Report of Study Group 4.2

“Frame of reference regarding Pipeline Integrity Management System (PIMS)”

Rapport du Groupe d’Etude 4.2

“Structure de référence pour une Système de gestion de l’intégrité des gazoducs (PIMS)”

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ABSTRACT

The scope of the paper is drawing up a reference frame on gas pipeline management system integrating the aspects of integrity, safety, environment and quality requirements. This frame should be used as a tool for the Managers to manage in optimum conditions their plants and their maintenance staff according the main lines hereabove, and it should be a reference frame able to justify, to the authorities and even the public, the efforts engaged by the operator.

RESUME’

Sujet : Elaboration d'un référentiel propre à la gestion d'un système de transport de gaz naturel par canalisations intégrant les aspects liés à l'intégrité et à la sécurité des ouvrages, au respect de l'environnement et aux exigences en matière de qualité. Ce référentiel peut être utilisé comme une aide à la Direction pour la gestion optimale de ses installations et ses propres équipes de maintenance suivant les axes décrits ci-dessus et il doit aussi constituer un référentiel permettant de justifier les efforts engagés par la compagnie vis à vis des autorités, voire du public.
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1. PURPOSE

1.1. THE PIMS

PIMS is defined as Pipeline Integrity Management System. It is a safety management system, whose field is pipeline integrity (see § 1.2). The field doesn’t cover occupational health.

Each natural gas pipeline operator has a system to manage all its resources and activities. This management system is specific to each operator. It generally integrates all the following activities: storage, compression, transportation and delivery of natural gas (see diagram below).

PIMS is based on such principles as:
- adoption of high technological standards in the construction,
- carrying out of proactive measures for ensuring that the pipeline system is maintained fit for purpose,
- working out of emergency procedures,
- incidents investigation,
- personnel's training,
- definition of roles and responsibilities of personnel.

It follows the basic principle plan, do, check and act (PDCA) which includes policy, planning, implementation and operation, inspection and corrective actions, and management review.

Architecture of a natural gas operator’s integrated management System

1. Company Management System
2. Pipelines Integrity Management System
In this management system, the PIMS represents all the resources (organisation, equipment, know-how, etc.) and activities provided by each natural gas pipeline operator to control the hazards associated with its natural gas transport network (see boundary of PIMS below).

The goal of the PIMS is to manage:

- the safety of the employees and the public;
- the protection of urban, natural or industrial environment;
- the service life and reliability of industrial equipment (natural gas transport network) taking technical and economic requirements into account.

NB: further in the document, these three items are summarised by the expression « safety and protection of the environment ».

1.2. BOUNDARY OF THE PIMS

The structure in the scope of PIMS are on-shore pipelines and related equipment (insulating devices, disconnecting devices, pre-pressure reduction devices, cathodic protection equipment, simple interconnections).

The delivery points, "complex" interconnections, storage facilities, terminals and compressor stations are not included in this scope.

1.3. OBJECTIVE OF THE FRAME OF REFERENCE

The frame of reference aims at describing the resources (mainly organisation and know how) and activities, for which the gas transport operator is responsible, that help to guarantee the safety and protection of environment. Authorities are also responsible for other matters (such as land use planning and emergency schemes) which are not described in the report.

The frame of reference presents, in the broadest possible manner, all the resources and activities provided for above. These resources and activities are nevertheless implemented according to the technical and economic requirements specific to each structure.

It should be noted that, for more precision about these resources and activities, it is possible to refer to the following standards, which often meet the minimum requirements of this frame of reference and give more details:

- **En 1594**: Pipelines for maximum operating pressure over 16 bar - Functional requirements (applicable in Europe),
- **ISO 13623**: Petroleum and natural gas industries - pipeline transportation systems (applicable outside Europe),
- national pipeline standards.

The present document aims at serving:

- as a frame of reference for natural gas pipeline operators,
  
  → It is based on the best practices of natural gas pipeline operators. (The IGU 1998 survey and "Pipeline Integrity Management and Safety" report conducted by the WOC 4/SG 4.3 and presented to the Nice IGU congress in 2000 have identified best practices. This work supports this frame of reference.)
  → It takes into account remarks of natural gas pipeline operators.

- in the medium term as a frame of reference for authorities,
It must support efforts made by the natural gas pipeline operators.

as a guide for optimal natural gas pipeline management.

It must represent a means of support for management
→ It must demonstrate the coherency of the security, environment and quality management systems.

This framework provides guidance on the safe management of pipelines.

It is based on the principles of the maintaining of the high safety level reached by Gas pipeline operators, proved by the good historical data and of its improvement when possible and necessary.

2. PIMS’ ARCHITECTURE

The resources and activities guaranteeing the integrity of natural gas pipeline materials are organised into processes.

These processes are described in the table below:
<table>
<thead>
<tr>
<th>Process</th>
<th>Role in the PIMS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Main services</td>
</tr>
</tbody>
</table>
| 1. Equipment                  | • Project management and project design and construction supervision regarding constructions and modifications | • Design rules  
                                 | • Pipeline construction techniques | |
| 2. Operation-Maintenance      | • "Routine" inspection and maintenance  
                                 |                                 | • Ground, vehicle, and aerial inspection  
                                 | • Preventive maintenance  
                                 |                                 | • Emergency plan  
                                 | • Corrective maintenance programmes  
                                 |                                 | • Intensive potential measurements  
                                 | • Emergency management  
                                 |                                 | • Intelligent pigging  
                                 |                                 | • Repair techniques | |
| 3. Training                   | • Definition of training programmes  
                                 |                                 | • Training institutes  
                                 | • Participation in training programmes  
                                 |                                 | • Training programmes  
                                 | • Assessment of training programme efficiency  
                                 |                                 | • Job descriptions | |
| 4. Purchasing                 | • Eligibility of suppliers  
                                 |                                 | • Performance tests  
                                 | • Purchasing process  
                                 |                                 | • Construction-work inspectors  
                                 | • Production and construction-work follow-up | |
| 5. Communication              | • Public information  
                                 |                                 | • Advertising pamphlets  
                                 | • Communication strategies  
                                 |                                 | • In-house newsletter  
                                 | • Team meetings  
                                 |                                 | • Bulletin boards | |
| 6. Safety                     | • Safety analysis  
                                 |                                 | • Safety management system  
                                 | • Work regulations and permits / authorisations  
                                 |                                 | • Safety assessment tools  
                                 | • Incident investigation  
                                 |                                 | • Experience feedback databases  
                                 | • Safety Management Reviews | |
| 7. Environment                | • Environmental analysis  
                                 |                                 | • Government gazette  
                                 | • Environment Management reviews  
                                 |                                 | • Standards body  
                                 | |                                 | • Journals | |
| 8. Quality                    | • Drafting / updating of procedures  
                                 |                                 | • Documentation system  
                                 | • Inspection / calibration of measuring devices  
                                 |                                 | • Company exchanges of information  
                                 | • Quality Management reviews  
                                 | | | |
| 9. Standards, Technology and Regulations Watch | • Company exchanges of information  
                                                                 | • Government gazette  
                                                                 | • Participation in congresses  
                                                                 | • Standards body  
                                                                 | • Contacts with institutions  
                                                                 | • Journals | |
| 10. System management         | • Responsibilities  
                                                                 | • PIMS IGU frame of reference  
                                                                 | • PIMS continuous improvement programme  
                                                                 | • Performance appraisal  
                                                                 | • PIMS reviews | |

Processes 1 and 2 are main processes ("skills"), enabling the natural gas pipeline operator to perform his primary tasks.

Processes 3 to 9 are horizontal / auxiliary to processes 1 and 2.

Process 10 is a global process that guarantees the system’s coherency (PIMS).

Each individual process is co-ordinated by a management loop: Policy, Planning, Implementation and Operation, Inspection and Corrective Action, Management Review.
3. SYSTEM MANAGEMENT PROCESS

This section provides a summary description of the activities specific to the management process, that contribute to the safety and protection of the environment.

Operators can manage the safety / environment aspects of all the resources and activities they are involved in, through the use of a safety / environment management system based on the requirements of a frame of reference. The standards hereafter are examples of such a frame of reference: ISO 14000, BS 8800, OHSAS 18001, or DNV ISRS© standards.

In this context, safety / environment policies and objects may be defined. Management then undertakes to develop and implement a safety / environment management system and continuously maintain, or improve its efficiency, if necessary.

3.1 MANAGEMENT COMMITMENT

The Top management provides visible and active leadership in developing and maintaining a supportive culture of Environmental and Safety matters.

The Top management may define an Environmental and Safety Policy in which overall objectives and a commitment to maintain or improve environmental and safety performance are clearly stated.
3.2 ORGANISATION AND RESPONSIBILITIES

The organisation and responsibilities for the management of Environmental and Safety may be defined and documented.

The role, responsibility, accountability, authority and interrelation of the personnel who manages, performs or verifies work affecting environmental and safety matters are defined:
- in the provision of resources, ensuring staff awareness of relevant hazards and the compliance with the environmental and safety policy;
- in the identification, recording and follow-up of corrective or improvement actions;
- in the control of abnormal situations including emergencies;
- in the identification of training needs, the provision of training and the evaluation of its effectiveness;
- in the implementation of the system.

3.3 HAZARD IDENTIFICATION AND CONTROL

Potential hazards for environment and safety from the transport activity may be identified and assessed. Appropriate controls and systems are implemented to reduce and manage those hazards.

The organisation may define and set up procedures in order to identify the hazards, assess their relevance and implement the necessary control measures, both in routine and non-routine activities.

The organisation includes the assessment results and the effects of the controls in the company policy when relevant.

3.4 PLANNING AND PERFORMANCE MONITORING

Planning to achieve safety objectives is required with performance indicators to measure and monitor the implementation of Environmental and Safety Policies on a regular basis.

The Operator sets up a Performance Measurement framework in order to demonstrate effective management of pipeline safety and environmental performance according to:
- the incidents that can happen;
- the consequences severity;
- the operational control (i.e. air emission, patrolling, intelligent pigging and so on)
- the elements of the Management System (i.e. public awareness, visit to landowners, training courses and so on).

3.5 INFORMATION MANAGEMENT

Environmental and Safety information are controlled to ensure that they are accurate, relevant and readily available to enable safe operations.

Procedures for ensuring that these information are communicated to and from employees and other interested parties may be defined.
3.6. AUDIT

Internal or external audits should be conducted to assess the effectiveness of the PIMS and identify areas to improve environment and safety standards.

In particular the audit procedures should mainly:
- determine if the Management System has been properly implemented and maintained and if it is effective in meeting the organisation's policy and objectives;
- review the results of previous audits;
- provide information on the results of audits to management.

4. THE EQUIPMENT PROCESS

The equipment process is the first and basic step that enables the natural gas transport network operator to ensure a safe and continuous supply of natural gas.

The equipment process, in the present document frame, means the design and the construction management and it is integrated in the natural gas transport Pipeline Integrity Management System (PIMS) in accordance with the principles set above in § 2 (cf. Schematic diagrams) both for new constructions and modifications.

Both the design and the construction should be carried out in accordance with the principles and the objectives described in the Environmental and Safety Policy.

This section provides a summary description of the two activities considering in particular the safety and protection of environment.

4.1. THE DESIGN MANAGEMENT

4.1.1. DESIGN PRINCIPLES

The management and the control of the design of new plants and of modifications of the existing ones are carried out assuring the fulfilment of the criteria and requirements about safety, in observance of the relevant national law.

Besides, the decisions and the solutions adopted in the design are in accordance with the Environmental and Safety Policy of the Company.

The design of the pipeline shall lead to a safe system for transmission of gas.

4.1.2. THE STANDARDS

In the planning, design actions and choices refer to specifications on the basis of prescriptive codes and procedures that are well documented and recognised both at national and at international level such as ANSI, API, ASME, CEN, DIN, ISO, IGE...

The natural gas transport operator can decide to define and adopt internal company standards based on the above references, adapted to its own skills and know-how.

The whole set of these standards satisfies the operating conditions in each State and ensures compliance with its specific legal requirements. It covers the pipeline design matter, like sizing, location, correct selection of materials and components, construction details, testing and commissioning into services.
Besides, they apply equally to associated plants and their components such as reduction stations, pressure control stations, metering stations and so on.

4.1.3. THE DESIGN SUPERVISION

The extent and detail of the design of a pipeline is sufficient to demonstrate that the integrity and availability can be maintained during the design life of the pipeline.

In order to manage the design activity of pipelines and equipment for assuring a high safety level and to provide solutions for preventing damages, development design plans can be arranged, according to the importance of the new pipeline or the modification.

These plans are suited for identifying:
- scope of the work,
- organisation for the execution (people and responsibilities),
- design data,
- execution activity,
- expected document list,
- execution program,
- planning of surveillance activity and safety aspects auditing,
- planning and control of the design.

The design takes into consideration all technical issues together with environmental and safety aspects.

Besides, the controlled release of gas or other materials during the following construction phase may be taken into account.

4.1.4. DESIGN OVERVIEW

The Operator defines, as first step, the general design data such as the diameter, the design pressure, the safety factors, the wall-thickness, the distance from buildings, the grade of the steel, the routing, the stations, the line systems etc.

Some of the most important aspects for the safety and environmental protection are reported in the following:

*Route selection*:

The pipeline route is selected with regard to soil characteristics, other pipelines and nearby buildings, sensitive areas, environment impacts and economical aspects.

In the areas crossed by the pipeline, the operator adopts the necessary safety measures that have been taken according to legislation or applicable standards.

*Wall thickness specifications*:

The required pipeline thickness and the related safety factor depending on steel quality and on the population distribution is fixed in the legislation or standards.

Crossing of railways, waterways, roads, flood defences can be subjected to special conditions.

The additional stress with respect to that determined by the internal gas pressure can also be evaluated for the relevant sections (i.e. non-stable soil, waterways, water formation, high traffic condition and so on). Special pipe geometry and wall-thickness should be chosen to obtain a lower stress level.
Where external interference is a potential hazard, significant prevention measures such as increasing of wall thickness depending on steel quality and safety factor or depth of cover or mechanical protection can be considered.

**Pressure control:**

It can be assured, by means of suitable equipment, that the intended maximum operating pressure can not be exceeded.

Besides, the line can be sectioned by means of shut-off devices located at a distance depending on pipe diameter, pressure, typology of valves (remote controlled or not), population and dwelling distribution around the pipeline.

**Corrosion protection:**

Buried pipelines are provided with a coating aiming at protecting them against the corrosive action of the soil into which they are laid down.

Coatings are made of suitable materials having particularly adequate qualifications as far as electric resistivity, adhesion to the steel, plasticity, strength, non-hygroscopicity, impermeability and inalterability by the aggressive agents of the soil.

Furthermore, the pipeline should be protected against corrosion by means of cathodic protection systems.

The sections of above ground pipelines is protected by means of coating or painting suitable to their environment.

According to the importance of the pipeline and to relevant internal standards, the line may be piggable.

The above design element list do not have to be considered exhaustive and each measure could be implemented according to technical and economical constraints that the designer has to evaluate case by case.

### 4.1.5. THE DESIGN REVIEW

The control to be put in practice in the following construction, testing, operation and maintenance can be considered and defined at each step of design thorough a preliminary identification of the design phases and of the potential hazards for safety and environment.

The designer can be internal or an external contractor to the gas operator.

The design can be independently reviewed and approved.

The Company organisation warrants the selection of a designer with adequate competencies in order to get a correct and complete design and to fulfil the accordance with the Environmental and Safety goals of the management system.

On conclusion of the design, a complete set of documents can be produced containing a description of the pipeline, drawings, data of pipeline components and structures, other construction information if required (for instance description and calculation for special crossing, environmental impact report if relevant and so on).
4.2 THE CONSTRUCTION MANAGEMENT

4.2.1. CONSTRUCTION PRINCIPLES

The construction of pipeline systems is undertaken as described in the national legislation, recognised codes and standards governing civil work, mechanical works, electric work, hydraulic work, welding and testing aspects.

Work is carried out in such a way as to ensure the safety of the workforce and third parties and protection of property.

The execution of a construction project is followed by competent personnel who knows the importance of conformance to the company policy about safety and environment and is informed and trained about the requirements of the management system.

4.2.2. THE CONSTRUCTION SUPERVISION

In order to manage the construction of a new pipeline or a modification of the existing ones, development plans, as for the design phase, should be carried out according to the relevance of the construction or modification activity. Operative plans for the environment and safety aspects have to be carried out as well.

The whole set of the construction solution has to be in accordance with the statements and the goals of the Environmental and Safety Company Policy.

The aspects managed in these plans should be:

- Organisation (people and responsibility) for the construction activity,
- Law requirements to be adopted,
- Environment and safety requirements and their control activities,
- Execution program.

4.2.3. THE CONSTRUCTION OVERVIEW

The Operator selects competent personnel in order to supervise and execute the construction project.

Some of the main aspects that can be considered according to the technical and economic requirements specific for each project and that could be adopted are:

**Material control:**

Pipes, control, monitoring and safety devices, pressure vessels, joint and fittings are constructed and certified to standards and/or company specifications.

Tests, including no destructive pressure testing and inspection can be carried out at the manufacturer’s premises, or construction sites, by a third party or qualified company employees so as to ensure that the purchased items are suitable for their incorporation in the gas pipeline system (see § 6.2 Purchasing).

Test and inspection can be performed in the factory, such as hydrostatic test, non destructive test of the welding, tensile and drop test and so on.
Excavation of trenches:

The excavation sections are normally determined by establishing, according to the diameter of the pipeline, the minimum width of the trench bottom and the minimum coverage, which refers to the finished plane of the right-of-way.

The material obtained from the trench (preserving the vegetal bed) can be stored at the side of the trench for re-use during the re-covering phase of the pipeline.

Pipe bending at the work site:

The bending is done with pipe-bending machines in all instances where the angle measurement of the route’s planimetric or altimetric deviations is such as not to be entirely absorbed by the elasticity of the pipes within the allowable minimum curvature radius limits and when the installation of prefabricated bends is not considered.

Tests before pipe laying:

Before the laying of the pipeline, a continuity test of the electrical insulation has to be carried out over its entire length at a tension level appropriate for the insulation characteristics of the coating itself.

Repairs are made to any defects that are uncovered and a re-check is carried out.

In order to check the integrity of the coating, electrical gradient measurements can be taken, after the pipeline has been laid and the hydraulic test done, to uncover any gaps in the insulation of the pipeline and to repair the damaged coating.

Pipe laying and backfilling:

The pipeline is laid in sections, with the appropriate means, and in such numbers so as to avoid bucklings and damaging stress to the pipes themselves and their coating. Once laid the pipe should be completely in contact with the bottom of the trench, not touching the trench walls and not in tension.

The backfilling takes place after the pipe laying, taking care not to cause any damage to the coating, and consolidating the materials used to avoid subsequent settlement.

The material excavated for clearing the right-of-way can be rearranged in order to restore the original shape of the land, with the excess material carried off when it cannot be spread out over the site.

This phase is undertaken with special care (bridles, fences, mattresses, hidden containment walls, etc.) in steeply-sloped sections, in order to guarantee stability and prevent washing away and erosion.

The proper execution of this phase is an important condition for achieving a good restoration of the land used for the project.

Coatings:

The pipelines and their fittings, on being laid, are coated on all their parts. Thus all the sections without coating (welded joints, damages parts, fittings, valves, etc.) are re-cleaned and protected with adequate coatings.

Welding:

The requirements of weldability and welding procedures are described in the company codes or standards. Only qualified welders are authorised to execute the work under the supervision of a qualified welding engineer. The welds are inspected by an independent expert using ultrasonic or X-ray techniques and recorded in a testing protocol.
Testing:

Each finished pipeline system is submitted to a hydrostatic pressure test and or a leak tightness test. An expert should verify all these tests.

Gas sweeping:

Before the pipeline is placed into operation, it is “swept” by eliminating air and any remaining test waster which may be present.

The above construction element list doesn’t have to be considered exhaustive and each measure could be implemented according to technical and economical requirements specifically case by case.

4.2.4. THE CONSTRUCTION REVIEW

The construction phase is usually carried out by external contractors. The company shall guarantee the selection of competent contractors.

The construction can be monitored by the Company that can have at its disposal the tools for verifying the accordance with the scheduled programme.

The modification that can be introduced during the construction phase with regard to the design expectations can be supported, if necessary, by a revision of the analyses of design and of the documentation.

All the modifications are in accordance with the Environmental and safety Company Policy.

Accordingly to the test, operating and maintenance actions are updated.

5. THE OPERATION – MAINTENANCE PROCESS

The operation-maintenance process is a primary process: it enables the natural gas transport network operator to ensure its primary tasks.

It is integrated in the natural gas transport Pipeline Integrity Management System (PIMS) in accordance with the principles set above in § 2 (cf. Schematic diagrams).

This section provides a summary description of the resources and activities specific to the operation-maintenance process that contribute to the safety and protection of environment.

It also describes the major interplays and synergies between the operation-maintenance process and the other processes of the PIMS.

It is structured in accordance with the management loop principles (Policy, Planning and Scheduling, Implementation and Operation, Verification and Corrective actions, Management Review).

5.1 OPERATION - MAINTENANCE PRINCIPLES

The operation - maintenance principles should be put in the company policy. More detailed operation and maintenance targets and goals can be set forth in addition in a formal document in which the Management undertakes to implement the necessary means and actions to guarantee an adequate safety level.
Theses principles should be based more specifically on a constant compliance with the statutory requirements, and, if safety analysis are done (see §6.4.3), it should integrate the resulting measures. It aims at controlling over time the condition of the structures and favouring preventive maintenance actions (on-condition or anticipatory).

The main goals of the pipelines and plants maintenance are to assure their proper and correct functioning and that the system carries the gas safely, economically and without interruption.

It hinges around four main axes:
- monitoring and "routine" maintenance of the structures,
- preventive maintenance programmes,
- corrective maintenance programmes,
- emergency situation management.

5.2. MONITORING AND "ROUTINE" MAINTENANCE OF STRUCTURES

5.2.1 PLANNING AND SCHEDULING

The organisation and management of the monitoring and "routine" maintenance of structures can be based on defined objectives, which are broken down into actions to be carried out.

*Examples of objectives:*
- reduce third party damages,
- reduce the number of accidents occurring on declared construction sites.

A maintenance plan is drawn up to take these objectives into account.

It indicates the frequency and the kind of monitoring and "routine" maintenance operations to perform.

*Examples of scheduled monitoring and "routine" maintenance operations:*
- aerial survey,
- on-foot reconnaissance of the pipeline path once a year,
- inspection of banks where the pipeline crosses rivers after spate.

The maintenance plan is drawn up and updated according to the experience feedback from the implementation of monitoring and "routine" maintenance operations in the preceding years.

*Various means can be used according to the need to develop the maintenance plan:*
- use of a systematic method such as maintenance optimisation through reliability, failure modes, effects and criticality analysis (FMECA),
- functional analysis,
- hierarchical rating of pipeline sections, according to an expert judgement.

5.2.2. IMPLEMENTATION AND OPERATION

Operational teams are in charge for the monitoring and "routine" maintenance of the structures.

They are generally stationed near the structures according to the local situation and conveniences.
The following table illustrates the main monitoring and "routine" maintenance activities that can be implemented.

It should be noted that other activities and complementary or equivalent actions may be implemented. Moreover, all these monitoring and "routine" maintenance activities and actions are not necessarily implemented simultaneously, but according to the technical and economic requirements specific to each structure.

<table>
<thead>
<tr>
<th>Principal monitoring and &quot;routine&quot; maintenance activities</th>
<th>Examples of associated monitoring and &quot;routine&quot; maintenance actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Survey:</td>
<td>• Reconnaissance on foot, by car, from the air</td>
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<tr>
<td>→ Environmental developments survey</td>
<td>• Processing statements of works to be performed</td>
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<tr>
<td>→ Prevention of third party damages</td>
<td>in the vicinity of structures</td>
</tr>
<tr>
<td>→ Inspection of specific points</td>
<td>• Survey of sites in the vicinity of structures</td>
</tr>
<tr>
<td></td>
<td>• Informing residents, town councils, etc.</td>
</tr>
<tr>
<td></td>
<td>• Visual inspection of river banks</td>
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<td></td>
<td>• Visual inspection of aboveground crossings</td>
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<td>• Inspection of the cathodic protection system</td>
<td>• Operating check of the cathodic protection stations</td>
</tr>
<tr>
<td></td>
<td>• Recording the parameters (potential + current) of the</td>
</tr>
<tr>
<td></td>
<td>cathodic protection stations</td>
</tr>
<tr>
<td></td>
<td>• Inspection of electrical connections</td>
</tr>
<tr>
<td>• Verification of the efficacy of the cathodic</td>
<td>• Measurement of the pipe / ground potential</td>
</tr>
<tr>
<td>protection system</td>
<td>• Verification of the pipeline / sleeve insulation</td>
</tr>
<tr>
<td></td>
<td>• Analysis of the drainage station parameters</td>
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<tr>
<td>• Preventive maintenance of the line stations</td>
<td>• Operating tests</td>
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<td></td>
<td>• Sealing tests</td>
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<td></td>
<td>• Cleaning</td>
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<td></td>
<td>• Greasing</td>
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<td></td>
<td>• Periodic replacement of filters</td>
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<td>• &quot;Routine&quot; corrective maintenance</td>
<td>• Maintenance of pipeline indications</td>
</tr>
<tr>
<td></td>
<td>• Repair / replacement of line station equipment</td>
</tr>
<tr>
<td></td>
<td>• Adjustment of line stations</td>
</tr>
</tbody>
</table>

The monitoring and "routine" maintenance actions are implemented in accordance with operating procedures by qualified personnel (cf. § 6.1).

5.2.3. INSPECTION AND CORRECTIVE ACTIONS

The monitoring and "routine" maintenance actions are subjected to traceability measures in order to track implementation of the maintenance plan and the analysis necessary for experience feedback.

If objectives have been set, indicators are established in order to gauge the meeting of these objectives.

Examples of indicators:

- rate of failure of cut-off components,
- number of third-party damages,
- continuity of supplies.
5.3 PREVENTIVE AND CORRECTIVE MAINTENANCE

5.3.1. PLANNING AND SCHEDULING

Defects can appear and/or develop during the lifetime of the structures, for various reasons (corrosion, construction problems, third party damages, etc.). Generally, these defects should then be identified and repaired before they reach a critical threshold that could lead to an accident.

Maintenance programmes should be prepared and executed to monitor the conditions of the pipelines and the plants. They provide information necessary to assess their integrity.

Furthermore, the changes in regulations and technology can impose or suggest the adaptation of the equipment constituting the natural gas transport network.

Taking these elements into account, various preventive or corrective maintenance programmes can be implemented on a case-by-case basis.

*Example of preventive maintenance programmes:*
- systematic programme of cut out for analysis during scheduled works,
- programme of inspection and "rehabilitation" of "specific" points,
- programme of inspection and "rehabilitation" of the condition of the entire network.

*Examples of corrective maintenance programmes:*
- upgrading of old pipelines to new standards,
- substitution or modification of deficient components.

It should be noted that most of these programmes involve heavy investments and extensive work. Consequently, the development of these programmes can be usually based on safety considerations that allow the allocation of the available resources in the most effective way. These programmes are generally scheduled over several years.

5.3.2. IMPLEMENTATION AND FUNCTIONING

The implementation of these programmes may require the modification of existing structures, if not their replacement by new structures. It therefore enters into the framework of the equipment process (cf. § 4).

It should be noted that the execution of the inspection and "rehabilitation" programmes can involve:

- *inspection tools:*
  - surface electrical measurements, close interval survey;
  - intelligent pigs;
  - others...
- *diagnostics tools for deciding on the acceptability of the detected defects:*
  - metallurgical examinations;
  - strength calculation software;
  - others...
- *repair techniques whose implementation guarantees the serviceability of the repaired sections over time:*
- composite sleeve;
- facing by welding;
- others....

These means can be implemented selectively according to the desired objectives.

They are implemented in accordance with operating procedures by qualified personnel (see § 6.1).

5.3.3 INSPECTION AND CORRECTIVE ACTIONS

Indicators (example: degree of advancement of inspection programme) should be established in order to measure the progress of the different programmes and assess their efficiency.

Precise experience feedback is structured and organised to allow dynamic adaptation of technical, organisational or financial aspects.

5.4. MANAGEMENT OF EMERGENCY SITUATIONS

5.4.1. PLANNING AND SCHEDULING

In the event of an accident that can have consequences, action must be taken rapidly to mitigate them.

The preparation of emergency plans provides a way of anticipating the means needed to deal with emergency situations and thus plan for:

- the appropriate methods / techniques / procedures,
- the necessary material (equipment) and human resources,
- training of the personnel involved,
- information of competent authorities, if necessary,
- etc.

5.4.2. IMPLEMENTATION AND FUNCTIONING

A surveillance centre works 24 hours a day to take the necessary measures (closing of remotely-controlled valves, etc.) and inform immediately all the intervening bodies involved.

Any person detecting an accident on a natural gas pipeline is asked to alert this surveillance centre, giving appropriate indications. Thus, the alert telephone number is indicated insofar as possible on the stations and markers along the pipeline route.

Teams can be called out 24 hours a day without delay to implement the emergency plan.

Actions should be adopted in order to:

- take all necessary measures to protect the environment and make safe the gas transport structures,
- provide internal and external information,
- co-ordinate the actions with the representatives of the Public Services responsible for Security, when necessary.
5.4.3. INSPECTION AND CORRECTIVE ACTIONS

The emergency plans should be updated and revised according to the technical development and the lessons learned from experience and exercises.

5.5. ELEMENT OF PROCESS REVIEW

The maintenance and the management of emergency situations have to be analysed. Such an analysis should be based on:

- a summary of the actions implemented,
- the main difficulties encountered while implementing these actions,
- the results of the actions with respect to the objectives,
- the possible lines for improvement.

The analysis results should be communicated to the top management, in order to update, if necessary, the operation-maintenance policy and associated objectives.

6. HORIZONTAL PROCESSES

6.1. TRAINING

All personnel (employees of the natural gas transport operator, but also of the subcontractors) are selected, trained and developed to carry out their respective technical duties in a safe and efficient manner. In addition, the organisation may define and set up procedures to ensure that its employees working at each level are aware of:

- the importance of conformance to the company policy, and to the requirements of the management system,
- their roles and responsibilities in achieving conformance to the company policy, the procedures and the requirements of the management system.

For persons employed in the gas sector, completed training qualifying them either as gas fitters, electricians, measurement and control engineers or a metal-processing trade education may be considered sufficient.

6.1.1. TRAINING ON THE JOB (INTERNAL TRAINING)

When beginning their employment, new employees receive detailed instructions related to the special circumstances that prevail when working with the substance gas. More specifically, the employees are informed about what to refrain from doing on grounds of safety, especially in the areas of surface facilities (e.g. taking along mobile telephones, flammable material, intervention in the system without prior consultation with the technical officer in charge, etc.).

Only when it can safely be assumed that an employee is familiar both with the local conditions and the functional tasks of the system, and is able to take all the necessary safety provisions in practice correctly, can he/she be assigned an unsupervised task.
6.1.2. TRAINING COURSES

The employees' basic training should comprise the following courses, according to their position and work:

- Safety engineering in gas utilities
  The aim of this course is to convey basic knowledge with regard to personal protective equipment, noise, electrical facilities, and operating materials, machine facilities, handling of cranes and elevators, rules related to pressure tanks and explosion protection. Depending on the assigned area, it may also be necessary for employees to become familiar with methods of handling gas pressure regulation stations, gas odorisation, gas compressors, plants, measuring stations and cathodic protection plants.

- First Aid:
  This course aims at teaching employees the First Aid procedure in case of accidents.

- Fire fighting training
  The aim of this course is to teach employees what steps can be taken to prevent fire and the procedure to be followed when extinguishing fires - tailored to meet the individual workplace requirements. It can include a practical fire fighting exercise in this course.

- Hazardous material
  This course aims at teaching employees methods of handling hazardous materials encountered at work, especially as regards their storage and transport. Moreover, the course intends to teach employees about labelling and the obligation to provide information with regard to such materials.

In order to benefit from one's own mistakes and those committed by others, superiors should schedule meetings with employees several times a year with the aim of avoiding such mistakes in future. More specifically, all situations that produce accidents causing personal harm must be carefully analysed and the conclusions drawn therefrom disseminated to the involved people.

It is also recommended to document all courses and training including the persons who attended.

6.2. PURCHASING

6.2.1. POLICY

The purchasing policy is based on the following principles:

- selecting and getting technically and economically appropriate products,
- continuous seeking of greater economic efficiency,
- compliance with internal procedures and regulations (international standards, national rules...).

In this context, it should be noted that the main components of the transport network (pipes and pipe coating, fittings and accessory equipment such as valves) are generally the object of specific purchasing procedures.
6.2.2. SCHEDULING

The purchasing of equipment or services may call for considerable lead times. This is the case in particular when qualification tests are required for a new equipment (e.g. qualification of a new tube manufacturing line, qualification of a new equipment).

Purchasing is thus, whenever possible, anticipated depending on the purchasing lead times required, so as to meet the principles of the aforementioned purchasing policy.

6.2.3. IMPLEMENTATION AND OPERATION

The main phases in the purchasing procedure are:

1. statement of requirements phase
   ⇒ In general, each purchase is the object of appropriate technical specifications.

2. preliminary selection phase
   ⇒ For some purchasing of equipment or services, qualification of suppliers / services providers (i.e. certification ISO 9001) and / or technical qualification tests may be necessary.

   The suppliers of the main transport network equipment (pipes and pipe coating, fittings and accessory equipment such as valves) generally are the object of a qualification.

   This qualification may involve:
   - technical tests to evaluate equipment performance under service conditions (e.g. pipe fatigue stress, sealing integrity of valves in the presence of methanol),
   - drawing up of a technical file providing an accurate description of equipment and manufacturing methods,
   - a technical evaluation of manufacturing facilities,
   - an evaluation of the quality system,

   Inspections of manufacturing operations and periodic audits may also be carried out and call a qualification into question.

3. purchasing process phase, i.e. :
   - call for proposals,
   - analysis,
   - placing of purchase order,
   - contract performance.

4. lessons learned phase :
   - Problems encountered during purchasing (in particular not meeting deadlines, difficulties in handling non-conformances, if any) may be traced to improve subsequent purchasing.

   According to a specific case, it is possible to use a shorter procedure. However, this shorter procedure should respect the safety policy of the operator.

6.2.4. CONTROL AND CORRECTIVE ACTION – PROCESS REVIEW

Status reviews may be carried out concerning:

   - the qualification of suppliers / service providers and technical qualification tests,
   - the implementation of technical specifications by suppliers / service providers,
These status reviews highlight the various problems encountered and are reflected in adaptations to the purchasing procedure.

6.3. COMMUNICATION

6.3.1. COMMUNICATION PRINCIPLES

The company should adopt procedures in order to ensure that information on relevant safety and environmental matters is transmitted to and from employees and others involved parties.

6.3.2. CONSTRUCTION AND OPERATION

Sensitisation of local authorities, stakeholders, public & industry about the influence on gas pipeline of the:

- vegetables plantation (some trees),
- third works nearby the gas pipeline,
- throwing chemical products nearby the gas pipeline,
- new constructions.

The operator could use prospectus, notices, in house newsletter to transmit the wanted message (giving the nearest phone number where they could call for emergency).

6.3.3. MAINTENANCE

A top manager appoints a team and assigns functional responsibilities for each member. Information has to be managed each time that the operation teams monitor and do the “routine” maintenance of the structures.

The reports of the company are transmitted to the designated team (Incidents and activities reports, Potential surveys of structures, ...).

6.3.4. EMERGENCY

Information and procedures dealing with the hazards prevention and covering emergencies are communicated throughout the company.

A liaison can be established with appropriate public authorities (fire and police officials).

6.3.5. CHECK AND MANAGEMENT REVIEW

Assessment on the information system efficiency should be established and analysed. It can be considered necessary in adapting a new way of communicating.
6.4. SAFETY AND ENVIRONMENT

6.4.1. PRINCIPLES

As said in §3, natural gas transport operator may implement a safety / environmental management system, following an external frame of reference. Such reference systems have a very wide scope and go beyond PIMS’ requirements. However, the specific safety / environmental activities described below maybe implemented in the PIMS.

6.4.2. GATHERING AND ANALYSIS OF INCIDENTS

Each relevant accidental damage to the transport network (pipelines and stations) during construction, operating or maintenance phases is the object of an analysis to identify its causes and define the corrective measures to be implemented. An accident report should systematically be drawn up.

An accident status review may be carried out periodically to highlight recurrent problems and take any necessary preventive measure. The Operator may establish procedures to define the responsibility and the authority for:

- handling and investigating accidents,
- taking actions to mitigate consequences,
- carrying out corrective and preventive actions.

It should be noted that a close co-operation between a group of major gas transmission system operators in Western Europe has been running for several years, to gather data on relevant incidents. This co-operation is formalised by the setting up of EGIG (European Gas pipeline Incident data Group), which updates a pipeline incident data base. The data collected are of direct relevance to pipeline design, operating and maintenance practices in Europe. In the light of this broad experience and degree of participation, the database can be used to monitor the safety record of gas transmission systems.

6.4.3. SAFETY ANALYSIS

A safety analysis can be carried out during the design of new pipelines to examine and set out the potential hazards that can affect them.

This analysis defines and justifies the safety measures taken to reduce the probability of occurrence of accidents and their effects. In particular, it stipulates the safety measures taken during the pipeline building and operating phase.

It can also indicate the principles to be used in drawing up the emergency plan.

6.4.4. ENVIRONMENTAL ANALYSIS

The purpose of the impact analysis is to determine the optimum conditions for inserting the projected pipeline into its environment.

In particular, it can include:

- an analysis of the initial condition of the site and its environment,
- an analysis of the project’s direct, indirect, temporary or permanent effects on the environment,
- environmental measures taken to eliminate, reduce or compensate such impacts.

6.4.5. TOP MANAGEMENT REVIEWS

Analysis of accidents (leakages, damages to the pipe, corrosions, …) are carried out periodically.

These analysis conclusions are taken into account during the reviews of other processes (in particular the Equipment, Operation - Maintenance, Training and Purchasing processes).

6.5. QUALITY

6.5.1 PRINCIPLES

Natural gas transport operator may implement a quality management system, following an external frame of reference. Such reference systems have a very wide scope and go beyond PIMS’ requirements. However, the specific activities of a quality process described below, should be considered as minimum requirements.

6.5.2 DOCUMENTATION

Documents drawn up in the PIMS context must be controlled. Before being circulated, such documents are reviewed and approved by authorised persons. They are readable, easily identifiable and accessible. Any non valid or obsolete document is withdrawn or appropriately identified as such.

Records are established and kept to provide evidence of conformity with PIMS requirements and to provide efficient operation of PIMS. They must remain readable, easy to identify and accessible.

6.5.3 CONTROL OVER MONITORING AND MEASUREMENT FACILITIES

The monitoring and measurement facilities needed to ensure the safety and protection of environment are:

- calibrated or checked at specified intervals or before being used, against measurement reference standards tied to international or national reference standards (when such reference standards are not available, the reference used for calibration must form the subject of a record),
- adjusted or readjusted whenever necessary,
- identified to determine the calibration validity,
- protected against any adjustments which may invalidate the measurement result,
- protected against any damage or deterioration during their handling, maintenance and storage.

6.5.4. EFFECTIVENESS CHECK

The control held over documentation and monitoring and measurement facilities is periodically evaluated by the company, in order to ensure that it is properly run. This check provides information to define the necessary preventive and corrective measures to improve the checked activities.
The conclusions of these effectiveness evaluation are also taken into account within the other processes reviews (in particular the Equipment, Operation – Maintenance, Training and Purchasing processes).

6.6. STANDARDS, TECHNOLOGY AND REGULATION WATCH

6.6.1. STANDARD

As the Gas Pipeline industry develops and undergoes changes, more and more new issues that are technical in nature have to be dealt with. Fortunately most of these issues have been addressed by the relevant international standards institution.

The standards used for the pipeline construction and operation are to be based upon the internationally accepted standards. Other local standards may also be used depending upon the operating philosophy developed by a pipeline company.

Substandard material and workmanship have been observed from time to time during inspection and need immediate rectification.

Stringent quality control system using competent inspection personnel and reliable destructive and non-destructive testing techniques should be utilised to adequately prove the strength and suitability of piping material and joints.

6.6.2. TECHNOLOGY

The company should undertake actions in order to maintain high technical knowledge and to introduce them when necessary to the technical development.

Some areas concerning the development of technology are:

a) Communication  
b) Cathodic Protection  
c) Pipeline survey  
d) Gas measurement  
e) Pipe coating  
f) Intelligent pigging  
g) Construction methodology  
h) Geographical Information System (GIS)

Sharing of experiences with other pipeline operators, pipeline journal reports and pipeline conferences are very useful to ensure pipeline operator are up-to date with technology.

6.6.3 REGULATION WATCH

Going by the current development in other part of the world and changes in relevant internal codes of practices, pertinent issues such as possibility of upgrading of pipelines would have to be addressed.

Based upon experience in most countries, the most significant factor contributing to the failure of gas pipeline is damages due to third party. An exchange of information from Pipeline Associations and keeping abreast with updated codes and practices is very important. Participation in Pipeline conferences will provide an avenue to voice out the pipeline operator concern.