UNITED NATIONS ECONOMIC COMMISSION FOR EUROPE

SAFETY GUIDELINES AND GOOD PRACTICES FOR PIPELINES

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TO THE CONVENTION ON THE TRANSBOUNDARY
EFFECTS OF INDUSTRIAL ACCIDENTS

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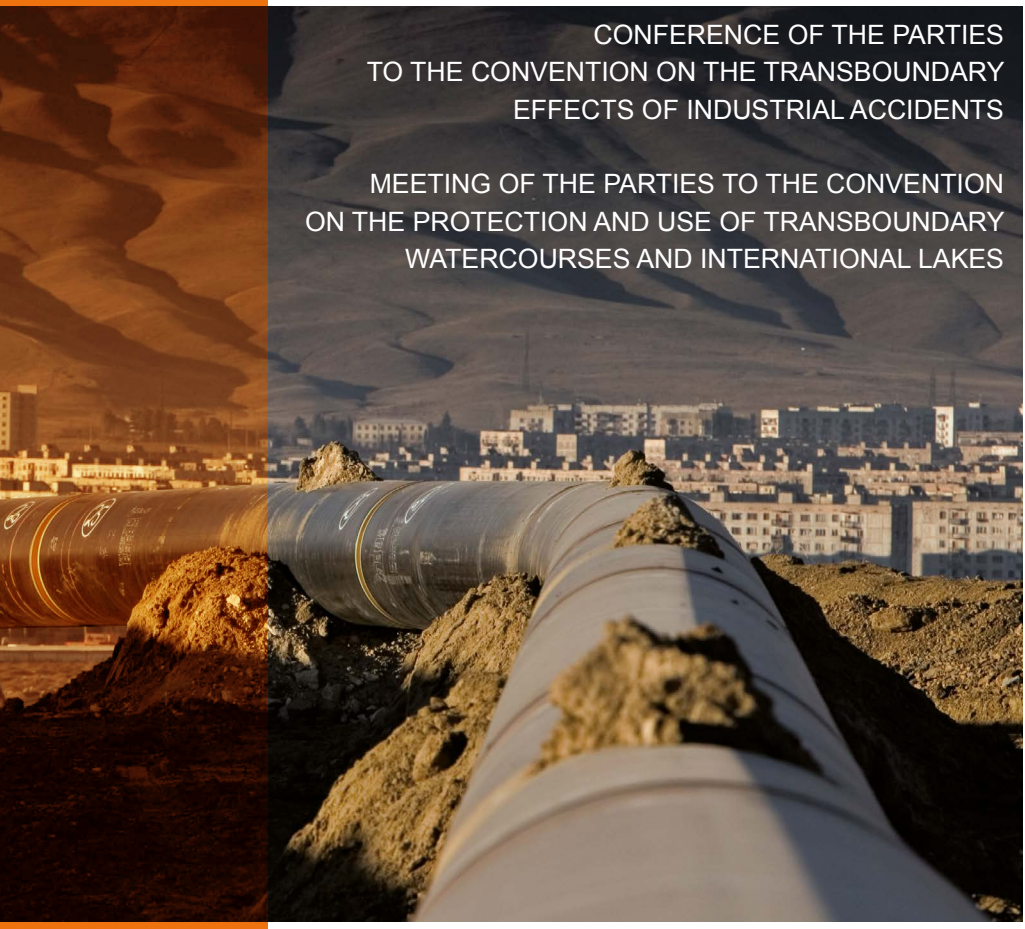
WATERCOURSES AND INTERNATIONAL LAKES



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Safety Guidelines and Good Practices for Pipelines, second edition.

Prepared and published by the United Nations Economic Commission for Europe Joint Expert Group on Water and Industrial Accidents.

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FOREWORD

Pipelines throughout the ECE region transport large volumes of hazardous substances, such as crude oil, its derivatives and natural gas. They are essential for the industrial and energy sectors and help to meet the needs for heat and energy for a large part of the region's population. In October 2011 the longest sub-sea pipeline in the world was inaugurated - the Nord Stream natural gas pipeline, running from Vyborg in the Russian Federation to Greifswald in Germany, covering 1,222 kilometres overall.

If pipelines are constructed, monitored, operated and maintained as required by international and national legislation and according to national and international industry standards and good practices, they can be safe and environmentally sound. However, they can also represent a serious risk to human health and the environment. External interference, corrosion and poor maintenance are the most common causes of pipeline accidents in the ECE region. Uncontrolled loss of containment, fires or explosions can lead to the loss of human life, accidental water pollution and major environmental catastrophes - as demonstrated by a number of pipeline accidents in the past two decades.

Although pipelines are operated with increasing care in many ECE countries, the safety of pipeline construction, operation and maintenance needs to be continuously guaranteed and further improved, where possible. This should also be seen in the light of the challenges posed by climate change, which may increase the probability of industrial accidents caused by extreme weather events and natural disasters.

I hope that these guidelines will be used by policymakers, public institutions, the business sector and civil society to enhance awareness and share experience and good practices for an improved pipeline safety across the ECE region. I would like to encourage the further implementation of the guidelines by Parties and ECE member States, which should help to prevent pipeline accidents and the severity of their consequences for human health and the environment.

Christian Friis Bach

Executive Secretary
United Nations Economic Commission for Europe

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BACKGROUND AND ACKNOWLEDGEMENTS

In response to the need to improve pipeline safety, United Nations Economic Commission for Europe (ECE) member countries decided to jointly develop safety guidelines and good practices for pipelines under two ECE conventions — the Convention on the Transboundary Effects of Industrial Accidents (Industrial Accidents Convention) and the Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention). In 2004, the Conference of the Parties to the Industrial Accidents Convention and the Meeting of the Parties to the Water Convention mandated the Joint Expert Group on Water and Industrial Accidents to draw up safety guidelines and a good practice for pipelines.

The guidelines were developed by the Joint Expert Group, co-chaired by Mr. Gerhard Winkelmann-Oei (Germany) and Mr. Peter Kovacs (Hungary), with the support of the Industrial Accidents and Water Convention secretariats. To support the work of the Joint Expert Group, an international steering group was established, with the following members: Mr. Gerhard Winkelmann-Oei (Germany, co-chair), Mr. Bas Weenik (Netherlands, co-chair), Mr. Bernd Zaayenga (Germany), Mr. Pavel Danihelka (Czech Republik), Ms. Lorena De Giorgi (Italy), Ms. Christiane Kühl (Germany), Mr. Jörg Ludwig (Germany), Mr. Sergey N. Mokrousov (Russian Federation), Mr. Ender Okandan (Turkey), Mr. Walter Reinhard (Germany), Ms. Carla Speel-Zuiderwijk (Netherlands). The members of the steering group actively contributed to the drafting of these guidelines.

The resulting safety guidelines and good practices, as presented in this publication, were endorsed by the Conference of the Parties to the Industrial Accidents Convention at its fourth meeting (Rome, 15–17 November 2006) and by the Meeting of the Parties to the Water Convention at its fourth session (Bonn, 20–22 November 2006). Both bodies encouraged Parties and other ECE member States to disseminate the guidelines for use by the appropriate authorities.

The guidelines have been reissued in 2014 to update the references and provide a basis for their application throughout the region, following their review by the Joint Expert Group on Water and Industrial Accidents. Authorities, pipeline operators and the public are invited to apply these guidelines and 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.

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INTRODUCTION

1. There is a widespread understanding and agreement that environmental degradation of transboundary watercourses and/or international lakes can be caused by large-scale release of hazardous materials as a result of pipeline failures. Such pollution, and the related damage or risk to human health, infrastructure and environmental resources, may have a negative effect on relations between neighbouring countries. These risks are posed by all pipelines, but there is particular concern regarding existing pipelines, some used beyond their service life.

2. Pipeline failures and incidents can lead to significant costs for operating companies and countries for items such as emergency response, clean-up and repairs, disruption of operation, claims for damages, lawsuits and legal costs, unscheduled closure activities and the loss of the company's share value. As such, accident costs almost universally exceed the costs a company would incur to ensure proper and adequate levels of safety and control to prevent such incidents.

3. The operation phase for pipelines can last many decades. In fact, pipeline construction and operation are constantly evolving processes, as practices vis-à-vis the design, operation and maintenance — as well as regulation — of pipelines evolve, sometimes significantly changing during the life of a pipeline. In addition, many national jurisdictions lack relevant regulations regarding issues related to the construction, operation and maintenance of pipelines. Information on pipeline operation and construction should be provided to the public in accordance with relevant provisions of the United Nations Economic Commission for Europe (ECE) environmental conventions.

4. In recognition of the risks posed by pipeline accidents and their potential impacts, the Parties to the ECE Convention on the Transboundary Effects of Industrial Accidents (Industrial Accidents Convention) and the ECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention) decided to draw up safety guidelines and good practices for pipelines. These take the form of a set of recommendations that will assist national authorities and operators in ensuring an adequate safety level for pipelines and the risks they pose.

5. The Joint Expert Group on Water and Industrial Accidents under the Industrial Accidents and Water Conventions established an international steering group to draw up the present guidelines. In drafting the guidelines, the steering group took into account input from authorities, operators of pipelines and non-governmental organizations (NGOs) in the context of two workshops and their follow-up: one on the prevention of water pollution due to pipeline accidents (Berlin, 8–9 June 2005); and a second on the prevention of accidents involving gas pipelines (The

Hague, 8–9 March 2006). The steering group also took into account existing safety guidelines in relevant areas, in particular the Guiding Principles for Chemical Accidents Prevention, Preparedness and Response from the Organization for Economic Cooperation and Development.

6. This guidance document contains principles and key elements for the safe transport of hazardous substances by pipeline, whether transboundary or not. The guidelines and practices set out herein are designed to prevent incidents and to limit accidental consequences for human health and the environment. It should be noted that security concerns (e.g., sabotage, destructive acts) and workers' safety are not within the scope of these guidelines; however these concerns should also be taken into account.

PRINCIPLES FOR PIPELINE SAFETY

7. Governments should provide leadership and create the basic administrative framework necessary to facilitate the development of a safe and environmentally sound transportation infrastructure, including pipelines.

8. The pipeline operator and/or owner has primary responsibility throughout the whole life cycle 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 by the pipeline operator and the national competent authorities.

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

10. 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.

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

12. Deterministic and/or probabilistic approaches should be used in evaluating the likelihood of pipeline accidents and their impacts on human health and the environment.

13. Appropriate measures should be taken in case of accidents. Emergency plans should be established by pipeline operators (internal emergency plans) and by

competent 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.

14. Land-use planning considerations should be taken into account both in planning the route for 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.

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

16. 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.

17. 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.

RECOMMENDATIONS

18. 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.

19 Following are recommendations to the ECE 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 ECE member countries

20. ECE 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 in this area, among others, through educational programmes.

21. ECE member countries should define a level of safety at least consistent with paragraph 18.

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

23. ECE member countries should make further efforts to bring about the 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 Kyiv on 21 May 2003.

24. ECE 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.

25. ECE member countries should designate competent authorities at the national, regional or local levels 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

26. 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.

27. 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.

28. Competent authorities should carry out a permitting process for new pipelines, including environmental impact assessment, in a transboundary context when applicable.

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

30. Competent authorities should ensure that pipeline operators:

    (a) Draw up and implement internal emergency plans;

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

31. 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.

32. Competent authorities should ensure that external emergency plans are put into effect without delay when a pipeline accident occurs.

33. 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.

34. Competent authorities should ensure that external and internal emergency plans are reviewed, tested and, where necessary, revised and updated at suitable intervals.

35. 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 clearly designating the responsibilities of the various actors.

36. 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.

37. 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 in a timely manner in order to prevent third-party damage to pipelines.

C. Recommendations to pipeline operators

38. Pipeline operators should design, construct, operate, maintain and monitor pipelines for transporting hazardous substances so as to prevent accidents and to mitigate the consequences thereof.

39. Pipeline operators should design, construct and operate pipelines at least in accordance with recognized national and international codes, standards and guidelines and, where appropriate, internationally accepted company specifications.

40. Pipeline operators should give consideration to various aspects that could affect the safety of a pipeline, such as design and stress factors, the quality of materials, wall thickness, the depth of burial, external impact protection, corrosion, markings, route selection and monitoring.

41. Pipeline operators should undertake hazard/risk assessments in order to choose among different options and to assess unusual circumstances.

42. 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;

    (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.

43. Pipeline operators should draw up and implement internal emergency plans and ensure that these are reviewed, tested, revised and updated at suitable intervals.

ANNEX

Technical and organizational aspects

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-chemical properties of the transported substances 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 the 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 life cycle.

- 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.

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 a 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.

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.

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 other relevant organizations, 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 ECE Industrial Accident Notification System.

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.

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.

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