Implementing Maintenance Programs for ageing pipelines: GRTG's experience

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ABSTRACT

One of the most important care of transmission's gas operator is to operate its gas network system in the very best conditions, i.e. running its system safely and reliably, taking into account the protection of the environment. This aim, is obtained by undertaking a very sever safety rules and codes in the design, construction & testing, operation and Maintenance of the gas transmission network.

The Algerian's company of Gas Transmission network administration ''GRTG'', is operating more than 13 800 km (more than 8 500 miles) gas pipeline network and related facilities, for national's consumption purpose. Among this total gas network's length, 19 % of the pipelines are aged over 30 years old (the oldest ones are greater than 50 years old).

In consideration of this factor, GRTG implement special programs for ageing pipelines which across high population density areas in order to evaluate the actual pipeline condition in operation. These programs planned for short and long term, deal with monitoring, preventive and corrective maintenance and are scheduled monthly, quarterly and yearly.

The present communication shows us the GRTG's experience in implementing programs for ageing pipelines, to mitigate the risk of pipeline failure (leak/rupture) or damage.

These programs consist of:

- In line inspection (inspection by intelligent tool)
- On line Inspection (CIPS-DCVG + cathodic protection history's data).
- Metallurgy, Mechanical and Hydrostatic tests over gas pipeline's test-tube (test-tube taken from the most sever part of a gas pipeline affected by corrosion points).

The chosen gas pipelines which will be discussed by the communication are those obtained from the works done on the following gas pipelines:

- Ø 14'''-16''-20'' Bir el Djir – Ravin Blanc (Oran) :4,85 km – age > 50 years old (un-piggable)
- Ø 16''Gué Port – Alger (Algiers) : 11,3 Km – age > 50 years old(piggable)
- Ø 14'' Ain el Biya-Bir El Djir (Oran) : 29 km – age > 50 years old(piggable)
- Ø 8'' Hadjar Essoud (Annaba) : 2,9 Km – age 38 years old(un-piggable)

The obtained results from different programs are illustrated by photos, tables and texts; time and costs were evaluated. Finally conclusion and recommendations will be given for transmission gas operators, who are interested to inspire with these presented works.

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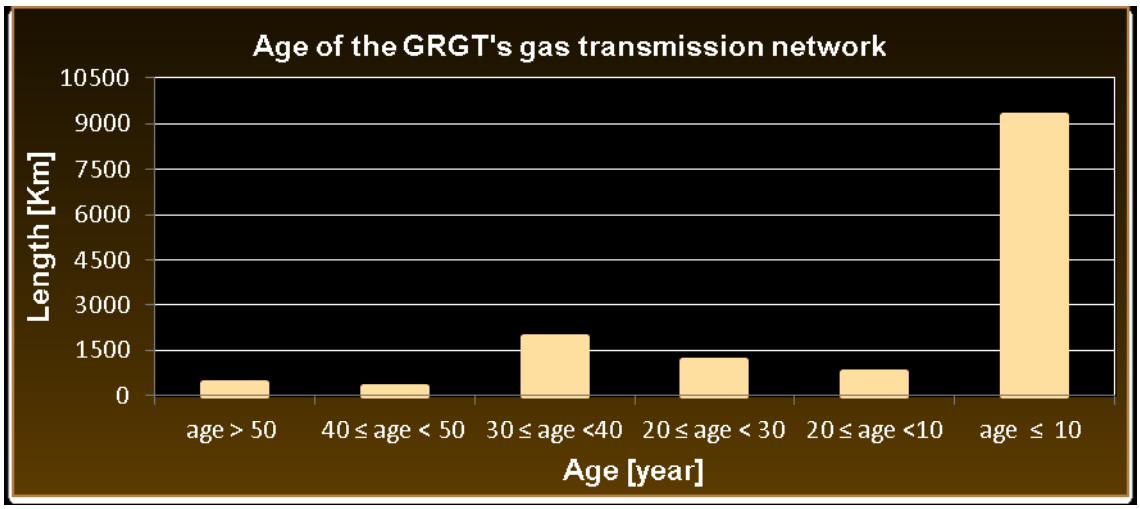
1. INTRODUCTION

As it was said in the abstract, one of the main GRTG's care is to operate its gas transmission network safely. Because a part of the gas pipelines are aged more than 40 years, GRTG gives particular attention to this tranche and started implementing special programs since the end of the 1990's.

In this report, firstly, the GRTG gas network's age will be given, then general actions undertaken and projected over the old gas pipelines, for protecting and evaluating the gas pipeline, in order to operate its gas network system in the very best conditions. Finally examples with results obtained from the fourth gas pipelines above mentioned are given.

2. GRTG'S GAS NETWORK AGE.

The GRTG's gas network is constituted by gas pipelines with diameter varying from 2'' to 28'', and the total length is greater than 8 500 miles. 16 % of the total length is aged more than 30 years as shown by the below histogram (260 miles are aged more than 50 years).



Due to a national interministerial decree, dated of March 3rd 2009, which stipulates, that all the gas pipelines feeding the national market will belong to GRTG's company, so the total length given above will be greater and the gas network's age will know a change (in addition to that a new diameter's range of 42'' will appear in the gas network of the company).

3. COMMITTED ACTIONS TO PRESERVE AGEING GAS PIPELINE'S INTEGRITY.

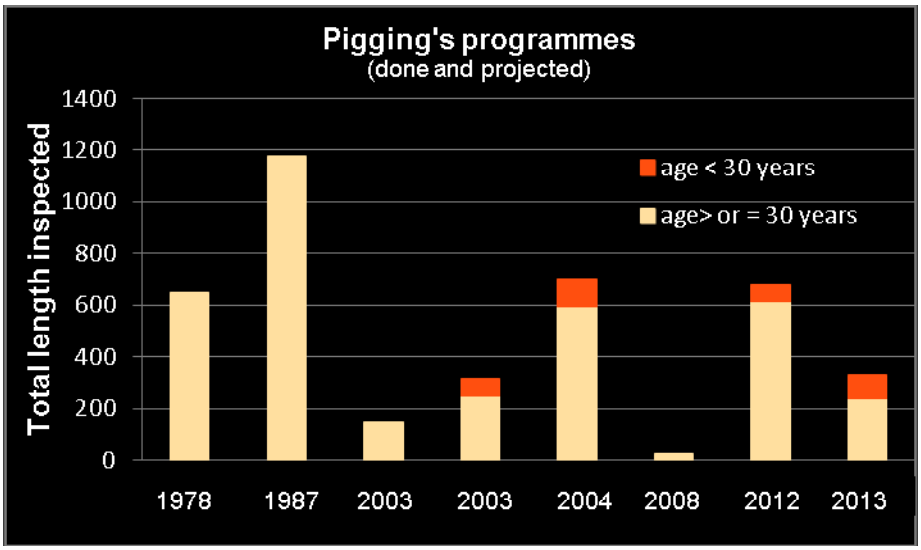
3.1 Preventive programs

As the majority of gas transmission companies, the ageing assessment technologies used by GRTG is undertaken by preventive programs:

- Pigging
- Cathodic Protection Monitoring

3.1.1 Pigging

Pigging is one of the sure mean to evaluate the wall thickness of a pipeline with accuracy. The first ones were undertaken on 1978, and then last ones started on 2008 and will continue till 2013 (the cost of these last programs is estimated to 800 Millions DA : less than 1 million euro). The different pigging programs undertaken by GRTG is shown by the below histogram.



3.1.2 Cathodic Protection Monitoring

The cathodic protection monitoring activity is undertaken in regional structures of the company called district. The pipeline's potential is measured quarterly, the rectifier's current-voltage outputs monthly, and each three-year, ON-OFF potential's surveys are undertaken(around 800 miles per year). The remote control of the CP system is under project.

From 2006, due to the rapid extension of the gas network pipeline's length and ageing of the gas transmission assets, the work load increases which necessitate the development of software system called GPO (*gestion de la protection des ouvrages* : management of the gas transmission asset's protection).

This system aim through its process to take in charge of the CP's data, from the field measurements till the analysis, inspection….., integrating all the maintenance process

undertaken by the company on the gas transmission asset. Thus, at any given moment, the company's personnel could get information about:

- the gas transmission network
- Electrical surveys undertaken for the gas transmission asset (daily, week, monthly, quarter, annual and unexpected ones).
- technical studies realized for the gas transmission asset
- Inspections
- Maintenance works undertaken on the gas transmission asset(by mean of reports, photos and videos)
- Incidents arisen on the gas transmission asset (causes, consequences, means engaged to overcome the situations……).

The last above fourth sections are under programming.

3.1.3 On line inspection

When pipeline's potentials level is below the criterion protection, On line (CIPS-DCVG) inspection is undertaken for investigating the affected area of the pipeline.

If we combine the electrical field survey methods: ON/OFF CIPS-DCVG measures, for which, we add historical CP's data, such as soil resistivity, potential surveys, Off rectifiers time and any other parameters which favor the instability of the steel pipe wall thickness. The analysis of the obtained results leads in preventing the existence of the corrosion points. This alternative is undertaken whatever the gas pipeline characteristics are (piggable and un-piggable pipelines).

The different Online inspection's programs planed by GRTG is shown by the below table

Year	Number of gas pipelines	Total length
2009	07	57,267
2010	07	149,718
2011	07	58,022
2012	06	80,4

The choices of the gas pipelines were done by taking in account the historical CP's data, the age and when they are nearby the habitations (i.e the ones which across high population density areas).

The On line surveys are undertaken by our own company's team (04 people at least)

3.2 Curative programs

Depending on the pipeline conditions (loss of wall thickness or presence of defect coating), the reparation method is done by:

- Reinforcement of the CP's system.
- Coating refurbishment
- Full welded shells
- Cut out
- Pipeline's displacement (partially or totally)

The last decade In line's inspection, permitted to the company to displace progressively 500 Km (~310 miles) [2006-2012] and repairing / eliminating more than 1600 corrosion points.

4. MAINTENANCE WORKS AND OBTAINED RESULTS FOR THE FOURTH CHOSEN GAS PIPELINES

The works and the obtained results for the fourth chosen gas pipelines are as follow:

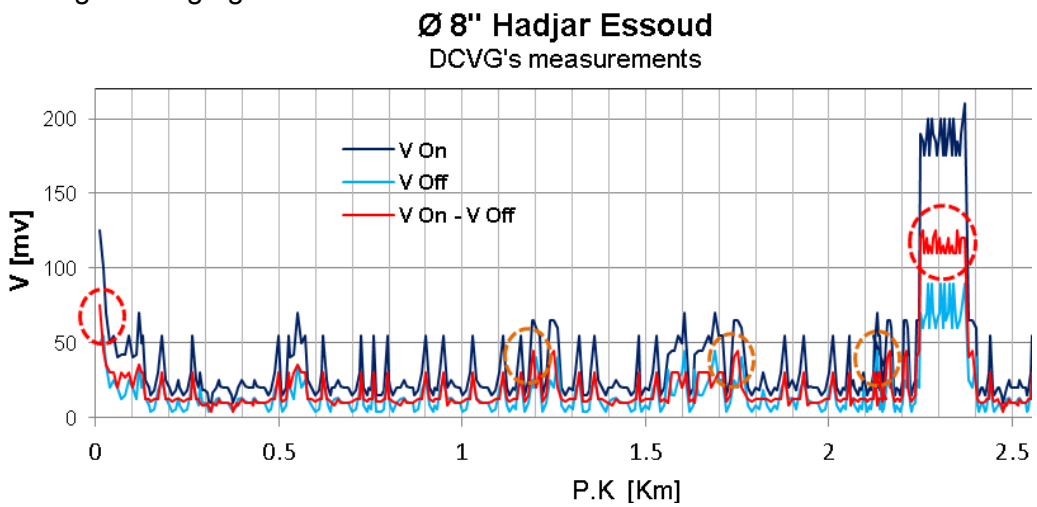
4.1 Ø 8'' Hadjar Essoud (Annaba) : 2,9 Km – age 38 years

The analysis of the historic CP's data of the gas pipeline [1990-2005], let us deciding to inspect the gas pipeline by the DCVG method, in order to delineate the coating defects.

The measurements were done in ON-OFF (by connecting a time contactor to the rectifier), of course, prior to undertake these measurements the pipe's location was done. They were taken each 5 meters (when necessary it's reduced to locate with accuracy the coating defect's epicentre).

Hundreds of data were gathered, to interpret easily the results we plotted (versus the distance covered), the gradient voltage difference VOn – VOff (Δ V) (we didn't make the CIPS surveys so we cannot use the IR % (100xΔ V/Δ P)).

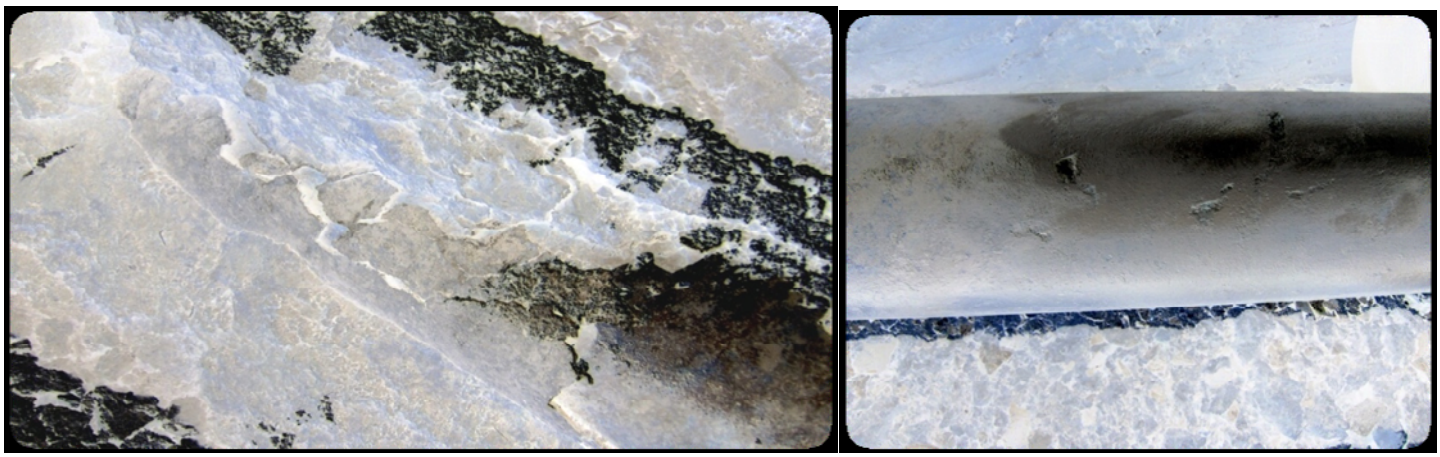
It's useful to remind that, when a direct current is applied to a pipeline, a voltage gradient is established on the ground, due to the passage of the current through the soil to the bare steel exposed at the defect. Generally, the larger defect is, the greater the current flow and hence larger voltage gradient.



P.K. : Kilometer Point.

When we analyzed the above plot, we decided to undertake two excavations between PK 0,010 to PK 0,030 (20 meters) and PK 2,250 to PK 2,370 (120 meters).

The first excavation permitted us to delineate three coating defects and notice that the pipe's wall surface is good.



The excavations done between PK 2,250 to PK 2,370 (120 meters), permitted us to notice large coating defects and the presence of 11 corrosion's points, in a 5 m of one section of the pipe.

Taking into account the obtained results from these two excavations and the presence of many houses near the gas pipeline, the company judged useful to replace the entire pipeline in order to avoid any hazardous situation.

4.2 Ø 14'''-16''-20'' Bir el Djir – Ravin Blanc (Oran) :4,85 km – age > 50 years old

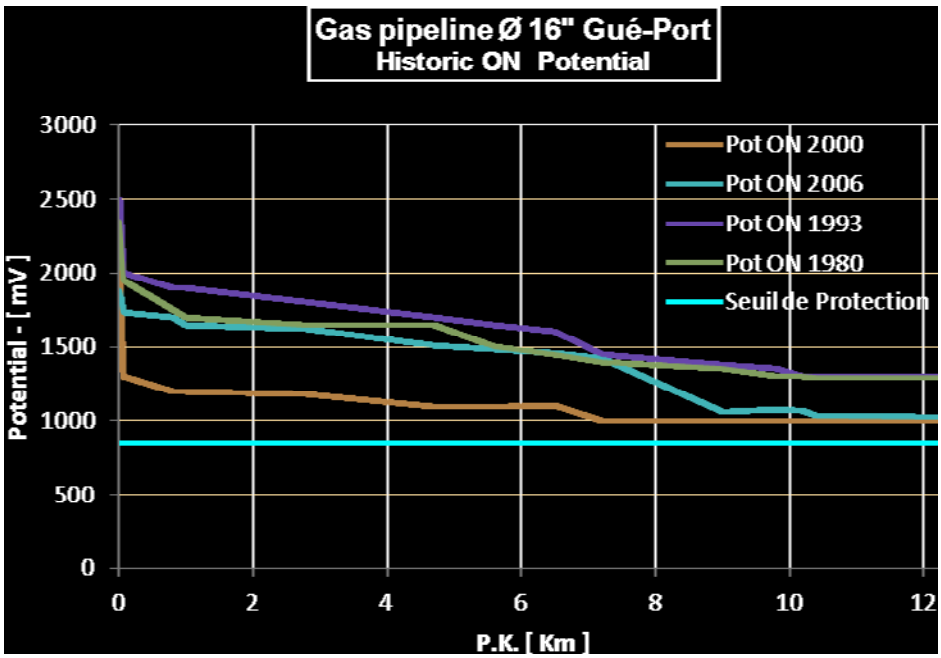
For this gas pipeline the historic CP's data is good. but because of the ageing and the fact it crosses high population density areas, the company decided to undertake On line's inspection. The analysis of the obtained data, gave us small chances to delineate the coating defects (no abnormal measurements).

The chosen excavations (boring 1 to 6) were then done by taking into account the high population density area, the lower soil resistivity and the obtained On line's measurements.

It was noticed that for the whole excavations done, the coating adhesion and the pipe's wall surfaces are good.

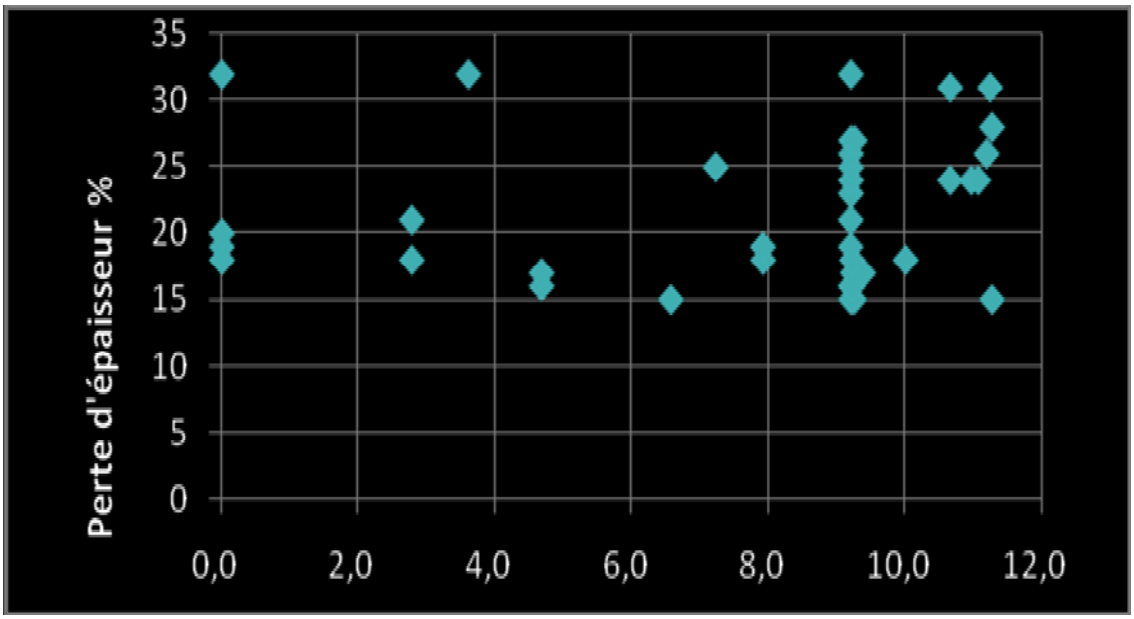
4.3 Ø 16''Gué Port – Alger (Algiers) : 11,3 Km – age > 50 years old

This pipeline ensured for many years the Algiers and its bordering cities, natural gas demand. By analyzing the historic CP's data, the gas pipeline was always protected (see the blow diagram), but because it crosses high population density areas, and the fact it's ranked among the ageing pipelines, the company decided to undertake In line's inspection.



As it's shown by the above diagram, the PC's level for the 80's – 90's and 2000's years, was always above the threshold of protection (so for the 60's and 70's).

The In line's inspection undertaken on 2003 revealed few pipe wall's thickness loss numbers, as it's shown by the below chart:



The effectiveness of the CP's system and the rigorous monitoring undertaken by the CP's operators permitted the company to maintain the integrity of the pipeline (the presence corrosion's points could be assumed negligible).

4.4 Ø 14'' Ain el Biya-Bir El Djir (Oran) : 29 km – age > 50 years old(piggable)

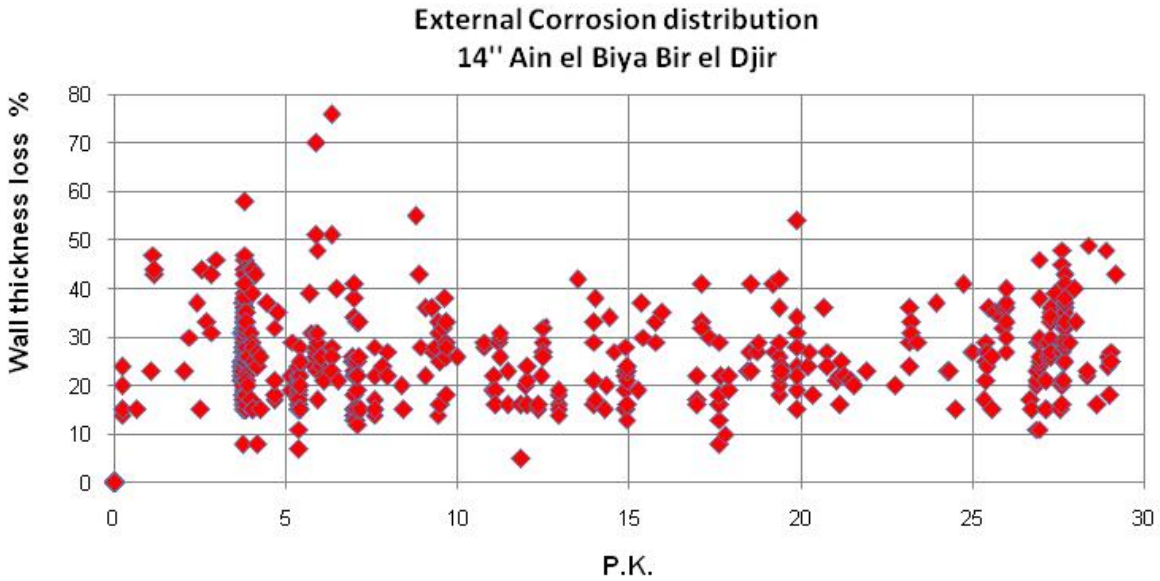
As the gas pipeline mentioned in section 4.3, the 14'' Ain el Biya-Bir El Djir was strategic in feeding natural gas to the Oran's region (two power plants). Contrary to what one might think, historic CP's data knew many times problems during the last 50 years, mainly due to the power cut (the CP's system was ensuring by one rectifier). It's also important to indicate that for some gas pipeline route's areas, the soil is marshy.

The In line's inspection undertaken on 2009 revealed the presence of 498 external corrosion's point, in which 34 are considered according to the ASME B 31 G, as dangerous points.

Another thing which surprised the company is the diminishing of the wall's pipe thickens from the internal surface. The results show that we've 1382 cases along the entire length of the pipe, among them 57 are considered dangerous.

The obtained results permitted to the company to establish rapid curative programs to eliminate the dangerous parts of the pipeline.

The In line's inspection results are shown by the below chart for the external corrosion points.



To get an idea about the size of the external corrosion and the cases where we've a diminishing of the wall's pipe thickens from the internal surface; we ranked them by % wall loss thicknes:

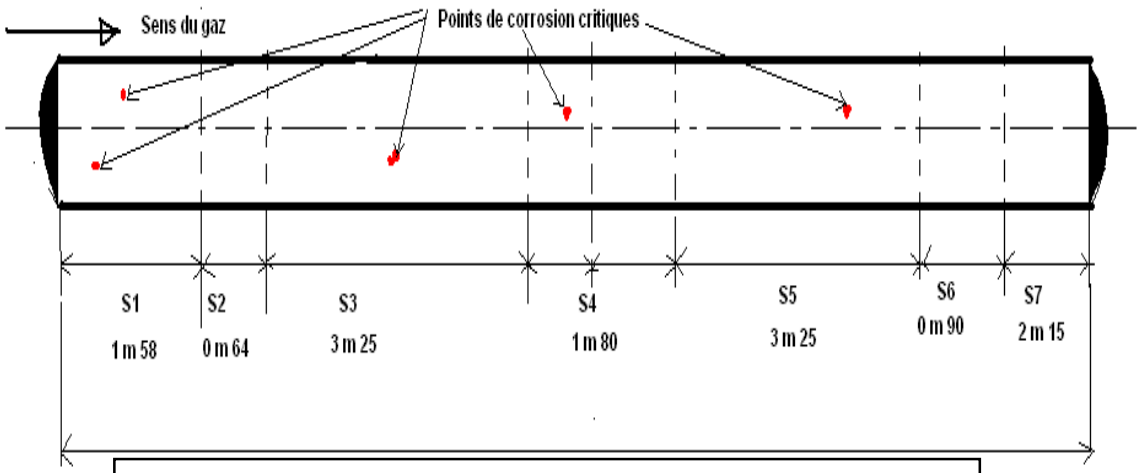
Pipe's wall loss thickens	% ≤10	10 < % < 20	20 ≤ % < 30	30 ≤ % < 50	≥ 50 %
Internal parts [number]	132	383	488	369	10
External corrosion[number]	6	107	219	159	7

This situation let the company, undertaking mechanical and hydrostatic tests.

⇨ Hydrostatic tests

A test-tube has been constituted by most sever part of the tubes removed from the pipeline after the cut out operations, as shown by the below photos :

The total length of the 7.9 mm wall thickness of the test-tube is 13,57 meters, and the total number of the external corrosion's point is 25 among them 05 are considered dangerous.



Corrosion distribution over the constituted test-tube: 13 m 57

The 05 dangerous corrosion's points are listed in the first lines of the below table :

N°	External Corrosion's size		RPR
	Length [mm]	depth [mm]	
1	48	47%	0.99
2	48	44%	0.99
3	63	36%	0.99
4	135	44%	0.87
5	120	38%	0.92
6	30	58 %	1.02

RPR is calculated according to the ASME B 31 G.

Testing procedure is taken form IGE/TD/1 (English procedure) to assess the tube's material of the 14'' gas pipeline.

The results are synthesized in the below table:

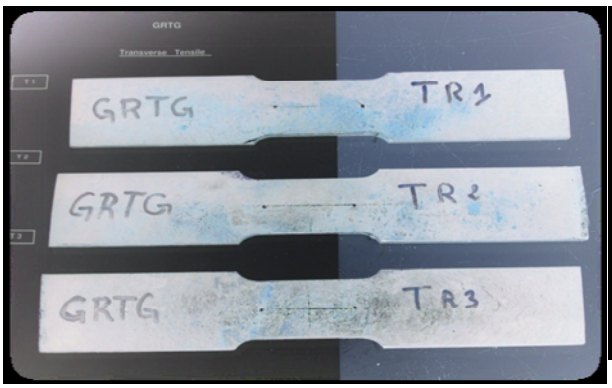
These results comfort little bit the company since the gas pipeline's pressure operation is lower to the value of 40 bars.

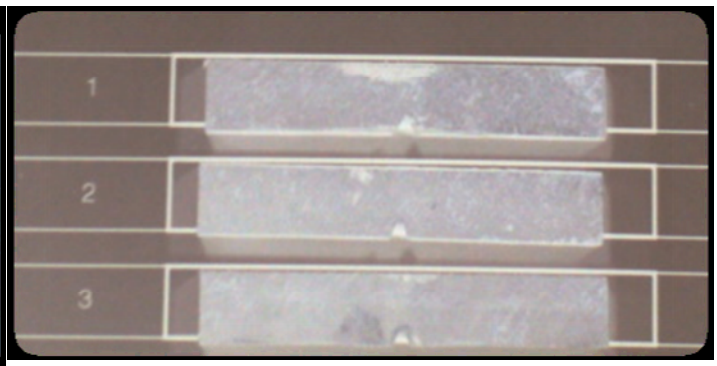
Time	**11H05**	**16H15mn**	**After 24 hours**
Test-tube thickness	7.9 mm	7.9 mm	7.9 mm
Circumference of the test-tube	1117 mm	1121 mm	1121 mm
Ambient temperature :	21.7°C	21.7°C	-
Pressure	-	120 bar	120 bar
Visual observations		No distortion	No distortion

⇨ Mechanical tests

The tests were undertaken at the GTP's laboratory, the sample given has the following characteristics

Length	[mm]	7800
Wall thickness	[mm]	7.1
RPR		0,92773304





Rupture :resistance to the tension. The absorbed energy to the shock of a material.

The analysis of the obtained results by the laboratory (for the tension and elasticity limits), permitted to conclude that the tested sample has the same mechanical's characteristics as the tube of X 42 (according to the API 5L).

5 – CONCLUSION.

All the gas operators have the same maintenance programs, and all aim to preserve the integrity of their gas pipelines, in order to operate them in the very best conditions, i.e. running their systems safely and reliably, taking into account the protection of the people and the environment.

By analyzing the results obtained from the above fourth gas pipelines, the age of a gas pipeline is not a decisive key to undertake the necessity for programming extra works. As an example the Ø 8'' Hadjar Essoud (Annaba) is aged 38 years has been replaced, in other hand the other are aged more than 50 years are still operating(another case not discussed in this report with diameter of 20'' and has less than 20 years has been totally replaced) .

When using a very sever safety rules and codes in the design, construction and testing, followed by preventive maintenance progr ams (rigorous monitoring CP's system), the pipelines will get a long life.

The In line inspection is the very best way for the gas operator to know with accuracy the real condition of the pipe wall thickness and hence ensure a safe operation of its gas pipeline, but due to the time to undertake it and the cost of the operation, without taking into account the time parameter from the call of tender to the data acquisition, the On line inspections are good, providing, to get first of all, a large ''BANK'' of PC data, and an experiment technicians.

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