



25th world gas conference
"Gas: Sustaining Future Global Growth"

SCC: A problem in the industry

And one way to manage it

By: Daniel FALABELLA, Integrity Chief

Date: Thursday, 7th June 2012

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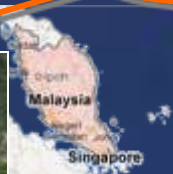
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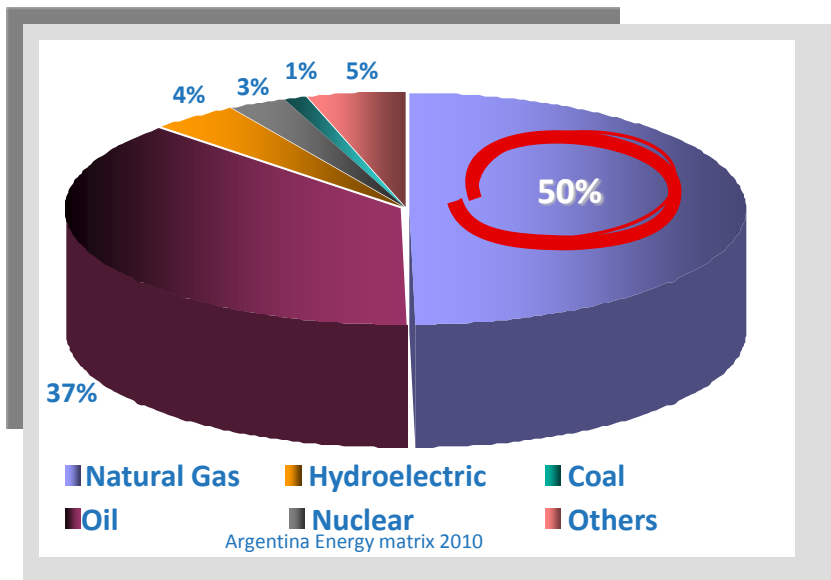
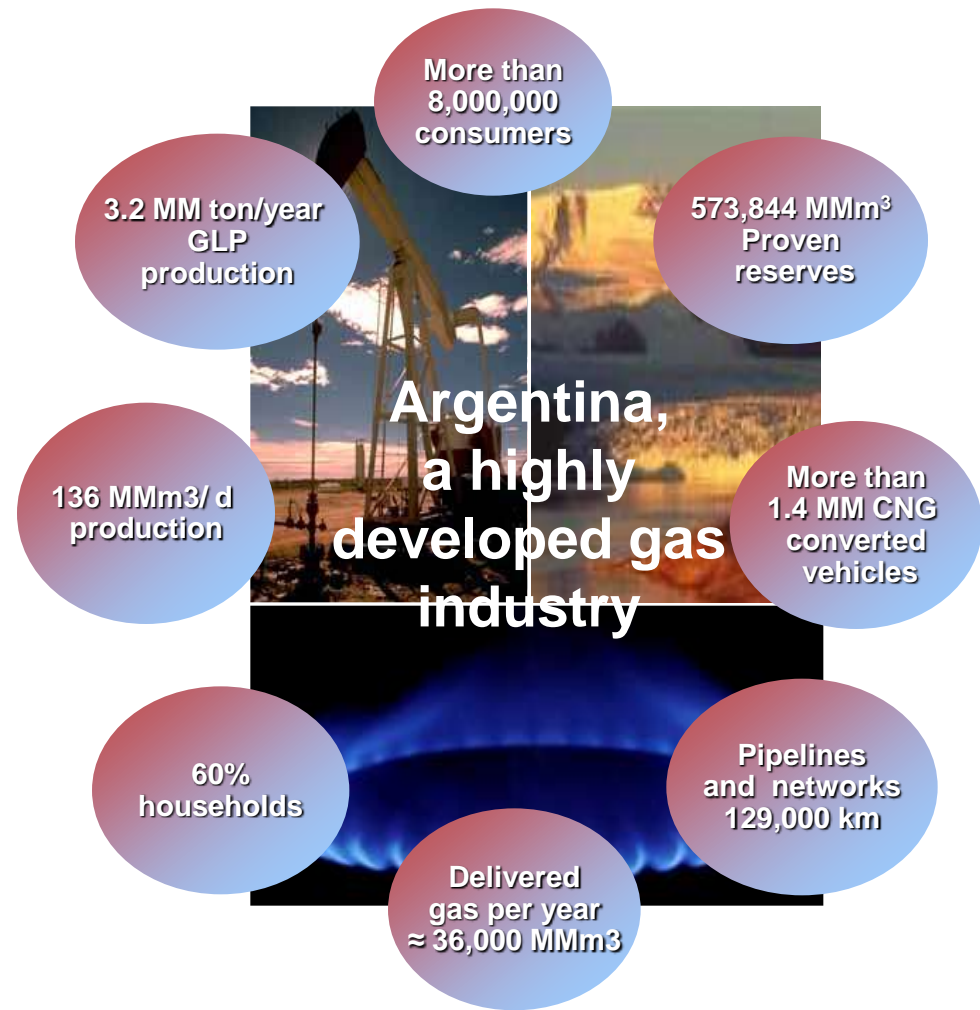


Malaysia & Argentina



Argentina Natural Gas in Figures

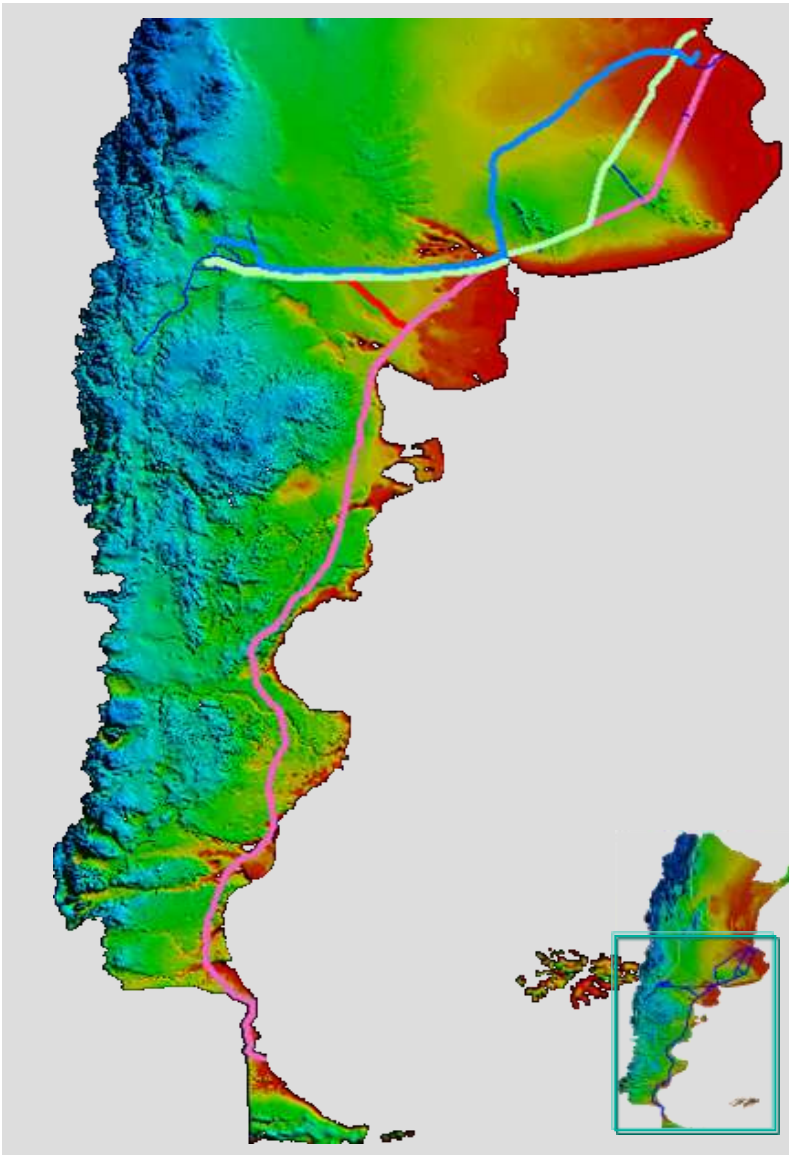
Natural Gas is over 50% in the energy matrix

Argentina, a highly developed gas industry

- More than 8,000,000 consumers
- 573,844 MMm³ Proven reserves
- 3.2 MM ton/year GLP production
- 136 MMm³/d production
- More than 1.4 MM CNG converted vehicles
- 60% households
- Pipelines and networks 129,000 km
- Delivered gas per year ≈ 36,000 MMm³

Characteristics of TGS system



- Largest Gas Transportation Company in Argentina
- Second LPG producer
- Approximately 60% of Gas Transportation
- 32 Compressor Plants
- Installed capacity: 800,000 HP
- 9,200 km of Gas Pipelines
- Average age of Transportation System: 30 years
- Coating type:
 - Asphalt: 5,640 km
 - Tape: 1,230 km
 - Three Layer Coating: 2,330 km

Integrity Threat Classification by three time – related defect types (according to ASME B31.8s)

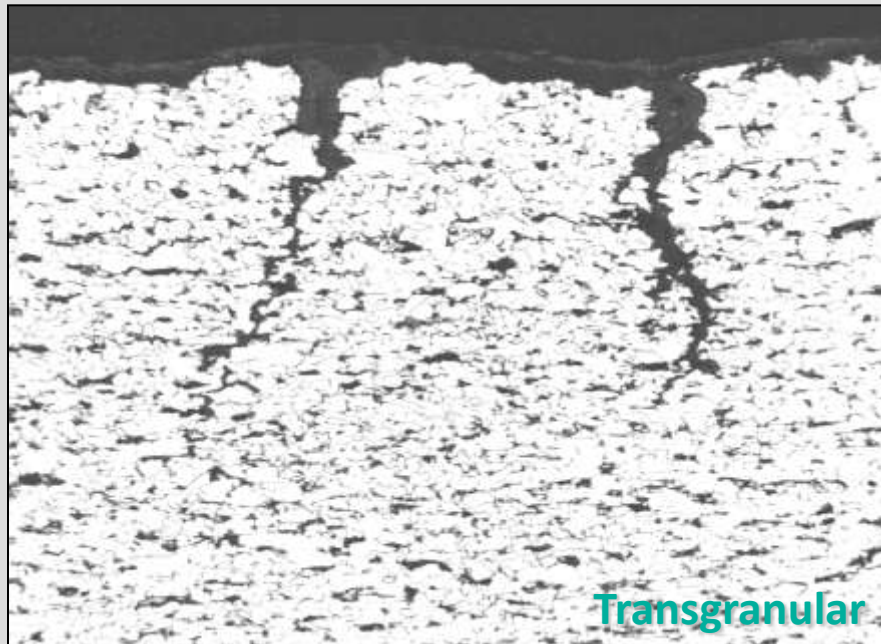
Time Dependent

1. External Corrosion
2. Internal Corrosion
3. Stress Corrosion Cracking

(SCC) appears as very thin, long and deep cracks, on the external surface of underground pipelines.

Low-pH SCC

(electrolite pH between 6.0 and 8.5)

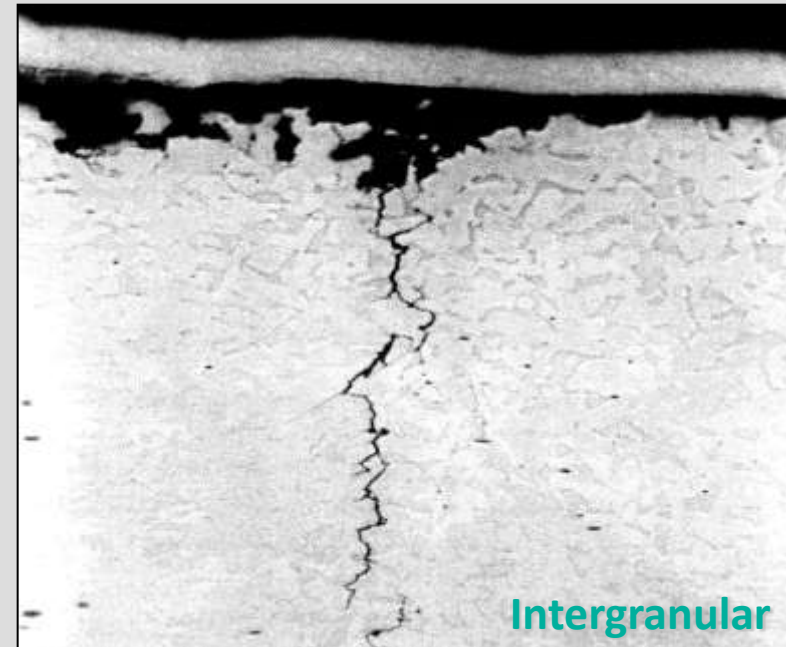


Transgranular

(Magnified 250 times)

High-pH SCC

(electrolite pH between 8.5 and 11)



Intergranular

(Magnified 250 times)

SCC defects in TGS's system

Over the last 15 years TGS has detected the following sites with SCC:



- Failures in service: 4
- Failures by pressure testing: 3
- Leaks in service: 2
- Detected by ILI tools: 2
- Detected by Direct Assessment: 26

ALL CASES OF SCC WERE CLASSIFIED AS HIGH pH SCC

Inspection techniques to identify SCC defects

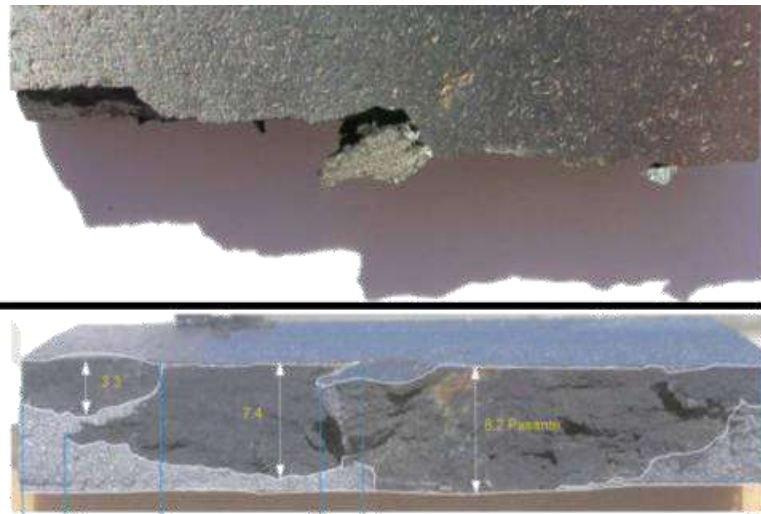
- Pressure testing



- In line inspection



Cross section of pipe with high pH SCC



- SCC Direct Assessment programme (Predictive Modelling + Direct Examination)



Inspection techniques

PRESSURE TESTING



Pressure testing is performed to determine if the line is able to operate at Maximum Allowable Operating Pressure (MAOP) without risk of failure attributable to the SCC phenomenon.

The test is carried out at a pressure that produces a hoop stress in the wall of the pipe 110% of specified minimum yield stress (SMYS) in the section under test .



The use of liquid in the test has advantages and disadvantages. The principal advantage is that liquid does not propagate failures because it is not compressible. The disadvantage is that the line needs to be out of service during the test.

Inspection techniques : PIPELINE IN LINE INSPECTION



Combination Magnetic tools
(Longitudinal Flow +
Transversal Flow)



Ultrasound tool



EMAT tool
(Electro magnetic
acoustic tool)

Inspection techniques: SCC DIRECT ASSESMENT (SCCDA)

SCCDA requires the integration of data from historical records, indirect surveys, field examinations, and pipe surface evaluations combined with the physical characteristics and operating history of the pipeline.

SCCDA is a continuous improvement process. Through successive applications, SCCDA should identify and address locations where SCC has occurred, is occurring, or might occur.

SCC direct assessment (SCCDA) is a structured process that contributes to improve safety by reducing the impact of SCC .

- Step 1: Pre – Assessment
- Step 2: Indirect Inspections
- Step 3: Direct examinations
- Step 4: Post Assessment



Factors used by TGS to prioritise susceptibility segments by SCC

❖ Pipe and Construction RELATED

- Coating faults
- Distances less than 3 km from over 15 year old rectifier equipment.
- Pipes coated with asphalt.
- Potential levels ranging between $-0.75 \text{ V} < E_{\text{off}} < -0.60 \text{ V}$
- Over 20 year old pipes

❖ OPERATIONAL DATA

- High operation stress levels
- Pipe operation temperature
- Leak /rupture history



Enlargement: X600

❖ SOIL ENVIRONMENTAL

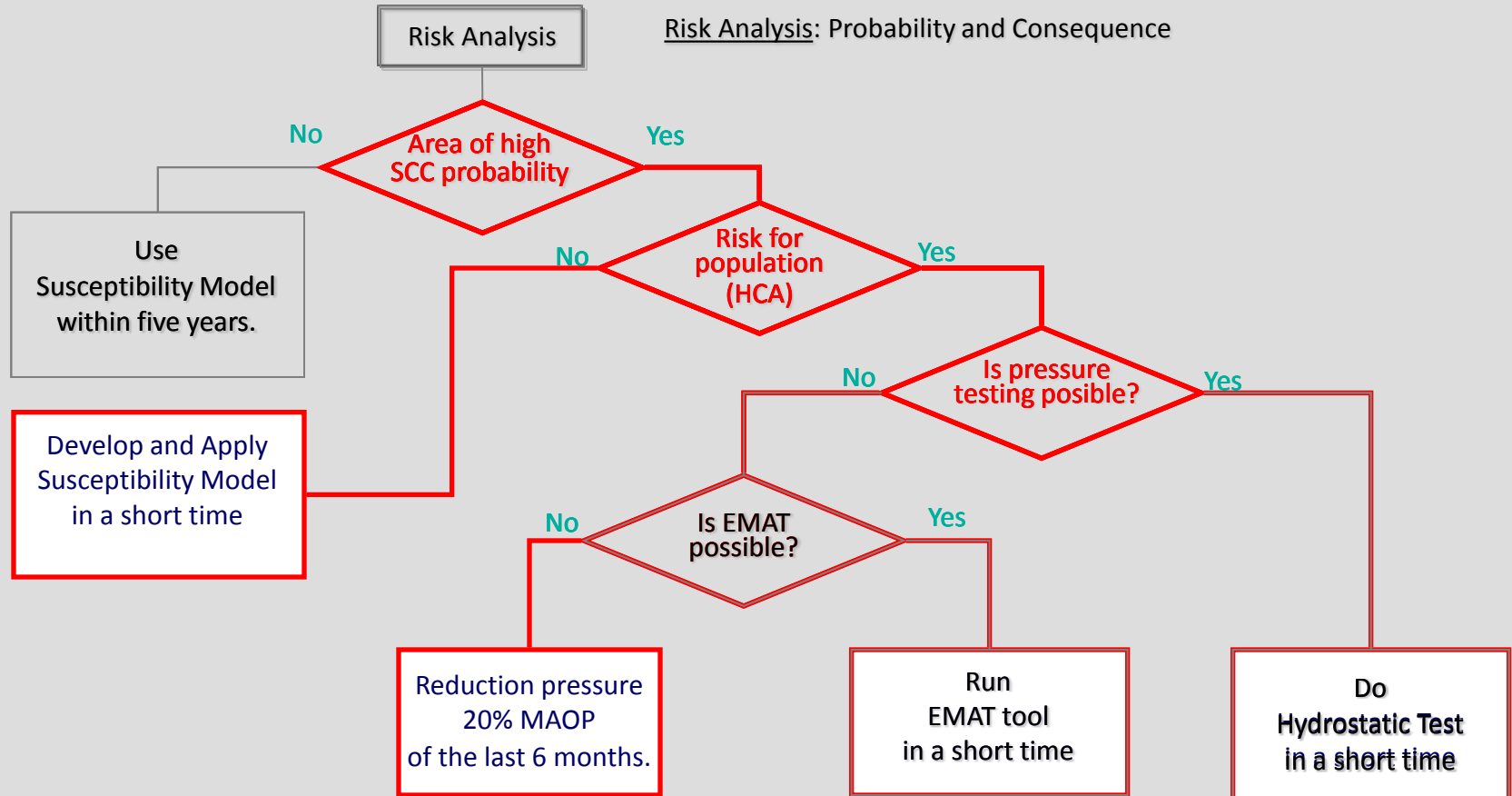
- High level of sodium and potassium
- Vegetation cover
- Carbonates and bicarbonates are present
- Good soil humidity level
- Poor soil drainage
- Low resistivity soil
- Proximity to temporary riverbeds or watercourses.
- Sloping soil

Inspection techniques: Advantages and Disadvantages

Inspection Techniques	Advantages	Disadvantages
Pressure Testing	Critical cracks fail. Reduction of propagation spread.	High effect on Gas Transport. Non critical cracks lengthened.
ILI by MFL + TFI tool	Low effect on Gas Transportation. It is not necessary to cut service to run the inspection.	Inadequate discrimination in the detection of high pH SCC cracks
ILI by Ultrasound tool	Accurate detection of cracks bigger than 2 mm depth and 30 mm length	High effect on Gas Transport due to liquid batch.
ILI by EMAT tool	Low effect on Gas Transportation. The tool does not require the use of liquid batch . Accurate detection of cracks in low pH SCC (>2mm deep and 40mm long POI 90%)	Effectiveness to detect high pH cracks still to be proved in field operation
Direct Assessment program	Low effect on Gas Transport	Low effectiveness

THE IDEAL METHODOLOGY TO FIND HIGH pH SCC IN PIPELINES IS STILL TO BE DEVELOPED.

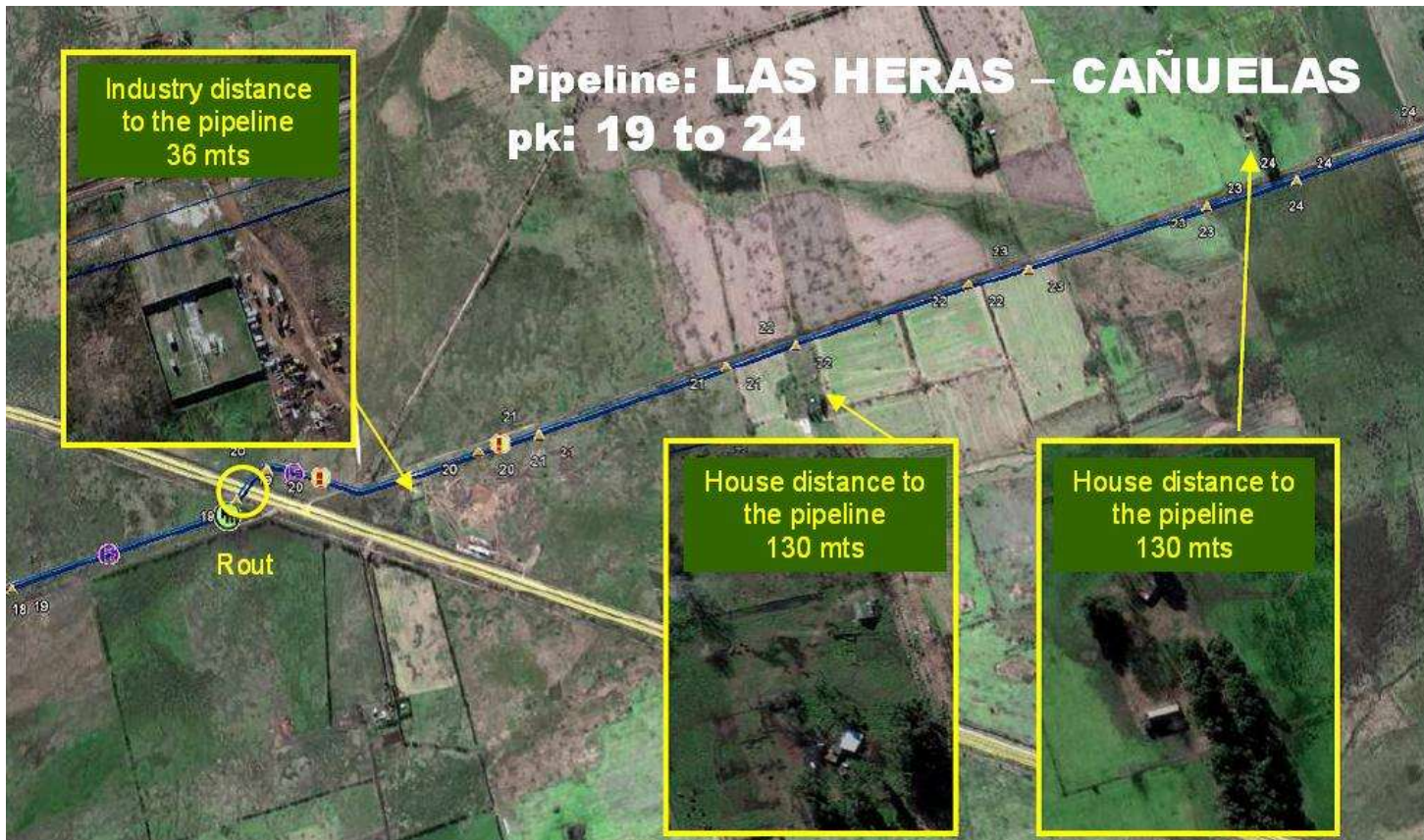
SCC mitigation programme implemented by TGS



MAOP: Maximum Allowed Operation Pressure

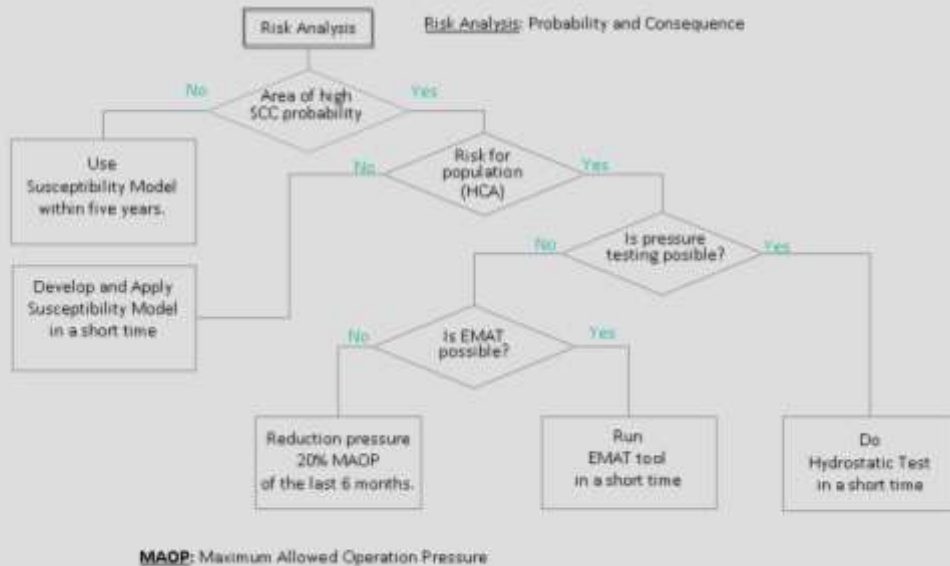
SCC mitigation programme

Risk Analysis



The Risk Analysis consists in ranking the segments of the pipeline system in terms of probability of failure by SCC (according to “ **Factors used to prioritise susceptibility segments by SCC**”) and consequence of failure (business, environment, population).

SCC short term mitigation programme implemented by TGS



SCC mitigation program implemented by TGS (as a combination of inspection techniques)

- **Pressure testing** in sections affected by SCC failure.
- Run **EMAT tool** in densely populated areas, and highly susceptible areas.
- **SCCDA** in probable areas of SCC.

Furthermore, TGS has decided to engage an international company to audit our SCC programme.

PRESSURE TESTING

Results

Characteristics:

- Diameter: 30"
- Pipe: API 5LX 52
- Wall thickness: 8.74 mm
- Pipeline age: 45 years
- External coating : Asphalt
- Test liquid: water



1° Step of pressure testing:

- Time: 1hour
- Pressure: 110% SMYS

2° Step of pressure testing:

- Time: 2hour
- Pressure: 80% SMYS



NO ruptures by SCC during Pressure Testing

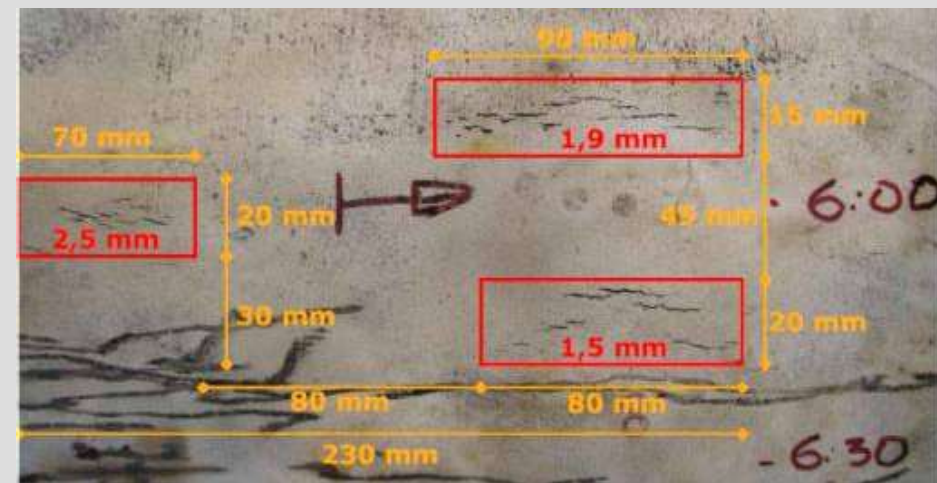
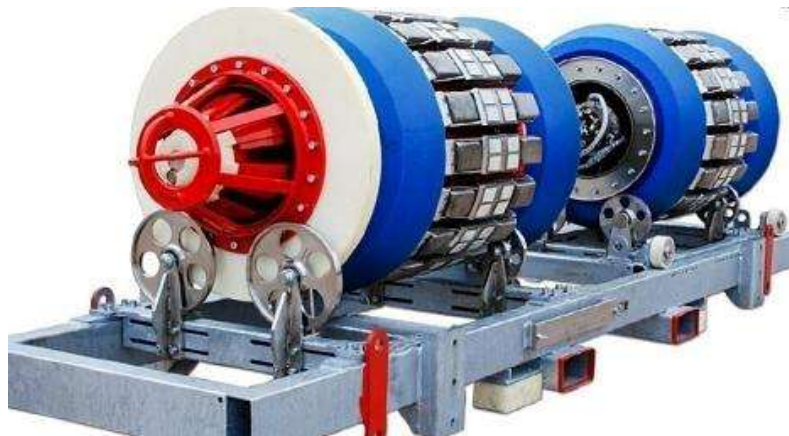
PIPELINE IN LINE INSPECTION

EMAT tool - Results

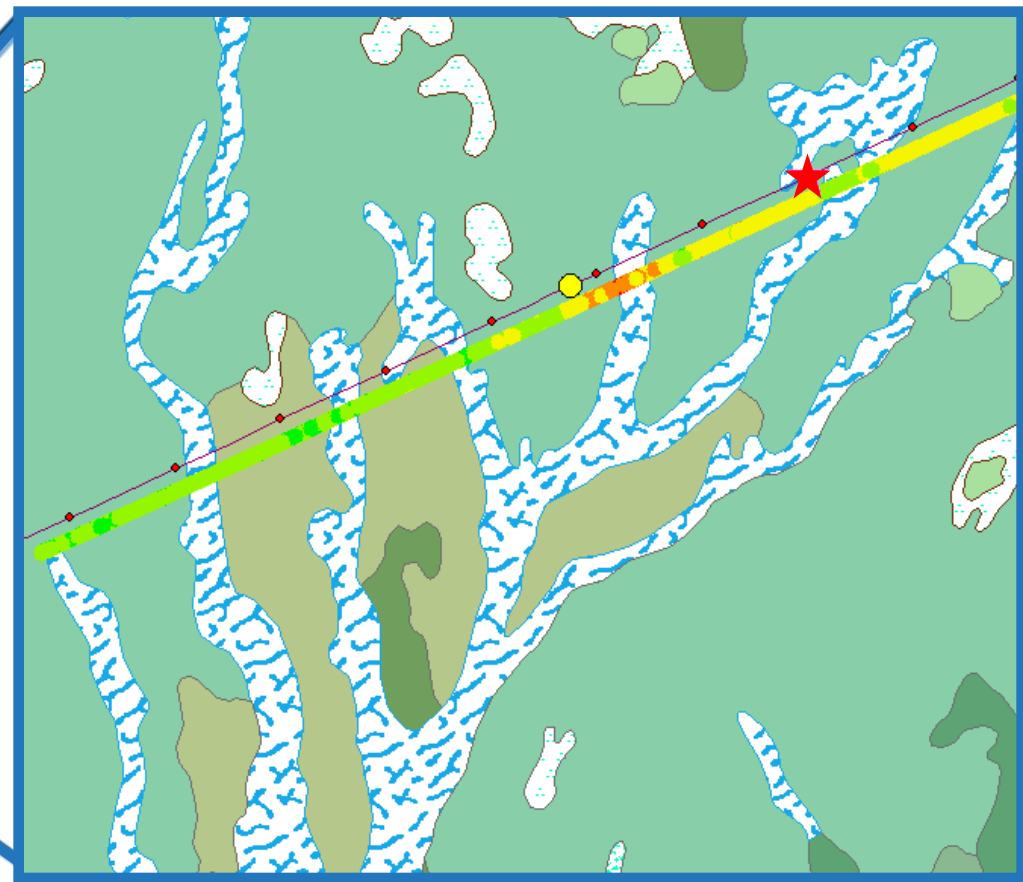
TGS has used two different technologies of EMAT tool.

Which one tool we inspected 500 km and it was possible to find two critical colonies of SCC. Now we are doing digs to control other points listed in the report .

With the second company we ran 300 km and at the time of writing this paper we have not received the results of the EMAT tool runs.



Improvement in SCCDA



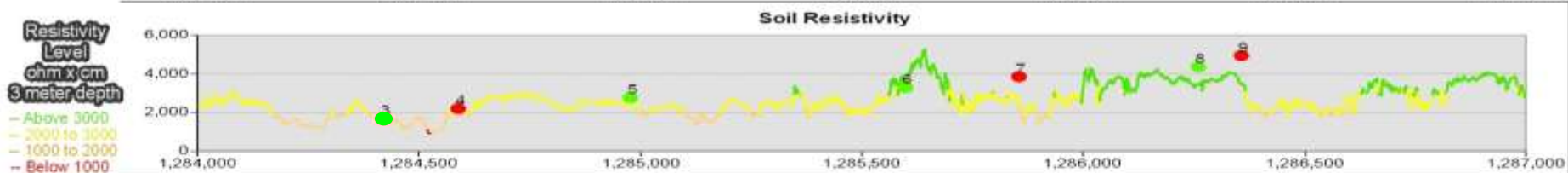
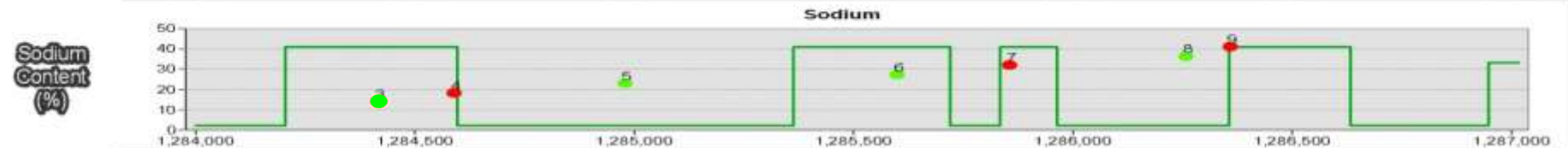
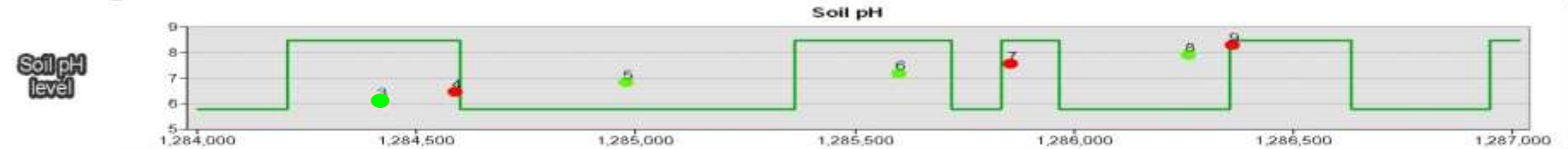
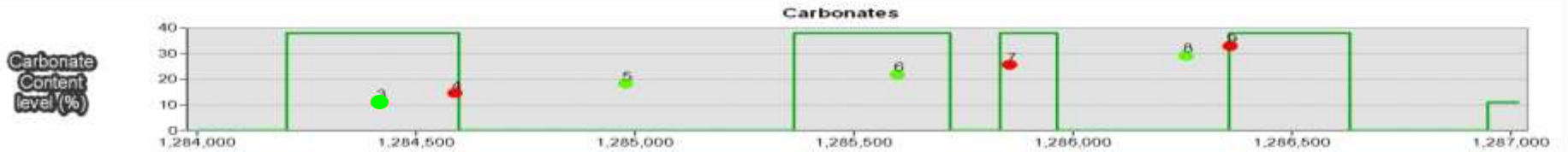
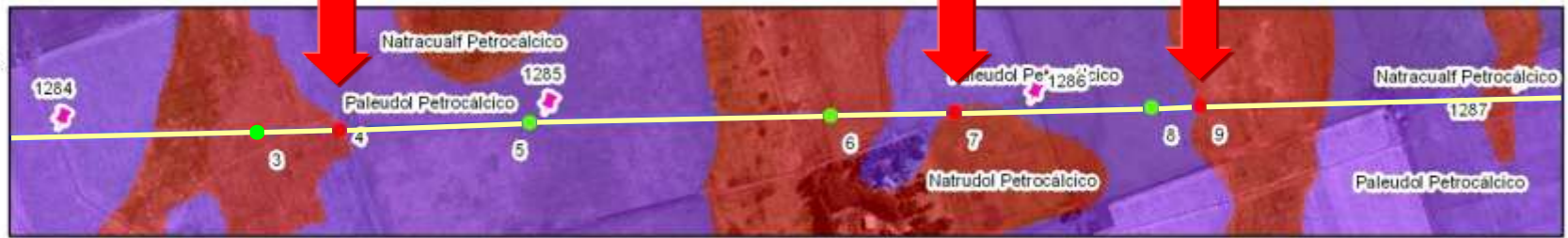
SOIL MODEL

Example of spreadsheet to select dig position

San Martin Pipeline - Section : 'La Sortija to Tandil' - From Pk 1,284 to Pk 1,287 - SCC Susceptibility Model

Contents

- Kilometer Post
- SCC Bell Hole ***
- SCC found?**
- No
- Yes
- Pipelines



Conclusions

- **Stress corrosion cracking is one of the time-dependent threats which can affect the integrity of gas transportation lines.**
- **In the last 15 years TGS has carried out a lot of research and an important number of field tasks to detect this phenomenon.**
- **Last year, one failures occurred in the pipeline system. For that reason TGS decided to review the principles used in the past to define their SCC Management programme.**
- **TGS developed a short term SCC mitigation programme based on Risk Analysis study and the best Inspection Technique. This programme was audited by external people.**
- **New variables were identified which enabled us to locate a site of high pH SCC.**
- **New spreadsheets of digs were made. It was possible to create an accurate forecast model to find significant sites with SCC.**
- **The programme implemented has allowed TGS to highly improve the operation of the system with high reliability and a low budget.**



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¡Thank you very much!



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