Other compliance costs (safety equipment, training of staff etc.).

Safety management systems are already mandatory in most Member States. Such management systems are also considered cost-effective for an operator. Hence, no additional costs are estimated for this provision.

In some Member States, pipeline operators are required to make risk assessments. The format of such risk assessments and the way they should be documented under a legislative option would have to be defined. The risk assessment of pipelines would be relatively standardised as most pipelines would face similar types of risks. For example they should consider how the operator maintains the integrity of the pipeline. It means that the "safety report" document could have a standard format, which would reduce the costs of this reporting requirement compared to costs of the safety report requirement in the Seveso II Directive.

In addition to requiring a risk assessment, most Member States already require documentation of the ongoing inspection and maintenance of the pipelines.

In contrast to Seveso, there is not the same need for internal emergency plans even though the operators should draw up contingency plans for handling incidents.

Reporting of incidents is already required in many Member States (all of those responding to the questionnaire).

The costs to operators of the general safety provision are based the unit costs applied to estimate the costs to Seveso installations and cost estimates from a previous study on introducing general safety legislation for pipelines.

As a rough indication of the administrative costs, the unit costs relevant for the Seveso II Directive could be applied to estimate the costs to pipeline operators. Some elements are less demanding while others go beyond the requirements of the Seveso Directive. All in all, it should give an order of magnitude estimate. The relevant administrative costs to be applied here are those relevant for upper tier Seveso sites. COWI (2010) includes a review of cost data for the Seveso requirements and suggests an annual cost of EUR 30,000 as the best estimate for upper tier installations.

A cost-benefit study undertaken as part of a previous review of the safety situation of pipelines asked a number of operators about time spent on safety provisions similar to safety management systems and risk assessment. The results were man-hour costs at a level similar to the Seveso unit "costs" applied here[31]. The 1998 CBA study estimated that the safety provisions would require in the order of 50 man-days as initial start-up costs and around 70 man-days in annual, additional staff costs per operator. Applying an average cost of EUR 500[32] per man-day leads to start-up costs of EUR 25,000 and recurrent costs of EUR 35,000.

Combining these cost estimates, EUR 35,000 in annual unit costs have been applied.

Table 6-3 Possible costs to operators of general safety provisions

Type of operator	Number of operators	Annual unit costs in EUR	Total annual costs in MEUR
Major pipelines	300	35,000	11

Source: MS questionnaire and COWI 2010

A large share of these costs is already incurred by the operators given the existing national legislative requirements.

[31] Seaman (1998) *Cost/benefit assessment of proposed pipeline instrument*

[32] Expert estimate: Average EU-27 salaries are in the order of EUR 200, but these tasks would have to be performed mainly by professionals and the majority of operators in Member States with above EU average price levels.

The additional costs of introducing EU legislation would depend on how the detailed requirements would be defined. At this stage, it is only possible to give an indication of the possible cost impacts.

Given that not all Member States have all provisions in place, a rough estimate is that the 'missing' provisions concern 10 per cent. The reporting of incidents - similar to the benchmarking discussed above - would generate additional costs. Hence, the costs could be in order of EUR 2 million annually. This is only an illustrative estimation of the potential costs of introducing new legislation.

Any additional investment in technical safety measures is difficult to estimate. All Member States refer to international technical standards, which apply to new pipelines. For existing pipelines, it will be expensive to add safety equipment.

Regarding operational costs, operators mainly need to increase efforts in the field of additional inspection of the pipelines. As described above in Section 4.3 on the baseline scenario, the annual pipeline inspection and maintenance work could be in the order of EUR 600 million. If further safety improvements require additional pipeline inspection and maintenance work, the costs could be substantial. For example, increasing inspection and maintenance by 10 per cent would generate costs in the order of EUR 60 million, while an increase of just 1 per cent would lead to annual costs of EUR 6 million.

Costs to CAs

Some of the identified gaps concern external emergency plans, land use planning and prevention of third-party interference. All of these safety provisions require action from CAs.

Given that third-party interference is one of the main causes of pipeline incidents, reducing the risk of accidents would require additional measures to be introduced by the relevant CAs. Updated digital maps, one-stop shop for contractors before doing any excavation work could be relevant measures. For example similar to the system in the Netherlands where any contractor doing excavation work is obliged to make an inquiry to a specific contact point, which will then collect data from pipeline operators about any type of pipeline (and cables) near the excavation area.

Experience from the Netherlands and the KLIC system[33] shows that contractors do not always follow requirements before starting excavation work. In almost half of the situations with third-party interference, regulations for contractors seem not to have been followed.

This suggests that preventing third-party interference is largely an issue of enforcement. Hence, there could be additional costs to relevant competent authorities in making sure that contractors get the necessary information and respect it.

The potential costs to CAs have not been estimated.

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[33] VELIN 2010, *Registratie en analyse van pijpleidingincidenten 2009*

6.3.5 Impact on protection level

It is difficult to quantify the impacts on the protection level against major accidents. It would require that a legislative proposal be developed in detail. The assessment of the current national legislation identified relatively few gaps so additional EU level legislation would only lead to a significant increase if the specific safety requirements were tightened.

Major accidents have been rare why it is not possible calculate statistics on the rate of major accidents. Incident data are therefore the main indicator for safety.

Estimation of the impacts on the overall incident rate of 0.14-0.28 incident per 1000 km of pipeline would require that each safety provision can be linked to each cause of incidents.

The main causes of incident are third-party interference, material or mechanical defects, corrosion and earth movements. The causes for which the operators have the main responsibility (all but third-party interference) account for about 50-60 per cent of the incidents. To decrease the incident rate, the operators would have to increase inspection and maintenance activities or to target their inspection based on better pipeline integrity systems that enable more 'risk'-based inspection. The trend of decreasing incident rates suggests that the operators already have enhanced inspection and maintenance efforts.

More information is needed about third-party interference to understand how specific measures can reduce the frequency of such interference. Most of the incidents relate to excavation work, and to reduce the risk of incidents the following issues should be considered:

- Availability of information about pipeline location (operators to provide updated digital maps)

- Easy access for contractors to this information before undertaking excavation work include time of the procedures (contractors might be tempted to start work if it takes too long to get the information)

- Information campaigns to make contractors aware of the significant risks associated with excavation work

- Penalties in case excavation work is started before permission and information about pipelines have been received.

Additional investigations are needed in order to define a "best practice" for preventing third-party interference.

Overall, a legislative action being either a specific pipeline safety directive or an amendment to the new Seveso III Directive could increase the protection level and reduce incident frequency. Applying a risk-based cost-benefit approach suggests that positive net benefits are not likely to be generated by introducing additional legislation. However, the EU safety approach as applied in the Seveso legislation is based on hazard potential. Whether the existing level of protection against the very infrequent major accidents is sufficient, would require a much more detailed assessment, including analyses of other safety performance indicators than the recorded incident rate.

6.4 Comparison of options

The impacts of the options are presented in the below table. Though some illustrative costs have been discussed, the available information does not allow for a detailed quantified impact assessment.

Table 6-4 Impacts of policy options - preliminary assessment

Policy option	Impact on protection level	Cost of implementation
Recommendations and benchmarking	Benchmarking might support the current trend of decreasing incident rates	Cost of developing recommendations could be in the order of 0.5MEUR Reporting and benchmarking could be around 0.5 MEUR annually
Extend Seveso Directive	As there are few gaps in national legislation, new EU legislation cannot be expected to have major impacts.	Possible additional administrative cost to operators - uncertain estimate of at least in the order of 2 MEUR per year If increased inspection and maintenance of pipelines is required, operators may face high costs (1% additional inspection and maintenance could cost 6 MEUR) Additional measures to prevent third-party interference could lead to higher costs for CAs Transposition and implementation could be in the order of 1 MEUR for MSs Due to differences in specific provisions for pipelines and different CAs being involved, CAs may have to cover additional, administrative costs
New Directive	As there are few gaps in national legislation, new EU legislation cannot be expected to have major impacts.	Possible additional, administrative cost to operators - uncertain estimate at least in the order of 2 MEUR per year If increased inspection and maintenance of pipelines is required operators may face high costs (1% additional inspection and maintenance could cost 6 MEUR) Additional measures to prevent third-party interference could lead to high costs for CAs Transposition and implementation could be in the order of 1 MEUR for MSs

In the above presentation, the effects of the option "New Directive" and the option "Extend Seveso Directive" are almost similar. This is based on the assumption that the same safety requirements can be included in both options.

The advantage of a separate pipeline directive is that it is easier to tailor definitions and provisions to issues relevant to pipeline safety. Pipeline safety also involves CAs different from those involved in Seveso. An amended Seveso III

Directive would require the involvement of additional CAs , which would increase the administrative costs of CAs.

6.5 Conclusions

The main objectives of this study were to assess need for and the value added of EU level legislation on the safety of onshore pipelines.

The findings of the assessment are as follows:

- Onshore pipeline transport of dangerous substances has a major hazard potential, which is demonstrated through several case examples;
- Major accidents with pipelines in the EU have so far been rare;
- The rate of incidents can be used as indicator for the level of safety management. The incident rates as recorded by EGIG and CONCAWE show a decreasing trend for both gas and oil pipelines;
- Based on information from Member States covering around 90 per cent of the pipeline network, the assessment found that there are some but not many gaps in national legislation when compared with a legislative benchmark.

This points to limited value added of additional EU legislation. The reservations to this conclusion are:

- The EGIG database on gas incidents covers a network of a little more than 50 per cent of the total gas transmission network. Data are not published annually, as it is the case for CONCAWE's incident report on onshore oil pipelines. It means that the understanding of the level and development of gas pipeline incidents is not complete.
- Third-party interference is one of the main reasons for incidents. Further reduction of third-party interference will require additional efforts from relevant CAs. Additional legislation may be necessary to enhance enforcement of rules designed to prevent contractors from undertaking excavation work without having obtained the necessary information about location of pipelines.

Given the shortcomings of existing incident statistics, introducing reporting and benchmarking could improve the decision basis for future considerations of pipeline safety, and it could help maintain focus on safety for both operators and CAs.

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In addition, we have gained access to a range of internal Commission documentation.

Appendix A Member State legislation

A.1 Approach and data collection

The key source to understanding the current situation was a survey among EU Member States of current legislation.

A questionnaire was submitted to relevant representatives of each Member State. The questionnaire is included in Appendix B. The main topics of the questionnaire include:

- Scope of existing legislation
- Requirements on technical safety measures
- Requirements to operators regarding safety management systems
- Information and reporting
- Specific coverage of the third-party interference issue
- Land-use planning
- Emergency plans
- Enforcement.

The questionnaire was submitted as an online questionnaire with the Appendix B text version as alternative way of answering. Most respondents used the Word document as it allowed them to receive input from several CAs or units.

A.1 Member State legislation

The following section summarises the findings of the survey.

To date, replies have been received from 17 Member States, three candidate countries and Norway. **The replies from Member States represent about 90 per cent of the pipeline networks in EU-27**.

Table A-7-1 Response to questionnaire by end September

	Has replied
Austria	
Belgium	√
Bulgaria	

	Has replied
Cyprus	
Czech Republic	√
Germany	√
Denmark	√
Estonia	√
Spain	√
Finland	√
France	√
Greece	
Hungary	
Ireland	√
Italy	√
Lithuania	
Latvia	
Luxembourg	
Malta	√
Netherlands	√
Poland	√
Portugal	√
Romania	√
Sweden	√
Slovakia	
Slovenia	
United Kingdom	√
Croatia	√

	Has replied
Iceland	√
Turkey	√
Norway	√

Based on replies received, the status of Member State national legislation is presented.

A.2.1 Scope of legislation

The majority of the Member States have several pieces of legislation - typically separate legislation for gas and other pipelines. A few Member States have one piece of legislation covering all types of pipelines.

In most countries, legislation has been amended or revised in recent years.

Table A-7-2 Type of legislation

	No legislation	One piece of legislation for all pipelines	Separate for gas and other substances	Other	Date of last revision	Plans for revision of legis-lation
Austria						
Belgium			√		2007	
Bulgaria						
Cyprus						
Czech Republic			√		2010	
Germany				√	2011	
Denmark			√		2010	
Estonia			√		2011	
Spain			√		before 2000	
Finland		√			2009	
France		√			2010	Yes
Greece						
Hungary						

	No legislation	One piece of legislation for all pipelines	Separate for gas and other substances	Other	Date of last revision	Plans for revision of legis-lation
Ireland				√		
Italy				√	2008	
Lithuania						
Latvia						
Luxembourg						
Malta	√					
Netherlands		√			2001	Yes
Poland				√	2003	
Portugal			√		2011	
Romania			√		2011	Yes
Sweden			√		2009	
Slovakia						
Slovenia						
United Kingdom			√		2003	
Total	1	3	8	4		
Croatia		√			2008	
Turkey				√		
Iceland	√					
Norway				√	2010	Yes

Also regarding scope of the legislation, there are variations across Member States as to how the scope is defined.

Table A-7-3 Scope of legislation

	Pressure	Diameter	Length	Sub-stances	Specific regulation for gas pipelines
Austria					
Belgium	Thickness of steel		Valves	All	Yes - pressure
Bulgaria					
Cyprus					
Czech Republic	>0.5 bar	No inf.	No inf.	All	Yes -pressure
Germany	>1 bar	No inf.	No inf.	All	No
Denmark	No inf.	No inf.	>70 km	Oil	No inf.
Estonia	Substance	>150 mm	No	Fluids	Yes - pressure
Spain	All	All	All	All[34]	Yes
Finland	No inf.	No inf.	No inf.	NG	No inf.
France	All	All	All	All	No
Greece					
Hungary					
Ireland	No inf.	No inf.	No inf.	No inf.	Yes
Italy	All	All	All	NG	Yes - pressure
Lithuania					
Latvia					
Luxembourg					
Netherlands	>1.6 bar	>50 mm	No inf.	All	Yes - dimension
Poland	>0.5 bar	>250 mm	No inf.	All	Yes - pressure
Portugal	>20 bar	>100 mm	No	No	No
Romania	No	No	No	All	

[34] No legislation for oil pipelines.

	Pressure	Diameter	Length	Sub-stances	Specific regulation for gas pipelines
Sweden	>4 bar	All	All	NG	n.a.
Slovakia					
Slovenia					
United Kingdom	All	All	All	All	Yes - pressure
Croatia	All	All	All	All	No
Turkey	No inf.	No inf.	No inf.	No inf.	No
Norway	All	All	(All)	(All)	No

A.2.2 Overall coverage of national legislation

The Member States were asked whether they find existing legislation sufficiently comprehensive or whether they believe that there are gaps in national legislative coverage.

Table A-7-4 Overall coverage of national legislation

	No or few less important gaps	Some important gaps	Many gaps
Austria			
Belgium	√		
Bulgaria			
Cyprus			
Czech Republic	√		
Germany	√		
Denmark	√		
Estonia	√		
Spain	√		
Finland	√		
France	√		

	No or few less important gaps	Some important gaps	Many gaps
Greece			
Hungary			
Ireland	√		
Italy	√		
Lithuania			
Latvia			
Luxembourg			
Malta			
Netherlands	√		
Poland		√	
Portugal		√	
Romania			√
Sweden	√		
Slovakia			
Slovenia			
United Kingdom	√		
Total	13	2	1
Croatia	√		
Turkey	√		
Norway	√		

Most of the Member States that have replied so far indicated that they consider legislation complete.

The Poland respondent indicates that there are no clear standards for the inspection of pipelines. In the case of Portugal, the question seems to the coverage of chemicals transport and gas pipelines which might not be covered.

A.2.3 Technical standards

The Member States were asked to state the most important technical standards in relation to pipeline safety.

Table A-7-5 Important technical standards

	ANSI	BSI	DIN	EN	ISO	Other
Austria						
Belgium				√	√	√
Bulgaria						
Cyprus						
Czech Republic				√	√	√
Germany	√		√	√	√	√
Denmark	No reference to technical standards					
Estonia	√		√	√	√	
Spain	√	√	√	√	√	√
Finland				√		
France				√		
Greece						
Hungary						
Ireland	√	√	√	√	√	
Italy				√		√
Lithuania						
Latvia						
Luxembourg						
Malta	No answer					
Netherlands						√
Poland						√

	ANSI	BSI	DIN	EN	ISO	Other
Portugal	√		√	√	√	√
Romania	√			√	√	
Sweden				√		
Slovakia						
Slovenia						
United Kingdom		√			√	√
Total	6	3	5	12	9	4
Croatia	√		√	√	√	√
Turkey	√	√	√	√	√	
Norway					√	√

A.2.4 Technical safety measures

The following technical safety measures are required.

Table A-7-6 Requirements of technical safety measures

	Pipeline Integrity Monitoring equipment	Leak detection equipment	Remotely operated safety valves	Location specific requirements to burial depth of pipeline	Location specific requirements to thickness of pipeline wall	Location specific requirements to avoid third-party damage
Austria						
Belgium				√	√	√
Bulgaria						
Cyprus						
Czech Republic	√	√	√			

	Pipeline Integrity Monitoring equipment	Leak detection equipment	Remotely operated safety valves	Location specific requirements to burial depth of pipeline	Location specific requirements to thickness of pipeline wall	Location specific requirements to avoid third-party damage
Germany	√	√	√	√		√
Denmark	√	√	√	√		√
Estonia		√		√		√
Spain	√	√	√	√	√	√
Finland	√	√	√	√	√	√
France	√			√	√	√
Greece						
Hungary						
Ireland						
Italy	√	√	√	√	√	√
Lithuania						
Latvia						
Luxembourg						
Malta						
Netherlands	Duty of care responsibility for operators - like Seveso - no specific technical requirements					
Poland	√	√	√	√	√	√
Portugal	√	√	√	√	√	√
Romania	√	√		√	√	√
Sweden	√		√		√	√
Slovakia						
Slovenia						
United Kingdom	*	*	*	*	*	*

	Pipeline Integrity Monitoring equipment	Leak detection equipment	Remotely operated safety valves	Location specific requirements to burial depth of pipeline	Location specific requirements to thickness of pipeline wall	Location specific requirements to avoid third-party damage
Total	11	10	9	11	9	12
Croatia	√	√	√	√	√	√
Turkey	√	√	√	√	√	√
Norway	√	√	√	√	√	√

Note: * The guidance on pipeline safety lists all these technical measures - but not directly included in the legislation.

A.2.5 Land use planning and requirements

As discussed in a previous section, the EIA Directive applies to only the largest pipelines.

Below is indicated whether Member States have additional requirements for EIA of pipeline installation.

An EIA is one way of considering land use issues at the time of construction, but it does not specify how such issues should be addressed.
Many Member States have implemented other measures in relation to land use planning. The table shows where safety zones are applied.

Table A-7-7 EIA and land use requirements

	EIAs	Specific safety distance	Other land use requirement to be observed
Austria			
Belgium	Ø>800 mm	√	√
Bulgaria			
Cyprus			
Czech Re-	Ø>800 mm	√	√
Germany	Ø>800 mm		√
Denmark	Ø>800 mm		√

	EIAs	Specific safety distance	Other land use requirement to be observed
Estonia	Ø>800 mm	√	
Spain	√	√	√
Finland	Ø>800 mm	√	√
France	√ (extended)	√	√
Greece			
Hungary			
Ireland	No inf.		
Italy	Ø>800 mm	√	√
Lithuania			
Latvia			
Luxembourg			
Malta	No answer		
Netherlands	Ø>800 mm	√	√
Poland	No answer		
Portugal	Ø>800 mm	√	√
Romania	Ø>800 mm	√	√
Sweden	Not required	√	√
Slovakia			
Slovenia			
United King-	√ (extended)		√
Total	12	10	12
Croatia	√	√	
Turkey	√	√	√

	EIAs	Specific safety distance	Other land use requirement to be observed
Norway	√	√	√

A.2.6 Safety management systems etc

One of the key requirements to pipeline operators regards the use of safety management systems. The questionnaire addresses the requirement for such management systems by legislation and the type of system is required. The questionnaire also includes questions about specific safety management elements (the legislation might not refer to a management system but to specific safety management requirements.)

The table below presents the replies on the use of safety management systems.

Table A-7-8 General SMS requirements

	No SMS required	General SMS required	Specific SMS for pipelines	Other	Comments
Austria					
Belgium				√	A general provision
Bulgaria					
Cyprus					
Czech Republic				√	Voluntary system
Germany		√			
Denmark	√				
Estonia	√				
Spain		√			General provision
Finland			√		
France			√		
Greece					

	No SMS required	General SMS required	Specific SMS for pipelines	Other	Comments
Hungary					
Ireland			√		
Italy				√	
Lithuania					
Latvia					
Luxembourg					
Malta					
Netherlands		√			
Poland			√		
Portugal			√		
Romania			√		
Sweden		√			
Slovakia					
Slovenia					
United Kingdom			√		
Total	2	4	7	3	
Croatia			√		
Turkey			√		
Norway			√		

In MS, where a specific SMS is required, the below table shows the elements included.

Table A-7-9 Elements in SMS if specific pipeline SMS is required

	Review and audit	Monitoring	Written documentation	Other elements
Austria				

	Review and audit	Monitoring	Written documentation	Other elements
Belgium	Not required			
Bulgaria				
Cyprus				
Czech Republic*	Not required			
Germany	√	√		√
Denmark	Not required			
Estonia	Not required			
Spain	√	√	√	√
Finland			√	√
France	√		√	
Greece				
Hungary				
Ireland	√	√	√	√
Italy	Not required			
Lithuania				
Latvia				
Luxembourg				
Malta	No answer			
Netherlands	√	√	√	
Poland	No answer			
Portugal	√	√	√	√
Romania	√	√	√	
Sweden			√	
Slovakia				
Slovenia				

	Review and audit	Monitoring	Written documentation	Other elements
United Kingdom	√	√	√	
Total	8	7	9	5
Croatia		√		
Turkey	√	√	√	
Norway	√	√	√	

In cases where Member States do not require SMS, other specific safety management elements may be required. The below table shows which elements are required.

Table A-7-10 Requirements for specific safety management elements

	Hazard identification and risk assessment	Inspection and maintenance plan	Surveillance of pipeline	Emergency planning	Organisation and personnel requirements
Austria					
Belgium		√	√	√	√
Bulgaria					
Cyprus					
Czech Republic*					
Germany	√	√	√	√	√
Denmark	√	√	√		√
Estonia	√	√	√		
Spain	Not always	√	√	√	√
Finland	√	√	√	√	√
France	√	√	√	√	√
Greece					
Hungary					

	Hazard identification and risk assessment	Inspection and maintenance plan	Surveillance of pipeline	Emergency planning	Organisation and personnel requirements
Ireland	√	√	√	√	√
Italy	√	√	√	√	√
Lithuania					
Latvia					
Luxembourg					
Malta					
Netherlands	√	√		√	√
Poland					
Portugal	√	√	√	√	√
Romania	√	√	√		√
Sweden		√	√	√	√
Slovakia					
Slovenia					
United Kingdom	√			√	
Total	11	13	12	11	12
Croatia	√	√	√	√	√
Turkey	√	√	√	√	√
Norway	√	√	√	√	√

* Not required but often implemented by operators

Concerning hazard identification and risk assessment, the MS have made the following specifications

Table A-7-11 Specifications of hazard identification and risk assessment

	Hazard identification and risk assessment		
	Qualitative description	Quantitative scenario analysis	Other

	Hazard identification and risk assessment		
	Qualitative description	Quantitative scenario analysis	Other
Austria			
Belgium	√		√
Bulgaria			
Cyprus			
Czech Republic			√
Germany			√
Denmark		√	
Estonia			√
Spain	If it is required	If it is required	
Finland		√	
France		√	
Greece			
Hungary			
Ireland	√	√	
Italy	No inf.		
Lithuania			
Latvia			
Luxembourg			
Malta	No inf.		
Netherlands		√	
Poland	No inf.		
Portugal	√	√	
Romania	√		√
Sweden	No inf.		

	Hazard identification and risk assessment		
	Qualitative description	Quantitative scenario analysis	Other
Slovakia			
Slovenia			
United Kingdom			√
Total	5	7	6
Croatia	√	√	
Turkey	√	√	
Norway	√	√	

Concerning inspection and maintenance plans, the MS have the following requirements:

Table A-7-12 Specifications of inspection and maintenance plans

	Inspection		Documentation		
	Frequency	Method	Results of inspections	Maintenance plan	Maintenance work
Austria					
Belgium	2 months	Visual	√	√	√
Bulgaria					
Cyprus					
Czech Republic	Specific	Specific	√	√	√
Germany	2 years	Pigging	√	√	√
Denmark	Monthly	Pigging	√	√	√
Estonia	2 years	Visual	√		√
Spain	3- months	Visual	√	√	√
Finland	8 years	Third party	√	√	√
France	6 years	Visual	√	√	

	Inspection		Documentation		
	Frequency	Method	Results of inspections	Mainte-nance plan	Mainte-nance work
Greece					
Hungary					
Ireland	Standard	Visual	√	√	
Italy	Specific	Visual	√	√	√
Lithuania					
Latvia					
Luxembourg					
Malta	No inf.				
Netherlands	Specific	Specific	√	√	√
Poland	No regulations on inspections of pipelines and their frequency				
Portugal	Standard	Standard	√	√	√
Romania	Standard	Visual	√	√	√
Sweden	Monthly	Visual	√	√	√
Slovakia					
Slovenia					
United Kingdom	n.a.	n.a.			
Total			13	12	11
Croatia	Annually	Visual	√	√	√
Turkey	5 years	Pigging	√	√	√
Norway	Risk based	Specific	√	√	√

A.2.7 Information and reporting

Almost all the Member States have requirements for dissemination of information to the public and requirements for incident reporting.

Table A-7-13 Information and reporting

	Information to public requires	Reporting of incidents required
Austria		
Belgium	√	√
Bulgaria		
Cyprus		
Czech Republic	√	√
Germany	√	√
Denmark		√
Estonia		√
Spain	√	√
Finland	√	√
France	√	√
Greece		
Hungary		
Ireland	√	√
Italy	√	√
Lithuania		
Latvia		
Luxembourg		
Malta		
Netherlands	√	√
Poland	√	√
Portugal	√	√
Romania	√	√
Sweden		√

	Information to public requires	Reporting of incidents required
Slovakia		
Slovenia		
United Kingdom		√
Total	12	16
Croatia	√	√
Turkey	√	√
Norway	√	√

A.2.8 External emergency plans

The questions addressed requirements to external emergency plans and the specific contents of such plans if required.

Table A-7-14 External emergency plans and their content

	Emergency plan required	Elements and measures in external emergency plan			
		Minimise effects	Protect man and nature	Clean-up	Testing and drills
Austria					
Belgium	√				
Bulgaria					
Cyprus					
Czech Republic	√	√	√	√	√
Germany	√	√	√	√	√
Denmark	√	√	√	√	
Estonia	No answer				
Spain	If it is required	√	√	√	√
Finland	√	√	√		

	Emergency plan required	Elements and measures in external emergency plan			
		Minimise effects	Protect man and nature	Clean-up	Testing and drills
France	√	√	√		√
Greece					
Hungary					
Ireland	√	√	√		√
Italy	-				
Lithuania					
Latvia					
Luxembourg					
Malta					
Netherlands	√	√	√	√	√
Poland	-				
Portugal	-				
Romania	√	√	√	√	√
Sweden	√		√		
Slovakia					
Slovenia					
United Kingdom	√	√	√		
Total	12	10	11	6	7
Croatia	√	√	√	√	
Turkey	√	√	√	√	√
Norway	√	√	√	√	√

Some MS have no legislation on external emergency plans.

Table A-7-15 Procedures for resolving safety issues

	New pipelines	Existing pipelines
Austria		
Belgium	Competent authority can impose specific regulation in authorisation	Relocation if required
Bulgaria		
Cyprus		
Czech Republic	Detailed land use requirements	Not answered
Germany	Competent authority can impose specific regulation in authorisation	Competent authority can impose specific regulation in authorisation
Denmark	Assessment of environmental effects prior to decision	EPA resolves issue
Estonia	Location specific requirements	No specific arrangements and procedures
Spain	Competent authority can impose specific regulation in authorisation and under operation	Competent authority can impose specific regulation in authorisation and under operation
Finland	Land Use and Building Act	Land Use and Building Act
France	Regulated in Safety Report	Regulated in Safety Report
Greece		
Hungary		
Ireland	CER issue consents to design	CER issue consent to design
Italy	Regulated by mandatory EIA	Local authorities must respect position of transmission lines
Lithuania		
Latvia		
Luxembourg		

	New pipelines	Existing pipelines
Malta	Not answered	Not answered
Netherlands	Regulated by the EIA. No fragile objects must be exposed to risk	The operator must ensure that the pipeline meets the legal safety requirements
Poland	Not answered	Not answered
Portugal	A risk analysis is required in the application for license	Must be operated in accordance with the result of the risk analysis
Romania	Procedures according to ISO and EN regulations	Standard procedures in accordance with Emergency Plan
Sweden	Compliance with zoning system is required and checked before construction permission	Operator must be informed about building permits close to safety zone
Slovakia		
Slovenia		
United Kingdom	Pipeline operators must notify competent authority by the end of concept design stage about safety issues	Restrictions for certain developments within a certain proximity of the pipeline
Croatia	Regulated in the Land Use Planning	Regulated through the building licenses
Turkey	Regulated in the Technical Safety and Environmental Regulation	Regulated in the Technical Safety and Environmental Regulation
Norway	Covered by land use planning regulation	CAs can require corrective actions

A.2.9 Third party interference protection

Concerning third-party interference, most Member States have some form of requirements to prevent or reduce such incidents.

Table A-7-16 Prevention of third-party interference

	Specific third party requirements in legis-	Specific measures in relation to third party interference		
		Updated maps	Single contact point	Other elements
Austria				
Belgium	√	√	√	
Bulgaria				
Cyprus				
Czech Republic	√	√	√	
Germany	√	√		√
Denmark	-	√	√	√
Estonia	√	√	√	
Spain	√	√		√
Finland		√	√	
France	√	√	-	√
Greece				
Hungary				
Ireland	√	√	√	
Italy	√	√	-	
Lithuania				
Latvia				
Luxembourg				
Malta				
Netherlands	√	√	√	
Poland	√			
Portugal	√	√	√	
Romania	No information			

	Specific third party requirements in legis-	Specific measures in relation to third party interference		
		Updated maps	Single contact point	Other elements
Sweden	-	√		
Slovakia				
Slovenia				
United Kingdom	√	-	-	
Total	12	13	8	4
Croatia	√	√	√	
Turkey	√	√	√	
Norway	√	√	√	

A.2.10 Enforcement by CAs

The inspection frequency is not clear from all the replies though many Member States demand annual inspections, while others have less frequent inspection requirements or risk-based inspection.

Table A-7-17 Overall coverage of national legislation

	Number of operators				Frequency of inspection
	Gas	Oil	Olefin	Chemicals	
Austria					
Belgium	4	5	7	7	Regularly
Bulgaria					
Cyprus					
Czech Republic	5	2	1	1	According to inspection plan

	Number of operators				Frequency of inspection
	Gas	Oil	Olefin	Chemicals	
Germany					At least every 2
Denmark		3			Annually
Estonia	1	1		1	5 years
Spain	> 40	1			
Finland	1 and 40				Annual
France	2	80	3	60	Annual for main operators
Greece					
Hungary					
Ireland	2				3 years
Italy	9				2-6 years
Lithuania					
Latvia					
Luxembourg					
Malta					
Netherlands	40				Annual
Poland	2	2	1	0	3-5 years
Portugal	1	1			Annual
Romania	5	3	3		
Sweden	4				Annual
Slovakia					
Slovenia					

	Number of operators				Frequency of inspection
	Gas	Oil	Olefin	Chemicals	
United Kingdom	50	25	25	25	Inspection plan
Croatia					
Turkey	1	3			
Norway	2	1			Annual or risk based

In most Member States the number of pipeline operators is relatively small.

Appendix B Questionnaire on national legislation

The questionnaire was developed as an on-line Internet based questionnaire.

Questionnaire on national legislation on safety of on-shore pipelines

Page 1

The aim of the questionnaire is to map the existing national legislation regarding safety of on-shore pipelines used for transport of dangerous substances. The questionnaire comprises the following:

- Contact details for the respondent
- General questions about national legislation covering the safety of on-shore pipelines
- Specific questions (in case such legislation exists) regarding

    - Requirement to operators:
        - when designing and constructing of pipelines
        - when operating pipelines
        - when reporting incidents

    - Requirements to public authorities in relation to:
        - emergency planning
        - prevention of third party interference and
        - land use planning

(This is only relevant for the on-line questionnaire:
You can navigate back and forward through the questionnaire by using the "Back" and "Next" buttons at the bottom of the screen. If you wish to save the questionnaire at any point, you can use the "Save" button which will give you a URL that can be bookmarked. This URL will bring you back to the point in the survey where you left off. If desired, the bookmarked URL can be sent via email so another user can resume the survey on a different computer. At the last page, you have the opportunity to get a preview of the answers which can be saved or printed.)

Page 2

Characteristics of your organization

Select country:
{Choose one}

( ) Austria
( ) Belgium
( ) Bulgaria
( ) Cyprus
( ) Czech Republic
( ) Denmark
( ) Estonia
( ) Finland
( ) France
( ) Germany
( ) Greece
( ) Hungary
( ) Ireland
( ) Italy
( ) Latvia
( ) Lithuania
( ) Luxembourg
( ) Malta
( ) Netherlands
( ) Poland
( ) Portugal
( ) Romania
( ) Slovakia
( ) Slovenia
( ) Spain
( ) Sweden
( ) United Kingdom
( ) Crotia
( ) fYRoM
( ) Iceland
( ) Norway
( ) Serbia
( ) Switzerland
( ) Turkey
( ) Other

Please provide contact information, in case we have additional or clarifying questions:

Name
{Enter text answer}
[ ]

E-mail
{Enter text answer}
[ ]

Telephone number
{Enter text answer}
[ ]

Name of organization
{Enter text answer}
[ ]

Page 3

General question on safety legislation

1. How is safety of on-shore pipeline transport covered in your national legislation?
{Choose one}
( ) No legislation on safety of pipeline transport
( ) One piece of legislation that covers all types of on-shore pipeline transport
( ) Separate legislation for gas pipelines and other pipelines
( ) Other

1.a. If other, please specify:
{Enter answer in paragraph form}
[ ]

Page 4

2. Is pipeline safety part of the national implementation of the Seveso II Directive?
{Choose one}
( ) Yes
( ) No
( ) Don't know

2.a. If yes, how is pipeline safety part of the national implementation of the Seveso II Directive?
{Enter answer in paragraph form}
[ ]

Page 5

3. How is the scope of the safety legislation defined; please specify:

3.a. Dimensions of pipes:

Pressure
{Enter text answer}
[ ]

Diameter of pipes
{Enter text answer}
[ ]

Length
{Enter text answer}
[ ]

3.b. Substances
{Enter answer in paragraph form}
[
]

3.c. Other scope, please specify
{Enter answer in paragraph form}
[
]

Page 6

4. Is the scope regarding the coverage of gas pipelines defined differently compared to the coverage of other pipelines (as you have described the scope in Question 3)?

{Choose one}
( ) Yes
( ) No
( ) Don´t know

4.a. If yes, please describe the scope of coverage for gas pipelines?

Length
{Enter text answer}
[ ]

Diameter of pipes
{Enter text answer}
[ ]

Pressure
{Enter text answer}
[ ]

4.b. Other relevant scope definitions for gas pipelines, please specify
{Enter answer in paragraph form}
[
]

Page 7

5. When was the legislation implemented or last time revised? (Please specify year)
{Enter text answer}
[ ]

6. Are there any plans for revision of the legislation for example in relation to coverage of CO_2 pipelines?
{Choose one}
( ) Yes
( ) No
( ) Don't know

6.a. If yes, please describe the ongoing/planned revision:
{Enter answer in paragraph form}
[ ]

Page 8

7. How do you overall consider the safety of on-shore pipelines to be covered in your national legislation?
{Choose one}

( ) No gaps or few less important gabs in national legislative coverage (comprehensive coverage)
( ) Some important gaps in national legislative coverage
( ) Many gaps in national in national legislative coverage
( ) Don't know

7.a. If some important gaps, please specify gaps:
{Enter answer in paragraph form}
[ ]

7.b. If many important gaps, please specify the most important gaps:
{Enter answer in paragraph form}
[ ]

Page 9

Requirements to operators

The following questions are related to the specific requirements to pipeline operators. If there are differences between the requirements to gas pipelines and other pipelines covered by the legislation, please answer the following questions about the specific requirements as those that are valid for gas pipelines and then describe the requirements regarding other pipelines in Question 19.

Page 10

Construction and design of pipelines

8. Are there references to technical standards?
{Choose one}
( ) No reference to technical standards
( ) Legislation requires technical standards to be followed
( ) Legislation refers to technical standards as guidance

Comments:
{Enter answer in paragraph form}
[
]

8.a If reference to technical standards, please indicate the most important technical standards in relation to pipeline safety.
{Choose all that apply}
( ) ANSI
( ) BSI
( ) DIN
( ) EN
( ) ISO
( ) Other

If Other, please specify:
{Enter answer in paragraph form}
[
]

Page 11

9. Are any of the following technical safety measures required?
{Choose all that apply}
( ) Pipeline Integrity Monitoring equipment
( ) Leak detection equipment
( ) Remotely operated safety valves
( ) Location specific requirements to burial depth of pipeline
( ) Location specific requirements to thickness of pipeline wall (local or local dependent design factor)
( ) Location specific requirements to avoid third-party damage
( ) Other technical safety measures

9.a. If Other, please specify:
{Enter answer in paragraph form}
[

]

Page 12

10. Is an Environmental Impact Assessment (EIA) required for on-shore pipelines that transport dangerous substances?
{Choose one}
( ) Not required for any pipeline
( ) Required for all pipelines
( ) Required for pipelines longer than 40 km and with a diameter above 800 mm
( ) Other definition of pipelines where an EIA is required
( ) Don't know

10.a. Please specify (other):
{Enter answer in paragraph form}
[

]

Page 13

11. Describe the specific land use requirements to operators:

11.a. Are there specific safety distances defined in the legislation?
{Choose one}
( ) Yes
( ) No
( ) Don't know

11.a. If yes, please describe:
{Enter text answer}

[ ]

11.b. Are there other land use related requirements?
{Choose one}
( ) Yes
( ) No
( ) Don't know

11.b. If yes, please describe:
{Enter text answer}
[ ]

Page 14

12. Notification of the location/route of the pipeline

12.a. Are the operators required to provide detailed information about the specific location of the pipeline?
{Choose one}
( ) Yes
( ) No
( ) Don't know

12.b. If yes, who should receive this information?
{Enter text answer}
[ ]

12.c. Are there other requirements to the operator in preventing third party interference with the pipeline?
{Enter answer in paragraph form}
[

]

Page 15

13. Are there any additional requirements to operators in relation to design and construction of pipelines?
{Choose one}
( ) Yes
( ) No
( ) Don't know

13.a. If yes, please specify:
{Enter answer in paragraph form}
[
]
Page 16

Operation of pipelines

14. Are operators required to have a Safety Management System (for example a Pipeline Integrity Management System)?
{Choose one}
( ) No safety management system required
( ) A general safety management system required
( ) Specific safety management system for operation of the pipelines
( ) Don't know
( ) Other, please specify [ ]

14.a. If a specific SMS is required, is it a Pipeline Integrity Management System?
{Choose one}
( ) Yes
( ) No
( ) Don't know

14.b. If a Safety Management System is required, which of the following elements are included?
{Choose all that apply}
( ) Review and audit of the Safety Management System
( ) Monitoring of the validity of the Safety Management System
( ) Written documentation of the Safety Management System
( ) Other elements, if relevant [ ]

Page 17

15. Are any of the following Safety Management Elements required?
{Choose all that apply}
( ) Organization and personnel requirements (roles, responsibilities, education and training,)
( ) Hazard identification and risk assessment
( ) Inspection and maintenance plans
( ) Surveillance of the pipeline route
( ) Emergency planning, including training and drills
( ) Management and control of changes
( ) Program for improvement

15.a. Concerning hazard identification and risk assessment:
{Choose all that apply}
( ) Qualitative description
( ) Quantitative scenario analysis
( ) Other [ ]

15. b. Concerning inspection and maintenance plans:

Frequency of inspection, please specify
{Enter text answer}
[ ]
Methods of inspection, please specify
{Enter text answer}
[ ]

15.c. Concerning inspection and maintenance plans:

Are any of the following documentation required?

Documentation and registry of the results of periodic inspections
{Choose one}
( ) Yes
( ) No
( ) Don't know

Documentation of maintenance plan
{Choose one}
( ) Yes
( ) No
( ) Don't know

Documentation of maintenance work
{Choose one}
( ) Yes
( ) No
( ) Don't know

Page 18

16. Are there any requirements about information to the public?
{Choose one}
( ) Yes
( ) No
( ) Don't know

16.a. If yes: Requirements to inform the public in the vicinity of a pipeline about the risks of accidents and relevant behavior, please describe:
{Enter answer in paragraph form}
[

]

16.b. If yes: Requirement to inform the public in case of a major incident, please describe:
{Enter answer in paragraph form}
[
]

Page 19

Reporting of incidents

17. Are there any requirements to report incidents?
{Choose one}
( ) Yes
( ) No
( ) Don't know

17.a. If yes, which incidents should be reported?
{Enter answer in paragraph form}
[

]

17.b. If yes, to whom should they be reported?
{Enter answer in paragraph form}
[

]

Page 20

Additional safety requirements to pipeline operators

18. Are there any additional safety requirements to operators of on-shore pipelines?
{Choose one}
( ) Yes
( ) No
( ) Don't know

18.a If yes, please specify:
{Enter answer in paragraph form}
[
]

Page 21

If there are differences in coverage between gas pipelines and other types of pipelines which transport dangerous substances, please describe the differences:

19. What are the requirements for the pipeline operators of oil and/or other substance pipelines different from the requirements on natural gas? Please describe any differences:

19.a. Requirements in relation to design and construction
{Enter answer in paragraph form}
[
]

19.b. Requirements on safety management system
{Enter answer in paragraph form}
[
]

19.c. Requirements about information to the public?
{Enter answer in paragraph form}
[
]

19.d. Requirements to report incidents?
{Enter answer in paragraph form}
[
]

Risk assessment
{Enter text answer}
[ ]

Inspection and maintenance
{Enter text answer}
[ ]

Other differences, please specify
{Enter text answer}
[ ]

Page 22

Describe the requirements to relevant authorities

20. Are External Emergency Plans required by the legislation?
{Choose one}
( ) Yes
( ) No
( ) Don't know

20.a. If yes, who is responsible for making External Emergency Plans?
{Enter text answer}
[ ]

20.b. If yes, what is included in an External Emergency Plan?
{Choose all that apply}
( ) Measures to minimize the effects of an incident
( ) Measures to protect man and the environment
( ) Provisions for restoration and clean-up of the environment following a major accident
( ) Testing of the plan (drills)
( ) Revision and updating
( ) Other, please specify: [ ]

Page 23

Describe if land use planning is addressed in the legislation and how it is implemented:

21. What is the procedure for resolving safety issues in location and routing of a new pipeline, please describe:
{Enter answer in paragraph form}
[
]

22. What is the procedure for resolving safety issues with an existing pipeline, please describe:
{Enter answer in paragraph form}
[ ]
Page 24

23. Are third party issues addressed in the legislation?
{Choose one}
( ) Yes
( ) No
( ) Don't know

If yes, please describe:
{Enter answer in paragraph form}
[

]

23.a. Does the competent authority have updated maps of existing pipelines?
{Choose one}
( ) Yes
( ) No
( ) Don't know

23.b. Is there a single contact point for the any third party contractor where all information about the location of pipelines can be obtained?
{Choose one}
( ) Yes
( ) No
( ) Don't know

23.c. Other measures to protect against third party interference? Please specify:
{Enter answer in paragraph form}
[

]

Page 25

Enforcement by the Competent Authority

Enforcement of requirements to operators:

24. Who is the Competent Authority?
{Enter text answer}
[ ]

25. How often is the operator's compliance with the requirements checked?
{Enter text answer}
[ ]

26. What is the approximate number of pipeline operators?

Number of gas pipeline operators
{Enter text answer}
[ ]

Number of oil pipeline operators
{Enter text answer}
[ ]

Number of olefins pipeline operators
{Enter text answer}
[ ]

Number of operators of pipeline transporting other chemicals
{Enter text answer}
[ ]

Page 26

Additional comments to national legislation on the safety of on-shore pipelines

27. Are the any other relevant aspects regarding the safety of on-shore pipelines that should be reported?
{Enter answer in paragraph form}
[

]

Thank you for replying to this questionnaire.