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COMMITTEE ON SUSTAINABLE ENERGY

Working Party on Gas
Ad Hoc Group of Experts on the Supply and Use of Gas

DIAGNOSTICS OF GAS TRANSMISSION LINES

(Consolidated report prepared by the delegation of Slovenia)*

Objectives of the report

1. Existing pipelines were designed and built according to extremely different codes and practices which were determined by various geological and constructional conditions, materials used and construction procedures. Gas of different quality is transported through pipelines which are operated under different conditions and are getting older and older.

2. Due to security, economic, legal etc. aspects, transport companies all over the world constantly monitor the condition of their pipelines and establish their integrity on the basis of collected data. An assessment can be made how long the pipelines are likely to be left in operation without the occurrence of some major defects. In many countries this process is called DIAGNOSTICS.

*/ In accordance with the decision of the first session of the Ad Hoc Group of Experts, held in January 2000 (ENERGY/WP.3/GE.5/2000/2, para 5(b)).

3. All the above was the reason that the (former) Meeting of Experts on the Transport and Storage of Gas approved the proposal of Slovenia to study the issue of diagnostics of gas transmission pipelines and in September 1998 the Meeting approved a questionnaire for data collection among ECE member States.

Introduction to the report

4. This consolidated report is based on the replies to the questionnaire prepared by the Government of Slovenia (ENERGY/WP.3/GE.3/1998/3) received from 15 countries: Belgium, Czech Republic, Germany, Denmark, France, Hungary, Croatia, Netherlands, Portugal, Poland, Romania, Russian Federation, Slovenia, Slovakia and Turkey.

5. In order to enable an easy review and comparison the replies were set up in tabulated form in which the names of the countries were abbreviated as follows:

B	Belgium	**P**	Portugal
CZ	Czech Republic	**PL**	Poland
D	Germany	**RO**	Romania
DK	Denmark	**RUS**	Russian Federation
F	France	**SLO**	Slovenia
H	Hungary	**SK**	Slovakia
HR	Croatia	**TR**	Turkey
NL	Netherlands		

Initial conclusions:

6. Denmark and Turkey replied on the basis of a draft version of the questionnaire (ENERGY/WP.3/GE.3/R.18/Add.1), so their replies were rearranged to suit the items in the latest version (where possible). The previous version did not contain questions Nos. 22 and 23 and questions Nos 8, 9 and 12 are shorter in scope.

7. All replies were included in their original form (as well as the abbreviations). When analysing the data of submitted answers, they were arranged into the following thematic groups with the addition of the numbers of questions and answers they include (in brackets):

- Regulations (Nos. 1 and 2)
- Organisation of diagnostics (Nos. 3, 4, 5, 6, 7 and 15)
- Methods and characteristic data (Nos. 8 and 9)
- Assessing the obtained data and frequency of this work (Nos. 10 and 11)
- Characteristic data (Nos. 12 and 13)
- Frequency of inspection and methods(Nos. 14, 16 and 17)
- Evaluation criteria and measures undertaken (Nos. 18, 19, 20, 21, 22 and 23)

8. Comments (in italics) on the answers either follow the answers directly or are given for the entire group of answers.

General conclusions:

9. Pipeline systems in these countries have been built and maintained under different conditions. According to specific circumstances each country has created its own approach to assure safe pipeline operation and secure transport of natural gas. Diagnostics is a new organized approach to monitoring of maintenance work and pipeline integrity.

10. The replies to the questionnaire are relatively heterogeneous which makes it rather difficult to establish a commonly valid commentary for the whole questionnaire. From the tables it can be seen that some countries did not respond to all the questions - this is indicated by a dash (-). Wherever possible the percentage of positive replies is given in a separate column.

Remarks submitted to the Rapporteur after issuance of the draft consolidated report

11. The draft questionnaire was issued two years ago and in the process of coordination there were no objections to it. After issuing the draft consolidated report, three responding countries submitted comments on the questionnaire. Those from Croatia contained only supplements to their original answers and were included under the appropriate questions. The remarks of Turkey confirmed their answers to the questionnaire and no modifications were made to the report except for a supplement to their answer to question 2.

12. A more substantial contribution from the Russian Federation regretted that some of the leading European countries in this field did not respond to the questionnaire. Furthermore it concluded that the current survey did not give answers to the problem as a whole, a description of the latest trends was lacking, and it suggested that preparation of such a study could be a future project of ECE. The Russian Federation commented that the main objective of the questionnaire was to acquire basic information about current procedures in diagnostics, and not to be a detailed study giving answers for the future development of diagnostics and optimal methods. We have to realize that diagnostics is a broader issue in the process of assuring pipeline integrity and that on-line inspection is only one of the phases in this process. Optimization of these phases is only the consequence of pipeline construction, the significance of the pipelines, their length, age and quality of maintenance, to enable maximum pipeline integrity at minimal cost.

13. Nevertheless, some general guidelines concerning the future development of on-line inspection are presented below:

- development of inspection devices for multi-diameter pipelines in one run since inner pipeline diameter is often changed for economic or other reasons (e.g. installation of reduced bore valves);
- development of controlled bypass on inspection devices that enables achievement of appropriate inspection vehicle velocity while the flow in the pipeline remains unaffected, causing no revenue loss;
- introduction of Transverse Field Inspection (TFI) tools for detection of narrow axial defects which are very difficult to detect with the existing Magnetic Flux Leakage (MFL) method in the vicinity of seam welds. This is particularly important in gas pipelines, as so far it is possible to detect stress corrosion cracking only by means of ultrasound inspection tools

which require a liquid medium enabling proper contact between tool sensors and pipe wall, while TFI and MFL methods have no such requirement;

- addition to the inspection vehicle of an inertial mapping unit for geographical location of girth welds (by means of Geographical Position System). This methods makes it much easier to locate the detected defects in remote areas and in addition even enables survey of the pipeline by means of satellite, etc.

I. REGULATIONS

Question No 1: Do you have any corporate (A) or State (B) recommendations or regulations (C) which help establish the gas pipeline condition?

Reply:

	B	CZ	D	DK	F	H	HR	NL	P	PL	RO	RUS	SLO	SK	TR	% Yes
A - corporate	-	Yes	Yes	-	Yes	-	Yes	1/	-	-	Yes	Yes	Yes	Yes	No	53
B - State	-	Yes	Yes	Yes	-	Yes	Yes	1/	-	-	Yes	-	Yes	-	No	47
C - regulations	Yes	Yes	Yes	Yes	-	Yes	-	1/	Yes	-	-	Yes	-	-	No	47

1/ In the Netherlands the legislative requirements about pipelines are scattered throughout several laws. In practice the Dutch Pipeline Standard NEN 3650 is used as if it were legislation. At present initiatives are taken to harmonise pipeline legislation, in view of general legislation for all transport modes (water, road, rail and pipeline) and a possible European Pipeline Directive.

Question No 2: If your answer under question 1 is affirmative, please give more detailed replies on title, level, publisher and date of appropriate regulation or recommendation.

Reply:

B Regulations on Transportation by Pipelines (Basic Law) - Kingdom of Belgium - Ministry of Economic Affairs , 12 April 1965

CZ -

D DVGW – Guidelines

DK Regulations for transmission and distribution systems (based on ASME) are given by the Directorate of National Labour Inspection

F GDF internal guide book (Technical and operational guidelines)

H Gombsz. V. Technical Regulation by Hungarian Mining Authority; 1981

HR General Maintenance Plan – by INA, The Mining Law (Government 1951); Law on safety in transportation of crude oil and gas through pipelines 1973

NL NEN 3650 – Requirements for steel transportation systems; NEN 3651 – Supplementary requirements for steel pipelines crossing major public works (dykes, high level canals, waterways, roads); NEN 1059 – Requirements for pressure reduction and measuring

stations for natural gas with inlet pressure < 100 bar; NEN 1091 – Requirements for steel gas transmission pipelines with design pressure > 1 bar and ≤ 16 bar and many others

P A complete list (whole page) of all regulations was given. Because it exceeds the scope of this questionnaire it is not possible to include it.

PL -

RO Gas transport through metallic pipelines - Technical prescriptions for the design, maintenance and exploitation of the anticorrosive protection system (cathodic protection, intensive potential measurements, etc) - Company standard (draft standard). State regulation is: N.D. 900/3783/1983 Maintenance and Major Overhaul of the Gas Transmission Pipelines

RUS Basic industrial document, Basic organization of diagnostics of pipelines

SLO The question is only related to the State regulations

SK Regulations for operation and maintenance – internal acts of GM

TR European standards

The replies to questions 1 and 2 show that regulations are present in all countries except two. In some countries State regulations are followed, in some countries gas companies follow their own rules. Countries' respective transport companies where the process of diagnostics ha been in use for a long time have incorporated their experiences as additional or internal regulations.

II. ORGANIZATION OF DIAGNOSTICS

Question No 3: Are gas pipeline conditions checked regularly?

Reply:

	B	CZ	D	DK	F	H	HR	NL	P	PL	RO	RUS	SLO	SK	TR	% Yes
Regularly	Yes	Yes	Yes	Yes	Yes [1/]	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	93

[1/] The frequency of controls depends on technology used.

Question No 4: What services or departments are responsible for checking pipeline condition?

Reply:

B Department of Construction and HSEQ

CZ Technical and Diagnostic Department

D Operating Department

DK Maintenance Department

F In GDF: Regional operational units + Centre of Operational Expertise and of Services (CEOS) (National Technical Support Centre)

H Department of Diagnostics
HR Ministry of Economy; State Office for Standardization and Metrology
NL The pipeline operator
P Contract between Portuguese State and TRANSGÁS
PL Operation Department
RO IN ROMGAZ: Pipeline Diagnostics and Cathodic Protection Department
RUS VNIIGAZ - ORGENERGOGAZ
SLO Maintenance and Technology Department
SK External and on-line inspection services + department for gas transmission
TR Flow Control (=Operation) Management

The results of inspection of pipeline condition serve as a basis for business, safety, investment and insurance decisions without which secure and long term operation is not possible. This is performed without exception by all involved companies.

Question No 5: Have you organized an expert working group for diagnostics?

Reply:

	B	CZ	D	DK	F	H	HR	NL	P	PL	RO	RUS	SLO	SK	TR	% Yes
	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes	Yes	87

Question No 6: Where are the data collected and where are they analysed (institution)?

Reply:

B Department of Energy and Quality and Security of Ministry of Economic Affairs
CZ Company IS
D By gas companies
DK Collected in the field and in the SCADA System and stored in the main computer for analysis
F See question 4
H MOL: Department of Diagnostics
HR INA: Technology Dept.
NL In-house or together with contractors
P TRANSGÁS sends the data collected to DGE (Directorate General of Energy) which is responsible for its analysis.
PL Operation Department
RO ROMGAZ: Pipeline Diagnostics and Cathodic Protection Department
RUS VNIIGAZ - ORGENERGOGAZ
SLO Maintenance and Technology Department; not in a special department
SK Slovak gas industry
TR Operation Group (Gas Control Centre)

The data are collected mainly by operating departments and analysed by relevant professional institutions. All the countries are aware of monitoring the pipeline conditions, but the approach is different.

Question No 7: Who in your company has access to the data referring to the operating gas pipeline and its maintenance as well as to the data requested by competent inspectorate authorities?

Reply:

B OPS and HSEQ
CZ Technical, Operational, Diagnostics Department
D Operating Department
DK The Operation Centre and Maintenance Department + everybody in the company
F GDF: CEOS
H Staff of the Department of Diagnostics
HR Director and persons authorized by him
NL Staff groups (Operational Department and Research Department) and the in-house User inspectorate have access to the data
P Operational and Commercial Department of TRANSGÁS and DGE
PL Operation Department
RO ROMGAZ: Gas Transmission Pipeline Maintenance Division
RUS -
SLO Management has access.
SK Division director and operational deputy director of regional plants
TR Operation and Maintenance Department

An expert group for diagnostics has been organized in all countries but two. These two countries have not formed a special group but perform this activity within different departments where for the sake of evaluating the data for diagnostics, all present their views on this issue and collaborate in preparing the common diagnostic report on selected pipeline sections.

The data are at the disposal mainly of those in charge of pipeline operation safety, which indicates the importance and confidential nature of these data. They are accessible to highly specialized departments at national transport companies or at relevant State inspection authorities. Establishing the pipeline condition is an extremely important and responsible task. In no country is such an evaluation made by the transport department of the national transport company itself, but by a specialized department within the transport company. Due to the significance and objectivity of the evaluation of these data, it is no coincidence that in more and more countries this task is performed by a specialized organization.

III. METHODS AND CHARACTERISTIC DATA

Question No 8: Which of the methods mentioned below are used either before or at the start of the pipeline operation?

Reply:

	B	CZ	D	DK	F	H	HR	NL	P	PL	RO	RUS	SLO	SK	TR	% Yes
Hydro pressure test P = ….	Yes 1.4x P_{oper} sometimes 1,25x	Yes 1.1x P_{oper}	Yes 1.5x P_{oper} ; P_{max}= 100% SMYS	Yes [1/] 1.5x P_{oper} ; P_{max}= 50 bar	Yes [2/]	Yes 1.5x P_{oper}	Yes 1.5x P_{max}	Yes 1.25x P_{max} allowable oper. [3/]	Yes [4/] (1.1-1.4)x P_{oper} P_{max}= 84 bar	Yes 1.5x P_{oper}	Yes 1.4x P_{oper}	Yes 1.25x P_{oper}	Yes 1.5x P_{oper}	No	Yes 1.5x P_{oper}	93
Stress test	No [5/]	Yes	Yes/No [6/]	Yes	No	Yes	No	No	No	Yes	Yes	No	No	No	No	33
On-line inspection:				No											Yes	
electromagn	No	Yes	Yes/No [6/]	-	No	No	No	No	Yes	No	No	Yes	No	No	-	20
ultrasonic	No	-	No	-	No	No	No	No	Yes	No	No	Yes	No	No	-	13
Air pressure test	Yes	-	No	-	Yes	-	No	No	Nitro-gen	No	Yes	Yes	Yes	Yes	-	40
Pipeline calibration	Yes	-	No	-	Yes	-	Yes	Yes	Yes	No	No	Yes	Yes	-	-	46
Other	100% U/S	-	No	-	-	-	No	-	Yes	-	-	-	-	-	-	

[1/] only after repair works
[2/] test pressure at hydro pressure test depends on the population density in the vicinity of pipeline:
Low density: P on site = P max oper. / 0.85 (or 0.9)
Middle and high density: P on site = P max oper. / 0.67 (or 0.9)
[3/] followed by a leak test at 1.0 x Pmax allowable operations.
[4/] depends on location class
[5/] in factory
[6/] some companies apply it, some not

Hydro pressure test is applied prior to or at the start of a pipeline operation in all countries but one. The height of the test pressure varies from 1.1 to 1.5 x P operating. Additional tests such as stress test, on-line inspection, etc. are applied to increase the integrity of a pipeline.

Only in one country are neither hydro pressure test nor stress test nor on-line inspection used prior to or at the start of a pipeline operation.

It seems that some countries use on-line inspection instead of stress test. Experience has established two basic philosophies:

- *to expose the pipeline to overstress at the very beginning in order to detect all hidden defects and faults;*

- *to register the initial condition of the pipeline and during maintenance to annotate the changes respecting its suitability for further safe operation. The assessment of the influence of gas flow on the pipeline is reliable if initial conditions are known. This is the reason why, in addition to the known standard test procedures, other methods, such as stress test, on-line magnetic or ultrasonic inspection, are increasingly winning recognition.*

Question No 9: Which of the data stated below help to assess the condition and reliability of the gas pipeline?

Reply:

	B	CZ	D	DK	F	H	HR	NL	P	PL	RO	RUS	SLO	SK	TR	% Yes
Type of corrosion protection	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	100
Results of cathodic protection measurements	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	100
Coating condition	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	100
Pipe wall thickness	Yes	No	Yes	Yes/ No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	86
State of the protection in view of external circumstances	Yes	-	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	86
No. of interventions after third party interventions	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	86
Gas pipeline exposure to traffic or mining vibrations	Yes	Yes	Yes	Yes	Yes	No	No	Yes [1/]	Yes	Yes	No	Yes	Yes [1/]	Yes	Yes	80
Pipe exposure to earth slides	No	Yes	Yes	-	Yes	No	Yes	Yes [2/]	Yes	Yes	Yes	Yes	Yes	Yes	-	73
Findings of former online inspection	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No [3/]	Yes	Yes	93
Results of localised non destructive test of pipeline material	Yes	Yes	Yes	-	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes [4/]	Yes	-	80
Results of pipeline material degradation test	Yes	Yes	No	-	Yes	No	Yes	Yes [5/]	Yes	Yes	No	Yes	No	Yes	-	60
Pipeline life	Yes	Yes	Yes	-	-	-	Yes	Yes	[6/]	Yes	Yes	Yes	Yes	Yes	-	66
Pipeline material	Yes	Yes	Yes	-	[7/]	-	Yes	Yes	[8/]	Yes	Yes	Yes	Yes	Yes	-	66
Type of coating	No	Yes	Yes	-	[9/]	-	Yes	Yes	[10/]	Yes	Yes	Yes	Yes	Yes	-	66
Other	[11/]	-	-	-	-	-	No	-	-	-	-	-	-	-	-	

[1/] rare events
[2/] rare, Netherlands is mainly "flat"
[3/] only the first inspection has been made
[4/] systematic monitoring of ground movements which might lead to pipe stress
[5/] stress corrosion
[6/] more than 35 years
[7/] manganese carbon steel
[8/] API 5L X 70
[9/] polyethylene, hydro carbon tar
[10/] PE 3 layer
[11/] location and proximity of other constructions

Most countries use all listed types of corrosion protection tests to evaluate pipeline condition. Some answers indicate that in some countries high quality materials are used, though the aim of the questionnaire was to indicate which facts help to assess the condition of a pipeline and not to indicate the quality.

IV. ASSESSING THE OBTAINED DATA AND FREQUENCY OF THIS WORK

Question No 10: Who is engaged in assessing data obtained on the above question?

Reply:

B HSEQ and Operations
CZ Operating, Technical and Diagnostics Department
D Operating Department, Experts
DK The Maintenance Department and Operation Department
F GDF: C.E.O.S. and operators at site
H Staff of the Department of Diagnostics
HR Gas Transportation and Storage Division
NL Regarding integrity/safety the companies engage the User Inspectorate Assessment. For pipeline Management the Operational Department evaluates. In practice a number of assessments/evaluations are carried out jointly.
P TRANSGÁS (Operational, maintenance and security departments)
PL Company operational staff and/or outside experts
RO ROMGAZ: Gas Transmission Pipeline Maintenance Division
RUS VNIIGAZ - ORGENERGOGAZ
SLO Technical Department
SK Department for gas transmission
TR Maintenance Department

In cases where gas transportation companies themselves consider the condition of the pipeline, specialized institutions are engaged and also the experience of other gas transportation companies which have accomplished similar activities is taken into consideration.

Question No 11: In what time periods is the above data collected?

Reply:

B when needed and/or continuously
CZ depends on kind of data
D the extent and timing of data collection depend on the type of data as well as on the company philosophy
DK when needed
F depends on technology and method used
H when needed and every 5 years
HR yearly and when needed
NL data on cathodic protection measurements twice a year; other when needed.
P half-yearly and yearly
PL corrosion protection system – monthly and quarterly; other when needed.
RO when needed
RUS quarterly and when needed
SLO half-yearly and when needed and depending on the regulation
SK when needed
TR monthly

The question was formulated very generally so replies were also rather general. The above data in the questionnaire refer to all the data listed in question No. 9.

The data are collected mainly in the technical departments of the companies. The intervals vary from monthly to yearly or when needed and depending on the regulation.

Prevailing answers "when needed" confirm the conclusion stated before that the approach to diagnostics is extremely different. Nevertheless it can be concluded that the condition of pipelines is under control. A systematic approach to data collection is noticeable and required. More and more State regulations determine the control intervals.

V. CHARACTERISTIC DATA

Question No 12: Indicate or add which methods of gas pipeline inspection are used during its operation or after major repair works.

Reply:

	B	**CZ**	**D**	**DK**	**F**	**H**	**HR** [1/]	**NL**	**P**	**PL**	**RO**	**RUS**	**SLO**	**SK**	**TR**	**% Yes**
Pressure test	Yes	No	No	Yes	No	Yes	Yes	-	No	Yes	Yes	Yes	No	Yes	Yes	68
Pearson method or other	Yes	Yes	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	80

	B	**CZ**	**D**	**DK**	**F**	**H**	**HR** [1/]	**NL**	**P**	**PL**	**RO**	**RUS**	**SLO**	**SK**	**TR**	**% Yes**
Cathodic potential measurement (funnel effect)	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	86
On-line inspection	No	Yes	Yes	Yes	Yes	Yes	Yes	-	Yes	Yes	No	No	Yes	Yes	Yes	73
Stress test	No	No	No	Yes	No	Yes	No	-	No	Yes	Yes	No	No	Yes	No	33
Cathodic protection performance	Yes	Yes	Yes	Yes	Yes	Yes	No	-	Yes	Yes	Yes	Yes	Yes	Yes	Yes	86
Measurements of external pressures on the pipe (land sliding)	No	No	No	No	No	No	No	-	No	No	No	Yes	Yes	No	Yes	20
Pipeline life	No	Yes	Yes	-	No	No	No	-	No	No	No	Yes	No	No	-	20
Pipeline material	No	Yes	Yes	-	No	No	No	-	No	No	Yes	Yes	No	No	-	26
Type of coating	No	Yes	Yes	-	No	No	Yes	-	No	No	Yes	Yes	Yes	No	-	40
Hydro test	No	No	No	-	No	No	Yes	-	No	No	Yes	-	Yes [2/]	Yes	-	26
Localised non-destructive test	Yes	Yes	Yes	-	No	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Yes	-	66
Pipeline natural degradation test	No	No	No	-	No	No	Yes	-	No	No	No	Yes	No	Yes	-	20
Other	-	-	Int. pigging	-	Int. pigging	-	-	Int. pigging [3/]	-	-	-	-	-	-	-	

[1/] Croatia does not have a parallel line. If there is a possibility of alternative source of gas supply, then the test can be done, otherwise the line has to be shut down during the test and the gas supply must be cut

[2/] for new parts of the pipeline

[3/] selective one line / 5 years

Contrary to answer No. 8 it is surprising that in the countries where hydro pressure test or stress test are not applied at the start of the pipeline operation, such tests are performed during the operation or after major repair works.

Applying hydro pressure tests during operation leads to the conclusion that there are at least two parallel lines that enable one line to be shut down for a couple of days to perform a hydro test (to fill water, test, empty the line, dry the line etc.).

Nearly all countries apply the Pearson method, cathodic potential measurement and cathodic protection performance during the operation of a pipeline. The majority of countries apply on-line inspection. The pipeline natural degradation test is rarely used. Non-destructive tests are widely used. On-line inspection has been introduced for practically all important pipelines as a procedure assuring maximum quality.

Question No 13: On what data is the priority of line inspections determined?

Reply:

	B	CZ	D	DK	F	H	HR	NL	P	PL	RO	RUS	SLO	SK	TR
Data from construction period	Yes	-	Yes	No	Yes	-	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Pipeline diameter	Yes	Yes	No	No	Yes	-	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Pipeline flow (Qmin)	-	-	No	No	No		No	No	No	No	Yes	Yes	No	No	No
Flow changes	-	Yes	No	No	No	-	No	No	Yes	No	Yes	Yes	No	Yes	No
Working pressure changes	-	Yes	Yes [1/] No	No	Yes	-	No	Yes	Yes	Yes	Yes	Yes	No	Yes	No
Findings of former on-line inspection	Yes	Yes	Yes	No	Yes	-	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Disadvantages of a location (e.g. slides)	-	-	Yes	No	Yes	-	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Effect of quality of the medium (gas)	-	-	Yes	No	No	-	Yes	No	Yes	No	Yes	Yes	No	No	No
Cathodic protection data	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Coating quality	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Risk of failure consequences (risk of life, damage to property, loss of service, cost of failure, environmental effects, public image)	-	Yes	No	-	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	-
Significance of the pipeline	Yes	Yes	No	Yes	Yes	-	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of consumers	-	Yes	No	No	Yes	-	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes
Number of interventions to the gas pipeline done by third parties	-	Yes	Yes	No	Yes	-	Yes	-	Yes	Yes	Yes	Yes	Yes	No	No
Other	-	-	-	-	-	-	No	Material, Cover	Yes	-	-	-	No	Yes	-

[1/] in special cases

When determining the priority of line inspection nearly all countries lay great emphasis on the data from the construction period, pipeline diameter, working pressure changes, findings of former on-line inspection, disadvantages of a location, cathodic protection data, coating quality, risk of failure consequences, significance of the pipeline, number of interventions to the gas pipeline done by third parties. The priority is largely influenced by the pipeline grid and thus assuring uninterrupted gas delivery (priority of gas supply)

VI. FREQUENCY OF INSPECTION AND METHODS

Question No 14: How often do line inspections take place (if different criteria exist for different pipelines, please indicate them)?

Reply:

B patrolling 1 x / week
CZ depends on number of defects, kind of coating
D when needed; no fixed intervals for intelligent pigging
DK once a year + current supervision via SCADA; extended inspection only after major repair works
F see question 3.
H -
HR when needed
NL on-line inspection for large diameter main transmission pipelines every 5 years ± 200 km. On-line inspection for regional pipelines (some non piggable) is at the development stage.
P see question 11.
PL when needed; there are no rules
RO when needed
RUS -
SLO on-line inspections approx. 10 years, all other methods half yearly or when needed
SK approx. every 5 years
TR every 3 months

The aim of the question was to obtain answers on the frequency of the on-line inspection, patrolling, route survey etc. separately. The replies of some countries are common for both on-line inspection intervals as well as for other kinds of inspection, so it is not possible to establish a rule of the frequency of on-line inspections (mainly when needed).

Question No 15: Do you use GIS or mapping system for the data processing in relation to question 13?

Reply:

B No
CZ Yes
D In development
DK Yes. All pipes are registered in the GIS system
F No
H Yes
HR No
NL Yes
P No

PL No
RO Mapping system
RUS To be put into operation in 1999
SLO Yes
SK Yes
TR No

It is noticeable that the use of GIS has become essential in monitoring and repairing the pipeline system. Surveyability also enables a systematic approach to preventive and curative maintenance. Already a small scale pipeline system cannot be managed well without GIS, due to the loss of surveyability. For larger pipeline systems GIS is even more important.

Question No 16: What methods are used during pipeline inspection? Please indicate percentage.

Reply:

	B	CZ	D	DK	F	H	HR [1/]	NL	P	PL	RO	RUS	SLO	SK	TR
Ultra-sound	100%			100%	-	10%	70%	[2/]				30%			100%
Magnetic		100%	100%	100%	[3/]	90%	5%	100%	100%	100%		70%	100%	100%	
Other				100% X-ray [4/]	[3/]		25%	[2/]			100% above ground survey				

[1/] all types of pipeline survey are meant, not only those concerning pipeline construction
[2/] refers to new works only: ultrasound 50 % (mainly mechanized US), X-ray 50 %
[3/] magnet flow leak detection or calibration pigs
[4/] if repair work (welding) has taken place

The aim of the question was to obtain the ratio between the magnetic flux leakage and ultrasonic method of on-line inspection or any other. From some answers it can be concluded that they indicate the methods for non-destructive weld testing and not the on-line inspection methods. The result is also influenced by the fact that ultrasonic devices for smaller pipe diameters are not yet commercially available. Liquid contact between the sensors and pipe wall is required.

Question No 17: For the "fitness for purpose assessment", do you process defects data yourselves or are they assessed either by an expert organization or by a pipeline inspection contractor?

Reply:

	B	CZ	D	DK	F	H	HR	NL	P	PL	RO	RUS	SLO	SK	TR
The company (yourselves)	100%	100%		100%	100% (with con-tractor's support)	10%	80%	In house Accredited User Inspecto-rate			100%	80%		100%	100%
On-line inspection contractor	100%		100%			90%	20%			100%		15%	100%		
Other expert organization									100% (ISQ)			5%			

In the majority of countries the defect data for fitness for purpose assessment are processed in the companies themselves, while in other countries on-line inspection contractors are engaged. Only in one country is this performed by both the on-line inspection contractor and by the company itself, which leads to the conclusion that the company supervises the contractor's work. The decision is connected with internal organization and the professional qualification of companies that are in charge of pipeline operation. Specialization of the on-line inspection contractor provides to a thorough professional approach and really impartial evaluation of the features a well as proposals for rehabilitation, which is even more important.

VII. EVALUATION CRITERIA AND MEASURES UNDERTAKEN

Question No 18: What criteria are used for assessing acceptability of corrosion defect pipelines?

Reply:

	B	CZ	D	DK	F	H	HR	NL	P	PL	RO	RUS	SLO	SK	TR	% Yes
ASME B31.G	Yes	Yes	Yes	-	No	Yes	Yes	-	Yes	Yes	No	Yes	Yes	Yes	Yes	73
Other	-	1/	2/	3/	GdF internal refer-ences	-	MAOP	4/	-	-	DIN 30676, DIN 50925, AFK 10	GAZ PROM internal criteria	-	-	-	

1/ method RSTRENG, company's calculations – finite element method + results from company's best tests
2/ method TüV Rheinland (RSTRENG), method Velnker (finite elements)
3/ no corrosion accepted
4/ method RSTRENG

Only in one country is no corrosion accepted. All other countries follow some internationally accepted rules (either ASME code or DIN standards) for assessing the acceptability of corroded pipelines. Some of them apply even more methods to assess the acceptability of corrosion defect pipelines. In some countries the companies follow their internal acceptability rules.

Question No 19: What types of defects (metal loss) are not repaired (% of Estimated Repair Factor = ERF)?

Reply:

B ERF < 1
CZ very different for different kind of defects (EXT, INT, MFG), coating…
D abt < 0.98 ERF – no statistics available
DK -
F metal losses are systematically repaired after detection
H below ERF < 1 are not repaired
HR -
NL roughly 25% are fit for purpose and are not repaired. Another 25% are repaired by grinding.
P each operating company establishes the repair procedures observing the technical rules and regulations
PL -
RO -
RUS if it is less than mentioned in question 21, unless the defects are very rough
SLO ERF < 0.95 for corrosion defects
SK less than 40 % wall thickness
TR defects < 5 % wall thickness

Four countries did not reply to this question. The answers show that as a rule defects with ERF < 1.0 (or 0.95) are not repaired. Others state % of wall thickness as a limit for a defect that does not need to be repaired (i.e. < 40 % WT, < 5 % WT). The answer is closely linked to the on-line inspection intervals. Shorter intervals allow to follow the progress of the feature responsible for the defect more effectively and thus to postpone its repair until it is really urgent. The results of previous inspections contribute significantly to the relevant decision. The decision is comprehensible and advisable as the results are unanimously clear to those who receive them as well as to those preparing instructions for further activities.

Question No 20: What types of defects are repaired immediately (replies are not obligatory)?

Reply:

	B	CZ	D	DK	F	H	HR	NL	P	PL	RO	RUS	SLO	SK	TR
Metal loss	Yes	-	80% Wt or ERF>1.2	-	25% Wt [1/]	70% Wt or ERF>1	-	[2/]	[3/]	-	-	-	ERF>1	-	>5% Wt
Cracks	Yes	Yes	[4/]	Yes	Yes	Yes	-	[2/]	[3/]	Yes	-	-	[5/]	-	Yes
Fractures	Yes	-	[4/]	Yes	Yes	Yes	-	[2/]	[3/]	Yes	Yes	-	[5/]	-	Yes
Other defor-mations	-	Dents+ other defects (combi nation)	[4/]	Deform ation>1 0% Wt	Cavity with scrat-ches	-	-	[2/]	-	-	-	-	Com-bined defects (corro-sion & dents)	-	-

[1/] after buffing
[2/] the question cannot be answered in a simple way. There are fracture mechanics-based in-house rules to fit this purpose, repair and replacement. Types of defects covered are gauges, dents, gauged dents, general corrosion, pitting corrosion and welds.
[3/] all defects according to ASME B 31.G
[4/] no statistics available
[5/] no such defects occurred

In such cases the use of international nomenclature for defect classification is advisable and highly important, particularly with regard to defect evaluation as well as to the priority of its repair.

Question No 21: What types of defects are repaired within 1 to 3 years after their disclosure (replies are not obligatory)?

Reply:

	B	CZ	D	DK	F	H	HR	NL	P	PL	RO	RUS	SLO	SK	TR
Metal loss	-	Very different	[1/]	[2/]	-	50% Wt	-	[3/]	[4/]	-	-	≥20%Wt	ERF>0.95	-	[6/]
Cracks	-	All	[1/]	[2/]	-	Imme-diately	-	[3/]	[4/]	-	-	≥150 mm length	[5/]	-	[6/]
Fracture	-	-	[1/]	[2/]	-	-	-	[3/]	[4/]	-	-	-	[5/]	-	[6/]

[1/] detailed investigation in case of ERF = 0.98. Expert opinion decisive for actions taken.
[2/] all defects
[3/] after occurrence/discovery, dependant on severity pressure reduction and direct repair
[4/] according to TRANSGÁS procedures all defects are repaired
[5/] no such defects occurred
[6/] all types of defects are repaired within 1 year

The answers show that the criteria for repairing the defects within 1 to 3 years are very different. It is in fact unusual since a pipe in need of repair has ultimately to be repaired. Different approaches can be justified by continuous transport, reduced maximum allowable operating parameters in the pipeline, etc. Some countries state the ERF (i.e. > 0.98 or > 0.95) or % WT (i.e. > 20 % or > 50 %), some have other criteria.

Question No 22: What kind of inspection do you apply for non-piggable pipelines?

Reply:

B Pearson, MFO, CP measurements
CZ CP measurements, Pearson (but there are only a few km of non-piggable pipelines)
D depending on data obtained under question 9.
DK -
F Pearson
H wall thickness measurement
HR Pearson method, measurement of wall thickness, CP measurement, pipeline material test
NL see questions 9 and 14
P leak detection by route survey, coating inspection and monitoring of cathodic protection system
PL corrosion and corrosion protection survey
RO above ground survey
RUS CP measurement, electrical measurement of coating
SLO Pearson, intensive measurements, measurements of cathodic protection, route survey
SK intensive measurement CIPS + DC VG, Pearson
TR -

The most relevant inspection method at pipelines that do not enable on-ine inspection (non-piggable lines) is the cathodic protection measurement and in case of anomalies the use of the Pearson method.

Question No 23: What kind of repair technology is used for various kinds of leaking and non leaking defects?

Reply:

	B	CZ	D	DK	F	H	HR	NL
Non leaking defects	Replacement or shell	Sleeves (epoxy, Clock spring)	Replacement of section; clamps (type British Gas or other)	-	Buffing/ replacement	Changing of the pipe in the section	Mechanical clamps, hot tapping	Grinding, welded sleeve and clock spring
Leaking defects	Replacement or shell	Cut out	Replacement of section	-	Sleeves	Changing of the pipe in the section	Mechanical clamps, cut out	In development, cut out

	P	PL	RO	RUS	SLO	SK	TR
Non leaking defects	Repair clamps & sleeves or replacement of pipe section	Weld deposition, dressing	Mechanical clamps, hot tapping + plugging	Bandaging	Recoating, welded split shells, epoxy sleeves, improvement of CP	Grinding, Epoxy filled sleeves, Clock spring. cut out	-
Leaking defects	ASME B 31.G	Clamps, shells, glass fibre epoxy wraps	Mechanical clamps, hot tapping + plugging	Bandaging	Temporary split sleeves, replacement of pipe section	Cut out, Repair split sleeves	-

The criteria for deciding to repair the defects within one and within three years are very different. They are based on the experience and quantity of such events since repairs are always costly.

Answers to questions 19, 20, 21, 22 and 23 show that the majority of the countries are aware of the importance of cathodic protection. In spite of the fact that the answers show a different approach to ensuring pipeline integrity, it can be seen that the countries are aware of the threat to environment posed by a bad pipeline. According to the state of the art technology, all companies take similar measures for repairing the pipeline. It is mandatory that a pipeline is repaired if possible without interruption of transport, without direct welding on the pipe, and presuming that the repair is final (and not temporary).

Remarks on the answers to questions that seem to have been misunderstood

No. 8 Slovakia seems to have made a mistake (not applying hydro test) in comparison to their answer to question No 12.

No. 9 France seems to have misunderstood the aim of the question which was to indicate the factors that help to assess the condition and reliability of the pipeline and not to indicate the values. The same refers to Portugal.

No. 12 Slovakia seems to have made a mistake answering either question No.8 or No.12 (they do not apply hydro test before the start of a pipeline operation but do so later, after major repair works, during operation). The same is valid for stress test. We guess that countries that have indicated the application of stress test (Denmark, Hungary, Poland, Romania, Slovakia) have a parallel line, so they can shut down the line for a couple of days to perform the test. The same is valid for hydro test (Croatia, Romania, Slovakia).

No. 14 This question aimed to obtain answers about the frequency of on-line inspection (and of other types of inspection) to be able to establish a rule of on-line inspection intervals. The answers are very common both for on-line inspection intervals as well as for other types of inspection.

No. 16 The aim of the question was to give the ratio between ultrasound or magnetic flux leakage system (or other) used at on-line inspections. The answers of Belgium, Denmark, Croatia and Turkey seem to indicate the methods for non-destructive weld inspection during pipeline construction.

No. 19 Estimated Repair Factor is a very applicable indicator for assessing the pipeline conditions and is used by on-line inspection contractors. From the answers we can conclude that it has not yet been widely adopted. This might be the reason for the lack of answers to this question.