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WORKING PARTY ON GAS

Meeting of Experts on the Transport and Storage of Gas
Twenty-eighth session, 19 September 1997

MAINTENANCE MEASURES AND REGULATIONS IN THE OPERATION AND MANAGEMENT OF GAS TRANSMISSION SYSTEMS

(Final consolidated report, transmitted by the Government of the Czech Republic) *

The questionnaire was replied to by the following ten countries:

- Croatia
- Czech Republic
- Germany
- Hungary
- Italy
- Netherlands
- Poland
- Russian Federation
- Slovenia
- Turkey.

* In accordance with the decision of the Meeting of Experts on the Transport and Storage of Gas at its twenty-seventh session, held in September 1996 (ENERGY/WP.3/GE.3/12, para. 5(c))

Generally it can be stated that the information contained in the replies was not consistent in quality. If, for example, frequency of maintenance actions was asked, some of the replies only stated "YES". It was thus relatively difficult to analyse the information.

Nevertheless, it should be said that the answers received - even when the sample was relatively small and not representative - can be usefully generalized, as these represent answers both from countries with a very old gas industry and from countries with a relatively recent gas history.

An analysis of the replies has shown that there are plenty of areas of gas transmission pipeline maintenance where the conceptions are relatively homogeneous in the countries that completed the questionnaire. On the other hand there are several areas where the meanings are absolutely different. Such items are marked by an asterisk.

The synthesis of entries received and analysed is presented in the same structure as the questionnaire.

1. Regular Maintenance of Pipelines

1.1 The philosophy of maintenance (1.1.1 to 1.1.3)

Generally in the majority of countries there is no system of maintenance and checking of pipelines in order to determine the age of pipeline. Only in Germany is there a system of Pipeline Integrity Management, covering the age of pipeline as one of the integral factors of pipeline reliability evaluation. In the Czech Republic greater attention is paid to old pipelines but it is not a complex programme. In Croatia pressure tests are performed on older pipelines, as well as measurement of wall thickness and coating checking.

There is no exact relation between the lifetime of the pipeline from the technical and economical (remission) point of view.

In all countries there exists a legislative system for operation, maintenance and checking of high-pressure gas pipelines which level varies between the law and the order of ministry (State department). Some countries are planning to use European Standards.

1.2 Pipelines maintenance

1.2.1 Survey of the right of way (r.o.w.)

.1 walking

The interval varies from every week, 2x a month to 1x a year. Russia reports from once a day to once a year. No interval is significantly preferred.

.2 driving

The interval from 1x a month to 4x a year, usually only in risk areas, Italy and Croatia 1x a week. Russia reports frequency from once a day to once a month.

.3 using of helicopters
Usually 1x or 2x a month, generally only on important lines. In Italy 1x a week on the principal transmission pipelines.
.4 clearing of the r.o.w. and accesses to the plants
Only when needed, an interval 1x in 2 years would seem to be enough.
.5 detection of leakages (which instruments are used)
Preferably the flame ionized detector (FID) based instruments are used, the checking is performed usually during a walking survey. In Russia laser detectors fitted on helicopters are also used. In Italy, in particular cases only.

Generally it should be stated that a walking survey is regarded as a detailed but not the most important means of condition evaluation. Checking of the pipeline neighbourhood (mainly due to digging activities) is generally made by helicopter, above all on main pipelines. The r.o.w. clearing, used in the past every year, has changed to a more flexible system, usually once every two years.

1.2.2 Survey of land-slides areas, and how it is performed
.1 geodetical measurements
The Czech Republic reports interval 2x a year, Slovenia and Croatia as needed; generally there is an effort not to lay the pipelines on unstable areas, e.g. in Germany and Poland the pipelines are constructed on unstable areas only in the case of undermined areas. In Italy measuring is performed by inclinometers.
.2 measurements on pipeline in unstable area and methods used for such measurements
Generally geodetical measurements are used or continuous measurement of stresses in pipeline by stable mounted strain-gauges. In Russia heat sensors are used. Croatia performs pressure tests by water or inert.
.3 regular system of stabilization of land slide area
Hungary stabilizes unstable areas by plastic net and grass, Croatia by grass only. In Italy, regular systems are drainage of water and retaining structures. Drainage of water is carried out by small ditches and by underground draining trenches. Retaining structures usually used are concrete block walls and gabion walls. Similar methods of stabilization are used in Russia.

Generally it is preferred not to lay the pipelines on unstable areas. If construction on such areas is necessary, the pipeline is usually checked, in most cases by geodetic methods. Stabilization of soil is not generally used.

1.2.3 Survey of inundated areas
Only Germany performs regular checking (3x a year). Croatia and Russia when needed.

1.2.4 Checking and maintenance of river and/or road crossings

.1 bridges

(*) The interval has a wide variability from 1x a week to 1x a year. Maintenance is performed on the basis of the results of checking.

.2 underwater crossing

The interval varies from 1x a year to 1x in 5 years. In Italy from every 6 months to every 5 years the depth of the river bottom is checked.

.3 casings

The interval varies from 1x a year to 1x in 5 years, typical is 1x a year.

1.2.5 Keeping of records on computers

.1 statistics

Typical is yes. In Italy and Poland PCs are not performed for registration and statistics of maintenance.

.2 working orders

Typical is yes, mainly often used types of orders. In Poland generally without using computers.

1.3 Cathodic protection (CP) and insulation of the pipelines

1.3.1 Measurements of CP potential (method used)

All the countries report measurements using $Cu/CuSO_4$ reference cell, interval varies in normal conditions from 12x a year to 1x a year, in Italy every month. In areas with heavier corrosion conditions (stray currents) 1x a month. In Italy 24 hours CP potential measurements are conducted on a monthly to 4-monthly basis.

1.3.2 Survey of insulation status (method used)

For coating status checking several methods are employed, beginning with simple comparison of CP current in different ages of pipeline and continuing with Pearson survey, close internal measurement or DC gradient measurements, thickness testing etc.

1.3.3 Provision made if error is found on

.1 pipeline and casing in touch

repair in maximum 3 years

.2 influence or interference of another facility

application of electric drainage in the case of influence or interference of railway lines. In the case of another facility interference, first an electric survey is performed to define the gravity then a provision is performed such as coating strengthening or modification of the CP system.

.3 interruption or reduction of CP current

find a fault and repair. In Poland experiments with remote monitoring are in course.

.4 diode breakdown in the draining installations

repair or replacement of unit.

.5 significant insulation damage (what criterion)

repair (only Croatia referred a criterion of significance - more than 100 m^2, the remaining countries made no comment).

System of CP checking is generally based on potential measurement; commonly a criterion of -0.85 V against $Cu/CuSO_4$ is respected. For coating integrity evaluation, several methods are used; typical is Pearson survey. Modern quantitative method is not preferred.

1.4 Maintenance of section and branch-off valves (SBV)

1.4.1 Regular control of SBV operation

.1 local control

Usually 4x a year, Croatia 1x a week, Russia 1x a month, Italy 1x a year

.2 remote control

The interval varies from 1x a month to 1x a year, the most used interval is 1x a year. In Poland it is not presently used.

.3 line damage automatic shut-off system check-up

The interval varies from 1x a month to 1x a year; the most used interval is 1x a year. In Italy such devices are not used.

1.4.2 SBV instrumentation equipment control

Interval from 2x a month to 1x a year; but 1x or 2x a year prevails. In Poland periodically and occasionally if there are indications.

1.4.3 Control of tightness (method used)

1x or 2x a year checking of external tightness (flanges, impulse piping). Tightness of closed valve is checked only in the case of fault of valve. In Italy every 2 months on remote control SBV, 1x a year on local control SBV. Checking of tightness is performed by ultrasonic gas detector.

Generally the maintenance of SBV is carried out at six-monthly or yearly intervals.

1.5 Special winter operations on distribution facilities

1.5.1 Pigging and measurement of dew-point of water in gas (method used, tolerable limit)

The system of no special pre-winter pigging prevails. In Italy dew-point is measured continually at border station. Tolerable limit is 80 ppm. Russia reports daily measurement.

1.5.2 Control of hydrate formation (drying/inhibiting/other method).

Inhibiting of hydrate formation is normally used. Only Croatia reports drying of gas on system input.

1.5.3 Inhibition of hydrate formation

Methanol injection is exclusively used. Italy does not report.

Compared with recent times, special pre-winter preparation is no longer used. If pigging is performed, the main reason is for improving the pipeline hydraulic properties. Eventual hydrate formation is controlled by methanol injection.

1.6 Maintenance of electric installations and grounding

1.6.1 Control of electric installations
(*) Intervals vary in wide scope from 1x a month to 1x in 5 years. An interval of 1x a year prevails

1.6.2 Measurements of the grounding system of the above-ground installations
Interval from 1x a year to 1x in 5 years. 1x a year prevails.

1.6.3 Check-up of the gas ramp in a boiler-room and control of the pump drive
(*) Interval from 1x a month to 1x a year. Italy does not report. Russia reports daily visual check.

The interval of electro-installation checking and maintenance varies very widely. It might also be the result of a different definition of normal operation measurements and special maintenance checking in different countries.

1.7 On-line internal inspection

1.7.1 System
There is undoubtedly a prevailing system of more or less incidental inspections, e.g. ad hoc inspections of pipelines where there are some operational questions or problems. Only Germany, Italy and the Czech Republic report a higher frequency of inspection of older pipeline. Croatia and Poland have not yet used internal inspection. Slovenia has used only internal geometrical inspection.

1.7.2 Frequency
As other reasons for on-line inspection pipeline than the regular interval are used, it is not possible to compare intervals used. Only the Netherlands refers to framed system, where an on-line inspection is done on every 100 km part of pipeline roughly 1x in 5 years. In Italy the frequency is from 1x in 3 years to 1x in 5 years.

1.7.3 Type of on-line vehicle used
In all the countries a magnetic flux leakage method is used.

Until now, internal inspection has been used as a method for checking the situation of pipelines in special cases rather than as a means for regular checking of the pipeline system.

2. Maintenance of technological equipment

2.1 Gas dehydration plant

The gas dehydration plants (in gas transmission systems) are operated only in Germany, Hungary and Croatia. The frequency of technological equipment maintenance was reported only by Croatia.

2.1.1 Measurement of dew-point
2x a year. Russia reports daily by calculation.
2.1.2 Chromatographic analysis
2x a year. Russia reports 1x a day at points of gas transfer for export.
2.1.3 Check-up of glycol regeneration equipment
1x a year
2.1.4 Servicing of glycol pump
1x a year
2.1.5 Control of working parameters of compressors and equipment
1x a year

2.2 Gas preparation and compressor plant

2.2.1 Check-up of valves
(*) Function is checked at frequencies in wide intervals from 1x a month to 1x a year. The Czech Republic reports visual checking 1x a day.
2.2.2 Lubrication of valves
Intervals from 1x a month to 1x a year. 4x a year prevails.
2.2.3 Check-up of regulation valves
(*) Intervals from 1x a day to 1x a year
2.2.4 Check-up of vessels under pressure
Intervals from 1x a year to 1x in 5 years. Longer ones prevail. Poland reports additional obligatory supervision by the State Pressure Vessel Inspection.
2.2.5 Safety valves control
Intervals from 1x a month to 1x in 4 years. 1x a year prevails.
2.2.6 Alarm equipment control
Intervals from 1x a week to 1x a year. 2x a year prevails.
2.2.7 Fire protection system checkup
Intervals from 1x a month to 1x a year. 4x a year prevails.
2.2.8 Anti-pompage protection system of compressor check-up
The most typical interval is 1x a year. In Italy, every 3 months.

Checking and maintenance of valves, regulators and security systems is carried out generally 2x or 4x a year, which can be cited as a proof of high quality of these systems compared with the situation some years ago.

2.3 Cooling system

2.3.1 Visual investigation
The interval 1x a day prevails. In Italy 1x a year.
2.3.2 Working parameters control
The interval 1x an hour prevails (as a part of compressor station control constant measurement algorithm).
2.3.3 Pressure drop measurement
Drop is permanently measured in Germany, the Netherlands and Russia (no interval mentioned). Croatia and Italy report an interval of 1x 2 hours.

2.3.4 Cooling system cleaning
.1 external surface
Generally from 4x to 1x a year
.2 internal surface
Usually only when needed (when a high pressure drop occurs). Croatia reports regularly 1x a year.

2.3.5 General repair (criteria applied)
The majority of countries report general repair only in the case of leakage; nevertheless the Netherlands refers to an interval of 20 years, and Croatia general repairs after 25,000 operational hours of relevant compressor.

The coolers are not held to be a part of compressor station needing extraordinary care. The only exception is permanent checking of output temperature as a part of compressor station control algorithm.

2.4 Compressors units

General part

2.4.1 Philosophy
The majority of countries report systems of maintenance based on producers' recommendation, usually on limits of the operational hours or the cycles start/stop. The Czech Republic reports partial application of on-conditions system, when necessity of control or maintenance is decided mainly on diagnostics results. Poland reports that manufacturers' instructions are modified depending on condition and experience.

Part maintenance and intervals

2.4.2 Lubrication system check-up
(*) Intervals ranging from 12x a day to 1x after 8,000 operational hours are reported. Russia reports that the lubrication system is under continuous automatic monitoring. The extent of works probably varies considerably.

2.4.3 System of check-up and maintenance if time based
(*) Because there are very different types of machines, the data are not comparable; for example, the same operation on Solar machines is recommended after 8,000 hours; on Nuovo Pignone after 32,000 hours. In Italy Jet compressor units check-up is performed every 6 months or 4,000 hours operational time. Maintenance is on condition and on the type of unit.

2.4.4 Regular diagnostic system (type, intervals)
The Czech Republic and Hungary report an interval of 2x a year. Methods used are vibrodiagnostics, tribochemistry and flue gases analysis.

2.4.5 Statistics of disturbances
.1 for servicing coordination - used by Croatia, the Czech Republic, Germany, the Netherlands, Italy and Russia, mainly for spare parts reservation
.2 used for discussion with manufacturers by all the operators.

3. Regular maintenance on measurement and regulation system (MRS)

3.1 Maintenance of MRS

3.1.1 Check-up of MRS and lines adjustment
Intervals from 1x a month to 4x a year

3.1.2 Adjustment of regulation and protection systems
Intervals from 6x a year to 1x a year

3.1.3 Restoration of vital parts of MRS
(*) The Czech Republic and Hungary report restoration based on results of control measurement; Turkey after reaching the operation hours limit. Slovenia at an interval of 1x after 5 years; Croatia 1x a year; Italy and Russia only when necessary.

3.1.4 Measuring equipment control
All the countries referred to follow laws or standards in this area. In Italy there is no State official order

.1 orifice
Intervals from 3x a year to 1x in 2 years

.2 turbine meter
(*) Intervals in wide range from 2x a year to 1x after 8 years. In Italy it is not used. In Russia not actually performed yet.

.3 rotating piston meter
Only the Czech Republic - 1x a year

.4 vibration gas meter
Only Hungary - 2x a year. Poland not used. In Russia not actually performed yet.

.5 ultrasonic gas meter
No intervals referred to. Poland not used. In Russia not actually performed yet.

.6 mechanical corrector
(*) Wide range of intervals - from 2x a year to 1x in 5 years. Poland not used. In Russia not actually performed yet.

.7 electronic corrector
(*) Wide range of intervals - from 1x a month to 1x in 5 years. 2x a year prevails. In Russia not actually performed yet.

.8 control and calibration of pressure, temperature and other instrumentation equipment and transducers
(*) Wide interval range - from 1x a month to 1x in 5 years.

Germany reports for all the types of measuring devices intervals from 1x a week to 1x a year.

Croatia uses for all the types system
- visual checking 1x a week
- function checking 1x a month
- official recalibration 1x in 5 years.

The intervals reported are in a very wide range, clearly indicating the need for a unified standard (for example European Norm), above all for recalibration intervals.

3.2 Control and adjustment of the station telemetry indicators

The interval 2x a year is commonly used. In Russia 1x a year.

3.3 Control and adjustment of MRS of heating system and heat exchangers

The interval 2x a year is commonly used. In Italy 6x a year, in Russia 1x a year. Poland reports that heating systems in bigger reducing stations are supervised by telemetry, smaller ones are inspected periodically with intervals usually of one week.

The operational stability of recent systems had made it possible to enlarge the interval between checking and adjustment of devices to 6 months, which is now commonly used.

3.4 Border station control

3.4.1 Visual check-up of installation
Intervals from 1x a day to 1x a month. Poland reports accordingly to the proper contract clause.

3.4.2 Control and adjustment of measuring equipment
Intervals from 1x a month to 2x a year. Poland reports accordingly to the proper contract clause.

3.4.3 Comparative control of the measured gas quantities
Commonly the balance input/output or input/selled volume are used. In Italy by double measurement and calculation lines. In Poland in newly-built stations orifice and turbine meters are in line.

Checking and recalibration of devices on border metering stations commonly has a higher frequency compared to the other measuring devices. This is due to the large volumes measured.

4. General information on systems used for registration and statistics of maintenance and damages

In general use are the systems of faults and maintenance data stored in both paper and computer form. They are usually stored in chronological order.

4.1 The planning and control of the maintenance system based on special software on PC is widely used.

4.2 Frequency of damages to pipeline system
The majority of countries do not report concrete data. The Czech Republic reports once every 10 years; Hungary 2x a year. Slovenia 5x in 10 years, but the extent of damage to the pipeline system is not reported.

4.3 Sources of damage of high pressure main gas pipelines
.1 damages of cathodic protection, defective CP system
Yes (Croatia, Czech Republic, Slovenia, Russia)
.2 mechanical by "third party"
Yes (except Turkey)
.3 agricultural activities
Yes (Croatia, Germany, Netherlands, Italy, Russia)

.4 natural causes (land-slides, earthquakes, etc.)
Yes (Czech Republic, Turkey, Italy, Russia)
The Czech Republic reports also the microbial-induced corrosion.

4.4 Gradual change of pipeline and MRS gravity control (with ageing)
Croatia performs pressure tests by water or inert gas on old pipelines, wall thickness measurement and coating checking. The Czech Republic and Germany report a higher intensity of on-line inspection on older main pipelines. The Czech Republic performs hydrotesting (stress-test) on selected old pipelines. Germany uses a higher frequency of close interval measurement of cathodic protection potential ("Intensivmessung") on old pipelines. Italy reports that the maintenance system does not depend on the age of pipelines and MRS. Russia reports that a complete inspection is made for old pipelines and the appropriate decisions are taken.

4.5 Elimination of disturbances and damage

4.5.1 Technological programmes for elimination of damages
Yes (all countries)
4.5.2 Design system modification on operation and maintenance knowledge
Yes (all countries)
4.5.3 Safety instruction for the gas pipelines systems
Yes (all countries)
4.5.4 Training of damage repair team
Yes (all countries)
4.5.5 On-duty at home
Mainly yes (all countries except Germany)
4.5.6 Responsibility of chief on duty
This responsibility was not specified by the majority of countries. In the Czech Republic the chief on duty has a responsibility to stop the transmission of gas. In Hungary the chief on duty has a responsibility to decide if and by what means the repair should be done. In Russia responsibilities are defined in the duty instructions.
4.5.7 Information system for people
Yes (all countries). Italy does not report
4.5.8 Cooperation with public organizations in the case of pipeline breakdown (police, firemen etc.)
Yes (all countries). Italy does not report

4.6 Repairs pipelines under pressure (methods used for temporary and for stable repair)

All countries report using different types of repair sleeves, both welded and screwed, made from steel or a combination steel/epoxy; in Russia also with magnets. Only Croatia states them as temporary. Poland does not report.

5. Exchange of experiences

The majority of countries stated an interest in exchanging the experience on regular checking systems of pipeline and MRS, also on risk elimination programmes.

The majority of countries did not show any interest in exchanging the experience on pipeline failures causes and statistics.

No country has reported any general remark.

6. System of European Standardization

Elaboration of European standards is in progress at this time. Standards are created within the framework of Technical Committees CEN (European Committee for Standardization * Comité Européen de Normalisation). EU and EFTA countries are represented in Technical Committees. The Technical Committee No. 234 with its Working Groups (WG) is responsible for elaboration of standards in the field of "Gas Supply".

Besides the CEN, the CENELEC Committees are engaged in elaboration of standards in electrical branches.

Individual standards are in different stages of elaboration (draft EN, preliminary EN, EN). The standards covered "Gas Supply" are namely as follows:

WG 2:	Functional requirements for the Materials, Design, Construction, Operation, Maintenance and Renovation of Gas Supply System up to and including 16 bar,	
	parts 1 - General	N 282 E
	2 - PE systems up to and incl. 10 bar	N 288 E
	3 - Steel up to and incl. 16 bar MOP.	N 289 E
WG 3:	Pipelines for gas transmission	prEN 1594
WG 5:	Functional requirements for gas metering systems for natural gas - Design, materials, construction, reliability, calibration, operation and maintenance	prEN 1776
WG 6:	Gas pressure regulating stations for transmission and distribution	N 290 E
WG 7:	Design criteria and operation recommendations for the gas compressor stations.	Draft 8-0

Normative References

General criteria for operation of various types of bodies performing inspection	EN 45004
Electric installations in potentially explosive gas atmospheres	prEN 50154
Protection against corrosion by stray current from Direct-Current systems	prEN 50162
Railway applications. Protection against corrosion by stray currents	prEN 50122-2
Corrosion protection of metal materials	CEN/TC 262

There are no strictly defined time limits or intervals for checking, inspection and maintenance activities in these standards.
The intervals/frequencies shall be determined by the owners or operators based on their experience, conditions and particular circumstances and bearing in mind the legislative requirements.
Continuous monitoring shall be carried out where appropriate and necessary.
