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MEETING OF THE PARTIES TO THE CONVENTION  
ON THE PROTECTION AND USE OF TRANSBOUNDARY  
WATERCOURSES AND INTERNATIONAL LAKES

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**PREVENTION OF ACCIDENTAL WATER POLLUTION**

**Safety Guidelines and Good Practices for Pipelines**

Submitted by the Joint Expert Group on Water and Industrial Accidents

Authorities, pipeline operators and the public are invited to apply these guidelines/good practices, which are intended to contribute to limiting the number of pipeline accidents and the severity of their consequences for human health and the environment

## Introduction

1. Pipelines are increasingly important as a means of transporting hazardous substances in the UNECE region. Crude oil, its derivatives and natural gas are among the main substances transported by the region's pipelines. Their key advantage is their ability to move large volumes of these substances quickly and over long distances. Pipelines are reliable, they have low operating costs compared to other modes of transport, and they have few transport-associated environmental impacts (such as exhaust, noise and congestion).
2. Pipeline construction does require long-term planning, including appropriate routing decisions as well as effective soil and water protection and protection of human beings. The main disadvantages of pipelines are: high investment costs and a certain lack of flexibility regarding delivery points and quantities of transported substances.
3. A well-planned, well-constructed, properly operated and maintained pipeline is a safe and environmentally sound means of transporting liquid and gaseous hazardous substances. However, like fixed installations handling hazardous substances, pipelines can be a serious threat to human health and safety and to soil, water and other compartments of the environment.
4. The effects of accidents involving pipelines can be very serious, as is shown by the oil leak in Komi Republic (Russian Federation) in 1994 and the gas explosion in Ghislenghien (Belgium) in 2004. External interference is the most frequent cause of pipeline incidents in the UNECE region. Other causes of incidents are corrosion and poor construction and insufficient maintenance.
5. Although pipelines are operated with increasing care and the majority of operators recognize the importance of maintaining the integrity of their pipeline networks, in many UNECE countries the safety of pipeline operation needs further improvement. There is a need to raise awareness and share experience and good practices among the competent authorities, pipeline operators and the public. As many pipelines cross borders between two or more countries, there is also room for harmonization across the region. Regulations and requirements concerning the safety of pipeline operation differ from country to country: they range from prescriptive to more goal-oriented approaches.
6. Against this background, UNECE member countries decided to draw up safety guidelines and good practices for pipelines jointly under the Convention on the Transboundary Effects of Industrial Accidents and the Convention on the Protection and Use of Transboundary Watercourses and International Lakes.
7. The Conference of the Parties to the Industrial Accidents Convention (ECE/CP.TEIA/2, decision 2000/5 and ECE/CP.TEIA/12, paras. 50–51) and the Meeting of the Parties to the Water Convention (ECE/MP.WAT/5 and ECE/MP.WAT/15) requested the Joint Expert Group on Water and Industrial Accidents to draw up safety guidelines and good practices.
8. A steering group established by the Joint Expert Group drew up guidelines and good practices. In doing so, the steering group took into account, among others, the input from

authorities, pipeline operators, research institutions and non-governmental organizations provided at and as a follow-up to two workshops: (a) on the prevention of water pollution due to pipeline accidents (held in Berlin on 8–9 June 2005); and (b) on the prevention of accidents of gas transmission pipelines (held in The Hague on 8–9 March 2006). The steering group also took into account relevant existing texts related to safety, in particular the Guiding Principles for Chemical Accidents Prevention, Preparedness and Response of the Organisation for Economic Co-operation and Development.

9. The following are the principles and key elements of the guidelines and good practices for the safe transport of hazardous substances by pipeline, whether transboundary or not. They are designed to prevent incidents and to limit accidental consequences for human health and the environment. Information should be provided to the public in accordance with relevant provisions of UNECE environmental conventions. At the same time, security concerns should be taken into account. Security concerns are not within the scope of these guidelines and good practices.

## **I. PRINCIPLES FOR PIPELINE SAFETY**

10. Governments should provide leadership and create and maintain administrative frameworks to facilitate the development of a safe and environmentally sound transportation infrastructure, including pipelines.

11. The pipeline operator and/or owner has primary responsibility throughout the whole lifecycle of its systems for ensuring safety and for taking measures to prevent accidents and limit their consequences for human health and the environment. Furthermore, in case of accidents, all possible measures should be taken to limit such consequences.

12. Pipelines for the transport of hazardous substances should be designed and operated so as to prevent any uncontrolled release into the environment.

13. Leaks from any part of a facility or pipeline that contain hazardous substances should be recognized adequately in a quick and reliable way, especially in environmentally sensitive or highly populated areas.

14. The pipeline operator should implement a management system to develop and maintain the integrity of pipelines. The integrity of pipelines should be ensured through adequate design, construction, maintenance, inspection and monitoring and through sound management.

15. Deterministic and/or probabilistic approaches should be used in evaluating pipeline integrity and impacts on human health and the environment.

16. Appropriate measures should be taken in case of accidents. Emergency plans should be established by pipeline operators (internal emergency plans) and by authorities (external emergency plans) and should be tested and regularly updated. These plans should include descriptions of the measures necessary to control accidents and limit their consequences for human health and the environment.

17. Land-use planning considerations should be taken into account both in the routing of new pipelines (e.g. to limit proximity to populated areas and water catchment areas to the extent possible) and in decisions concerning proposals for new developments/construction in the vicinity of existing pipelines.

18. Pipeline operators and the authorities responsible for pipelines should review and, if necessary, develop and implement systems to reduce third-party interference, which is a main cause of accidents, including their transboundary effects.

19. Information on the safety of pipelines, the geographic position of pipelines, safety measures and the required behaviour in the event of an accident should be supplied to persons likely to be involved in case of a pipeline accident. General information should be made available to the public.

20. Regular exchange of information between pipeline operators and authorities regarding good practices, improvement of pipeline safety, and past accidents and near-miss cases should be considered.

## **II. RECOMMENDATIONS**

21. These guidelines and good practices provide a minimum set of requirements for achieving a basic level of safety for pipelines. Taking into account their existing regulatory frameworks as well as scientific and technical developments, different countries may apply different policies, measures and methodologies to achieve this goal.

22. Following are recommendations to the UNECE member countries, competent authorities and pipeline operators. The technical and organizational aspects, listed in the annex, are an integral part of these guidelines and good practices.

### **A. Recommendations to UNECE member countries**

23. UNECE member countries should adopt policies for the safe transport of hazardous substances in pipelines, aimed at limiting accidental consequences for human health and the environment. They should raise awareness and share experience and good practices, among others, through educational programmes.

24. UNECE member countries should define a level of safety at least consistent with paragraph 21.

25. National legislation should be clear, enforceable and consistent among different countries in order to facilitate international cooperation in, for example, the development and implementation of emergency plans.

26. UNECE member countries should aim at the early entry into force of the Protocol on Civil Liability and Compensation for Damage Caused by the Transboundary Effects of Industrial Accidents on Transboundary Watercourses, adopted in Kiev on 21 May 2003.

27. UNECE member countries should establish a system of permits and of land use planning procedures with the involvement of the public in order to ensure that pipelines are planned, designed, constructed and operated in a safe way. They should also ensure adequate monitoring and control.

28. Competent authorities should be designated at the national, regional or local level that, alone or together with other authorities, have the necessary competences for the tasks addressed in these guidelines and good practices.

### **B. Recommendations to competent authorities**

29. Competent authorities should ensure that the objectives of preventing and limiting the effects of accidents are taken into account in their land-use policies, with particular regard to safety distances and/or other relevant policies.

30. Competent authorities should set up appropriate consultation procedures to facilitate implementation of the policies established. The procedures should be designed to ensure that technical information about safety for humans and protection of the environment is available, on a case-by-case or generic basis, when decisions are taken. Competent authorities should also ensure that the public is able to give its opinion.

31. Competent authorities should carry out the permitting process, including environmental impact assessment, in a transboundary context when applicable.

32. Competent authorities should set up a system of inspections or other control measures in order to ensure that pipeline operators meet requirements.

33. Competent authorities should ensure that pipeline operators:

(a) Draw up and implement internal emergency plans; and

(b) Supply the authorities designated for that purpose with the necessary information to enable them to draw up external emergency plans.

34. Competent authorities should draw up and implement external emergency plans with measures to be taken in the vicinity of pipelines where the effects of accidents might be noticeable.

35. Competent authorities should ensure that external emergency plans are put into effect without delay when an accident occurs.

36. Competent authorities may require the pipeline operator to provide any additional information necessary to enable them to fully assess the likelihood of an accident with transboundary effects, to determine the scope of possible increased probability and/or aggravation of accidents with transboundary effects, and to facilitate the preparation of an emergency plan and the necessary cross-border cooperation.
37. Competent authorities should ensure that external and internal emergency plans are reviewed, tested and, where necessary, revised and updated at suitable intervals.
38. Competent authorities should ensure that proper consideration is given to the prevention of third-party interference. They should provide the appropriate regulatory framework needed to control activities carried out by third parties in the vicinity of pipelines, including clear awareness of responsibilities.
39. Given that external interference is known to be the leading cause of pipeline accidents, competent authorities should ensure that an exchange of information about the geographic position of pipelines between involved stakeholders is being fostered. An up-to-date record of the geographic position of pipelines should be kept.
40. The information should be made accessible to the public and to interested stakeholders and should be released on request at short notice. Especially in the case of excavation activities by third parties, information about the geographic position of pipelines should be exchanged quickly in order to prevent third-party damage to pipelines.

### **C. Recommendations to pipeline operators**

41. Pipelines for transporting hazardous substances should be designed, constructed, operated, maintained and monitored so as to prevent accidents and to mitigate the consequences of those that do occur.
42. Pipelines should be designed, constructed and operated at least in accordance with recognized national and international codes, standards and guidelines and, where appropriate, internationally accepted company specifications.
43. Consideration should be given to various aspects which could affect the safety of a pipeline, such as design and stress factors, quality of material, wall thickness, depth of burial, external impact protection, corrosion, markings, route selection and monitoring.
44. Hazard/risk assessments should be undertaken in order to choose among different options and to assess unusual circumstances.
45. The pipeline operator should:
  - (a) Draw up a document establishing a pipeline management system (PMS) and ensure that it is properly implemented. The PMS should be designed to guarantee a high level of protection of human health and the environment;

- (b) Demonstrate to the competent authority that the PMS has been put into effect;
  - (c) Establish performance indicators for monitoring the PMS; and
  - (d) Make the document that describes the PMS, including the associated performance indicators and safety measures to prevent accidents and limit their consequences, available to the competent authority.
46. Pipeline operators should draw up and implement internal emergency plans and ensure that these are reviewed, tested, and revised and updated at suitable intervals.

## **Annex**

### **Technical and organizational aspects**

#### **I. DESIGN AND CONSTRUCTION**

Safety measures should be incorporated at the earliest conceptual and engineering design stages.

##### **A. Engineering design**

- The safety of the pipeline should be demonstrated through a suitable hazard-/risk-assessment procedure taking into account all credible scenarios, including breakdowns and external additional loads.
- The highest and lowest internal pressures as well as the pressure gradients for the most unfavourable operating case should be calculated for the entire length of the pipeline taking into account the transporting capacity, the physical properties of the transported medium and the route profile.
- The static, dynamic and thermal additional loads to which the pipeline can be subjected (e.g. stress from soil and traffic loads or the effects of terrain) should be determined. Examples of additional loads include stress from soil cover and traffic on the pipe crown, longitudinal stresses from impeded thermal expansion in stations, and stresses caused by vibrations in the vicinity of pumps and compressor stations.
- The influence of pressure surges should be considered in the dimensioning and design of the pipeline.

##### **B. Materials**

- Pipelines should be constructed with the most suitable materials available to ensure their integrity throughout their lifecycle.
- Proof of the suitability of the materials used should be provided.
- Pipe sections should be tested under standard conditions.
- The most unfavourable operating conditions, including breakdowns, should be taken into consideration.

##### **C. Piggability**



- Pipelines should, with the exception of short lateral sections and stations, be piggable for inspection purposes.

#### **D. Corrosion protection**

- **External corrosion:** Underground pipelines should be protected with a suitable coating and cathodic corrosion protection; and above-ground pipelines should have a suitable paint layer or coating.
- **Internal corrosion:** If there is a possibility or evidence of internal corrosion, appropriate measures should be taken.

#### **E. Fire and explosion protection**

- Pipelines should be constructed, manufactured and equipped as well as maintained and operated so as to ensure the safety of employees and third parties, particularly against the risk of fire and explosion.

#### **F. Safety equipment**

- Pipelines should be equipped with practical and effective facilities for safe operation. In particular:
  - The operating pressures should be continuously measured and independently recorded and evaluated;
  - The operating temperatures should be continuously measured and independently recorded where practicable and evaluated (e.g. at the inlet of a line before it goes underground);
  - Maximum operating pressures and temperatures must not be exceeded during normal operation or shutdowns;
  - The volume of dangerous substances which can escape during an incident/accident should be limited (e.g. by automatic shutdown systems);
  - Leaks during both steady-state and transient operation should be detected and the point of damage should be rapidly located; and
  - Liquid escaping from operating facilities (e.g. pumps, measuring equipment, valve stations) should be collected in safety release systems.
- Proof of the suitability of safety equipment for the operating functions in question should be provided.

### G. Height of covering

- The height of the covering of buried pipelines should be adapted to suit local requirements in order to minimize the possibility of external interference.

### H. Marking

- The route of the pipeline and its equipment should be marked in a suitable way.

## I. CONSTRUCTION AND TESTING

The construction and testing should be carried out by qualified enterprises. Additionally, certified experts should witness and approve this work.

- Tests should be carried out on material, construction, welding and laying work. In particular, a sufficient number of non-destructive tests should be performed on the welds to assess the proper performance of the welding work. In areas with high protection requirements, all welds should be tested.
- Before the pipeline is commissioned, a strength and tightness test and a function test of the safety equipment should be performed. To ensure safety, the equipment should be certified and its performance efficiency should be tested prior to commissioning in the presence of a certified expert.
- The final acceptance document can only be issued after it has been proven that the pipeline has been constructed and can be operated in accordance with the notification/permit.

## II. PIPELINE MANAGEMENT SYSTEM

The pipeline management system (PMS) should include that part of the general management system which includes the organizational structure, responsibilities, practices, procedures and resources for determining and implementing the accident prevention policy.

The PMS should address the following issues:

- **Organization and personnel:** Roles and responsibilities of personnel involved in the management of hazards at all levels in the organization; identification of the training needs of such personnel and provision of appropriate training; involvement of employees and, where appropriate, subcontractors;
- **Identification and evaluation of hazards, including transboundary hazards:** Adoption and implementation of procedures for systematic identification of hazards arising from normal and abnormal operation and assessment of their likelihood and severity;

- **Operational control:** Adoption and implementation of procedures and instructions for safe operation, including maintenance of plants, processes and equipment;
- **Management of change:** Adoption and implementation of procedures for modification of processes and storage facilities, including the design of new installations;
- **Planning for emergencies:** Adoption and implementation of procedures to identify foreseeable emergencies by systematic analysis and to prepare, test and review emergency plans for responding to such emergencies;
- **Monitoring performance:** Adoption and implementation of procedures for the ongoing assessment of compliance with the objectives set by the pipeline operator's accident prevention policy and safety management system, and of mechanisms for investigation and taking corrective action in case of non-compliance. The procedures should cover the operator's system for reporting accidents or near misses, particularly those involving failure of protective measures, and their investigation and follow-up on the basis of lessons learned. Because improvements may affect several parts and aspects of the pipeline safety management system, every improvement should be subject to a performance analysis and should be properly managed;
- **Audit and review:** Adoption and implementation of procedures for periodic systematic assessment of the effectiveness and suitability of the safety management system, including the management of improvements; documented review of the safety management system's performance, and updating of the system by senior management.

As part of the safety management system, the pipeline operator should continually monitor the operation of the pipeline and should keep the registered data.

### III. EMERGENCY PLANNING

Emergency plans should be established, reviewed, tested and, where necessary, revised and updated by the pipeline operators (internal plans) and by the authorities (external plans) at suitable intervals. The review should take into account changes to the pipelines and changes within the emergency services concerned; new technical knowledge; and knowledge concerning the response to accidents. In particular, the emergency plans should be established in accordance with the provisions of joint bodies, such as international river commissions.

Emergency plans should be established with the objectives of:

- Containing and controlling accidents so as to minimize their effects and limit damage to human health, the environment and property;

- Implementing the measures necessary to protect human health and the environment from the effects of transboundary accidents;
- Communicating the necessary information to the public and to the services or authorities concerned in the area;
- Providing for the restoration and clean-up of the environment after an accident.

Emergency plans should be coordinated between pipeline operators and competent authorities as well as with fire brigades and other disaster control units.

#### **A. Internal emergency planning**

Internal emergency plans should at least include:

- Names and/or positions and contact data of persons authorized to set emergency procedures in motion and of the person in charge of and coordinating the on-site mitigation action;
- Name and/or position and contact data of the person responsible for liaising with the competent authority in charge of the external emergency plan;
- Arrangements for initiating and activating the alert and call-out procedures continuously;
- Arrangements and devices for receiving warnings of incidents;
- For foreseeable conditions or events which could trigger an accident, a description of the actions which should be taken to control those conditions or events and to limit their consequences, including a description of the safety equipment and the resources available;
- Arrangements for limiting the risks to persons on site, including the way in which warnings are to be given and the actions which persons are expected to take upon receiving a warning;
- Arrangements for providing early warning of the accident to the competent authority responsible for setting in motion the external emergency plan; the type of information which should be contained in an initial warning; and arrangements for the provision of more detailed information as it becomes available;
- Arrangements for training staff in the duties they will be expected to perform and, where necessary, coordinating this with emergency services.

#### **B. External emergency planning**

It should be ensured that external emergency plans are drawn up in consultation with the public likely to be affected by a transboundary accident originating from a pipeline.

External emergency plans should at least include:

- Names and/or positions and contact data of persons authorized to set emergency procedures in motion and of persons authorized to take charge of and coordinate action;
- Arrangements for receiving early warning of accidents and for alert and call-out procedures;
- Arrangements for coordinating the resources necessary to implement the external emergency plan;
- Arrangements for providing assistance with mitigation action;
- Arrangements for off-site mitigation action;
- Lists/maps of sensitive areas and objects with their specifications;
- List of the agencies and organizations that can assist with the management of the incident;
- Arrangements for providing the public with specific information on the accident and the actions it should take;
- Arrangements for notifying the emergency services of neighbouring countries in the event of an accident with possible transboundary consequences, in accordance with the UNECE Industrial Accident Notification System.

#### **IV. INSPECTION**

The pipeline should be inspected and maintained regularly. Only reliable trained staff and qualified contractors may carry out maintenance and inspection work on a pipeline.

Inspections or other control measures should be sufficient for a systematic technical, organizational or managerial assessment of the systems being used for pipelines. In particular:

- Pipeline operators should demonstrate that they have developed appropriate performance indicators to monitor the pipeline management system (PMS);
- Pipeline operators should demonstrate that they have taken appropriate measures to prevent accidents;

- Pipeline operators should demonstrate that they have provided appropriate means for limiting the consequences of accidents; and
- Any data and information submitted should adequately reflect the conditions of the pipeline(s).

Relevant regular inspection and maintenance work includes, for example:

- Continual recording of the data relevant for plant safety and its evaluation;
- Walking surveys/air surveillance of the pipeline route at regular intervals;
- Examination at regular intervals of all equipment serving the safe operation of the pipeline;
- Monitoring of the effectiveness of cathodic corrosion protection;
- Special surveillance measures in mining and potentially land-sliding areas; and
- Regular inspection of pipelines to detect any non-acceptable and temporarily acceptable defects (corrosion, minimum wall thickness, cracks, laminations, dents, folds).

The pipeline should be inspected by certified experts at regular intervals as far as required by the notification/permit.

These inspections should in particular focus on whether the pipeline is in proper condition and on the functioning of the equipment ensuring pipeline safety.

## **V. HAZARD/RISK ASSESSMENT AND LAND USE PLANNING**

Hazard/risk assessment in principle may consist of one of the following four elements, or of a combination thereof:

- Deterministic approach (safety defined as a discrete value)
- Probabilistic approach (safety defined as a distribution function)
- Qualitative methods (non-numerical assessment)
- Quantitative methods (numerical assessment)

Of the various methods used for hazard/risk assessment in land use planning, the most common are:

- “Consequence-based” methods (assessment of the consequences of pre-selected credible accidents without quantification of the likelihood of these accidents)
- “Risk-based” methods (presentation of the likelihood of a certain undesired effect, usually in the form of a numerical value)
- Hybrid methods:
  - Semi-quantitative methods (a subcategory of the risk-based methods)
  - Tables of fixed distances (may be considered a simplified form of the consequence-based method)
- “State-of-the-art” approach (assumes that if measures which have proved their effectiveness in the past exist sufficient to protect the population from a “worst conceivable” accident, sufficient protection will also be available for any less serious accident)

Depending on the pipeline situation and possible scenarios in a specific situation, hazard/risk assessment may result in:

- The determination of a specific distance or a no-effect distance, or a fixed distance reflecting the basic level of safety which should be taken into account between pipelines and residential and other sensitive areas. These safety distances should be used in land use planning in situations involving the construction of new pipelines or modifications to existing pipelines, or where new developments in the vicinity of existing pipelines are expected.
- Clarification of the relationship between the material used to construct the pipeline, the type of pipeline and the safety distance. The depth and thickness of a pipeline, the type of material used and the pressure are all factors that influence the safety distance.