Detection of Corrosion Within District Heating Piping Using High Resolution, Low Risk, Smart Inline Inspection Tools

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Introduction – Global Leader of Asset Integrity Solutions

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Case Study

In the winter of 2020, external corrosion led to a leak and an unexpected interruption of service within the district heating network of La Rochelle operated by an Engie Solutions Company - Salines Energies Services (SES).

Concerned that additional corrosion could occur, SES was presented with the challenge of developing a strategy to safeguard the future reliability of the network.

An operations system risk assessment based upon best engineering practices was needed to aid in the decision as to whether the pipework needed to be replaced in its entirety or if more economical and efficient repairs could be performed to return system reliability.

Network Information
– Second Generation Ducted System

1. Date of original installation – 1971.
2. Heat generation – 2 Biomass fuelled boilers, installed in 2002 and 2015.
3. Main feeder and return pipework - DN400 (16”) diameter with a distance of 1.5km. Total distance of network including reduced diameter offtakes 7.74km (4.8 miles)*.
4. Design pressure - 25 Barg (363psig).
5. Operating pressure – 10 Barg (145psig).
6. Nominal pipework wall thickness - 8.8mm (0.346”).
7. Minimum bend radius - 1.5D.
8. Minimum operating temperature - 60°C (140°F).
9. Maximum operating temperature - 110°C (230°F).
10. Pipework Situation - Concrete channel supported every 7 metres (22 ft) by steel crossmembers.
11. Since original installation approximately 4km (2.5 miles) of the network has been renewed with more modern pre-insulated pipework.
12. Original sections of the network insulated with a basic rockwool system.

** Distance to be multiplied by 2 to realize feeder & return total distance*

Cause of the Corrosion (Damage Mechanism)

Breakdown of the ducting cover allowed ingression of water/salt water to enter the chamber from above.

Soaking of the rockwool insulation resulted in consistent saturation of the pipework leading to the onset of external corrosion and a subsequent through-wall leak.

The leak occurred in original piping situated approximately 1km (0.625 miles) downstream from the boiler plant within the feeder pipe just prior to a transition from original to upgraded pipe.

Post Leak Operational Review – 2 x 1km of Pipework

OPTION \ IMPACT	Operational (Customer Impact)	Financial (Operator Impact)	Future Operations (Customer & Operator Impact)	Summary
Continuation of Service Prior to Leak	**High**	**High**	**High**	+ Immeasurable financial cost/risk. + Incapable of reliable client service delivery. + Contractual obligation to always ensure best practice of operations.
Replace / Upgrade	**High**	**High**	**Low**	+ Greatest financial cost/risk. + Greatest operational revenue loss. + Greatest client inconvenience. + Future integrity of replaced segments secured.
Condition Assessment Leading to: Repair and or Replace	**Low**	**Low**	**Low**	+ Financial consequences managed with minimal impact to customer and operator. + Future integrity of evaluated and repaired/replaced segments secured. + Provision of physical data as to support business case should pipework be beyond economical repair.

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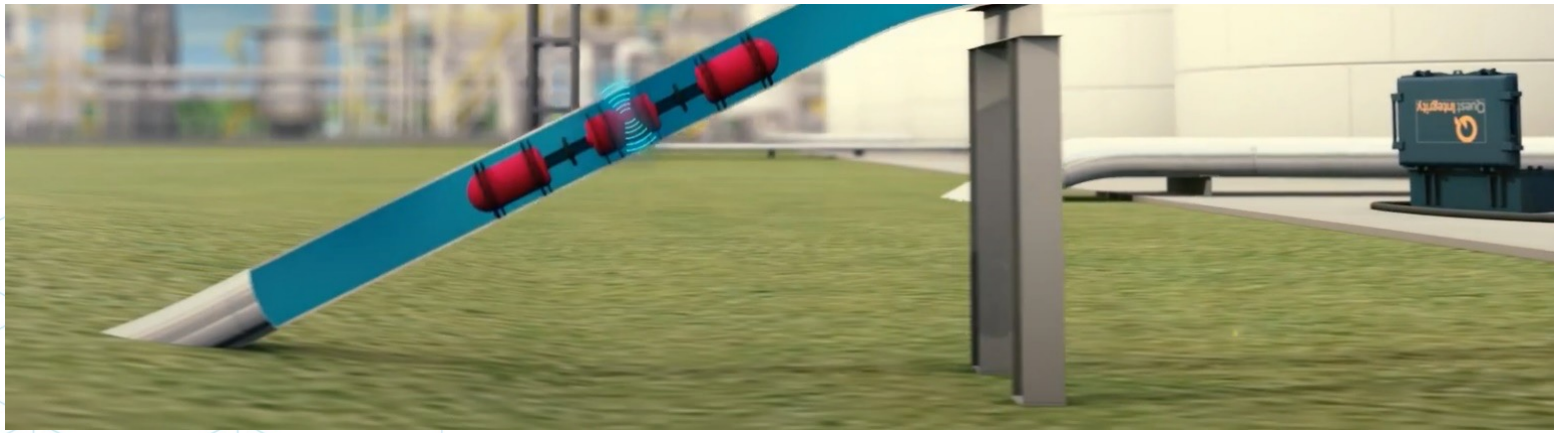
Inline Inspection – A Solution for Network Condition Assessment

2007 - Quest Integrity launched InVista™ Ultrasonic Inline Inspection Tools specifically engineered to address the 'Difficult to Inspect' Pipeline Sector of the Oil & Gas Industry.

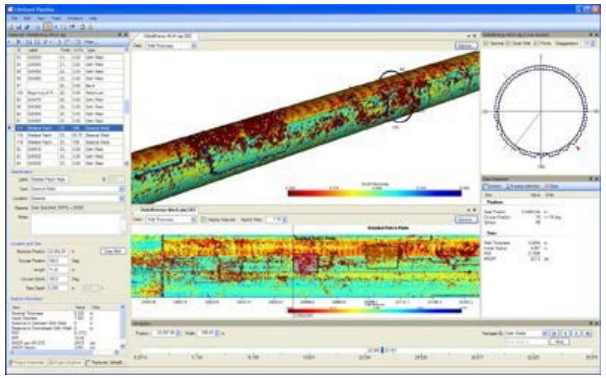
2017 - Quest Integrity awarded first inspection for a DHC operator in Paris, France and has continued to inspect complex challenging DHC pipework throughout the last 5 years.

2021 - Quest Integrity recommended and awarded the Inspection & Reporting Scope of Work of the Case Study - 2 x 1km Feeder & Return Lines.



Quest InVista™ Ultrasonic Inline Inspection Tool

Paris DH Inspection Project



Data Viewer

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Scheduling & Network Preparation

7-Day Program - Includes 3 Days On-Site	Project Span (Days)						
Work Task	1	2	3	4	5	6	7
Equipment Preparation							
Mobilize Crew and Equipment							
Safety induction, Permit approval							
Equipment Setup							
Feeder Line Cleaning & Inspection							
Equipment Transfer to Return Line							
Return Line Cleaning & Inspection							
Data Check & Line Reinstatement							
Demobilize Crew & Equipment							
Equipment Servicing & Replenishment							
Denotes Days On-Site							
Denotes Travel/Mob/Preparation Days							
Denotes Days With 24-Hour Shift							
Denotes Days Site Specific Training							

7-Day Schedule for Inspection

Section of Piping To Be Removed From Feeder & Return Line in Boiler Room

Valved Offtakes Installed to Feeder & Return Line 1km Downstream From Boiler Room

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Equipment Installation

Temporary L/R & Ported Blind Flange

Mobile Pump Unit

Looping of Feeder & Return Line

Cleaning & Inspection (Data Acquisition)

Cleaning

Before Use

Bi-directional Medium Density Spiral Wire Brush Pipework Cleaning Tool

After Use

Condition evaluation confirmed go-ahead for InVista™ Inspection Tool

Inspection

Post Inspection

Quest InVista™ Inspection Tool received within Return Piping awaiting removal & data download

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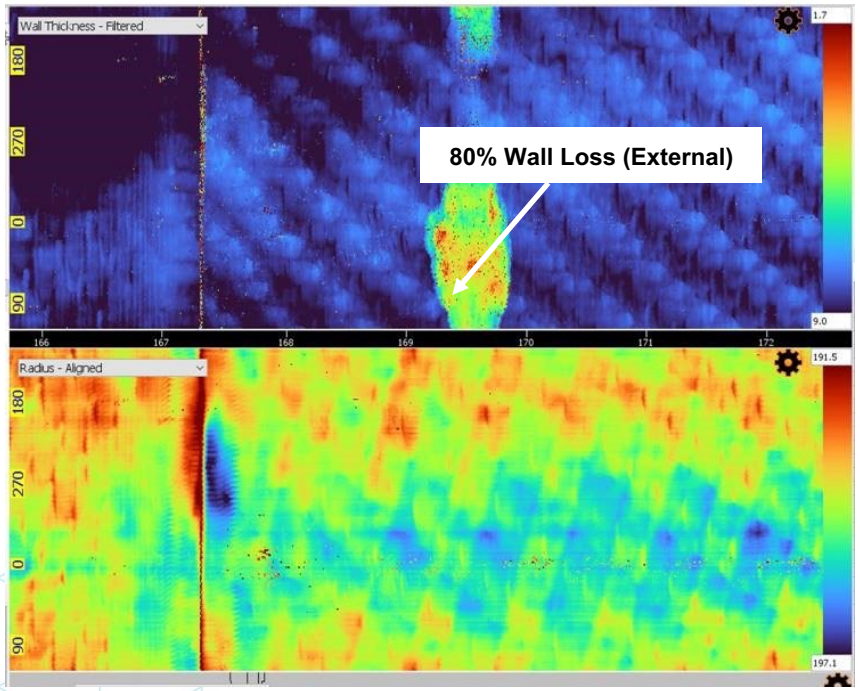
Onsite Inspection Results – Immediate Threat Identified



Return Pipework – 165m From Boiler House

Excavation

Corrosion Located / Physically Recovered

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Analyzed Inspection Results

Feeder Pipework Corrosion Summary

*Metal Loss Depth %	External	Internal	Total
15% ≤ * < 20%	17	1	17
20% ≤ * < 30%	56	1	57
30% ≤ * < 40%	10	0	10
40% ≤ * < 50%	5	1	6
50% ≤ * < 60%	0	0	0
60% ≤ * < 70%	0	0	0
70% ≤ * < 80%	0	0	0
* ≥ 80%	1	0	1

Return Pipework Corrosion Summary

*Metal Loss Depth %	External	Internal	Total
15% ≤ * < 20%	7	0	7
20% ≤ * < 30%	23	0	23
30% ≤ * < 40%	7	0	7
40% ≤ * < 50%	5	0	5
50% ≤ * < 60%	2	0	2
60% ≤ * < 70%	0	0	0
70% ≤ * < 80%	3	0	3
* ≥ 80%	1	0	1

External Corrosion

+ Five external metal loss defects between 70% & 80% to be addressed for remediation as soon as possible.
+ Two external metal loss defects within the return pipework to be considered as borderline threats.

Internal Corrosion

+ Three areas of internal corrosion within the feeder pipework (nothing within return pipework) – no immediate threat.

Analyzed Inspection Results

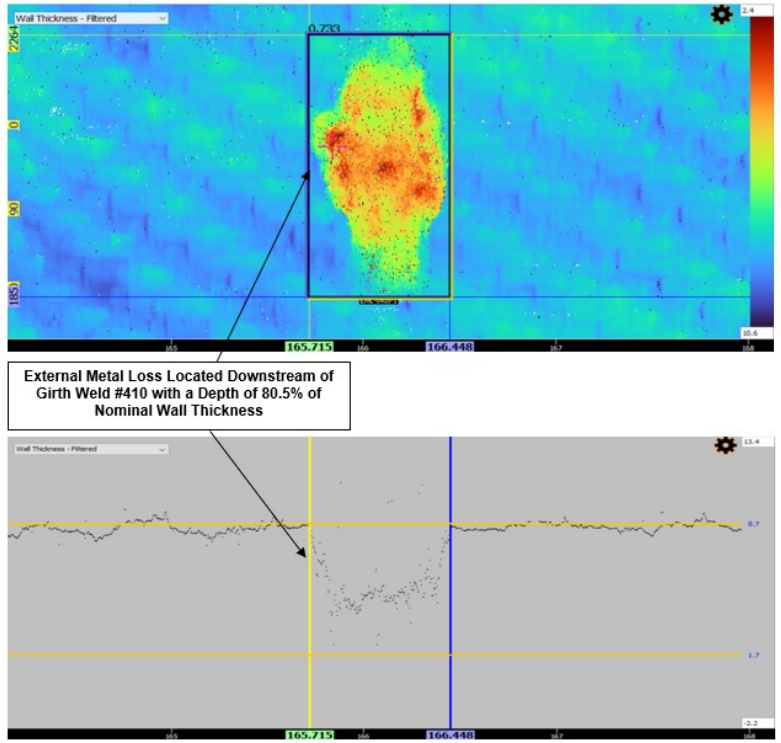
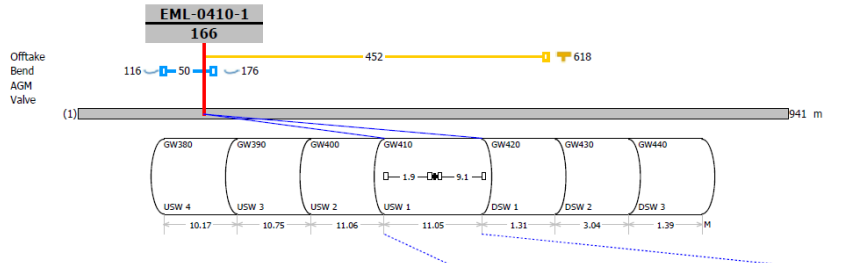


Figure 1. C-Scan and B-Scan of External Metal Loss EML-0410-1

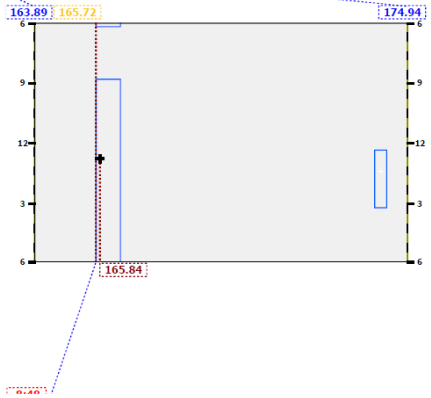
Feeder Pipework Corrosion Summary

Tronçon Principal (Feeder) Return-Pipeline — EML-0410-1

Odometer (m)	165.715	Length (mm)	732.5	Feature Box Start	8:48	264°	Depth (%) Tnom	80.53
SMYS (kPa)	265000.0	Width (mm)	996.4	Tmm Orientation	12:47	24°	Depth (mm)	7.0
Tnom (mm)	8.7	Tmed Joint (mm)	8.5	Feature Box End	6:09	185°	Feature Type	Corrosion - External
OD/ID (mm)	406.4	388.9	IDmed Joint (mm)	388.6	Circ Extent	281°	Pipe Class	Seamless
Comment								



Feature	Label	Odometer (m)	Relative Position (m)	USW Rel. Position (m)
Bend	BND	115.67	(50.05)	(48.22)
USW 4	GW380	131.90	(33.81)	(31.99)
USW 3	GW390	142.08	(23.64)	(21.81)
USW 2	GW400	152.83	(12.88)	(11.06)
USW 1	GW410	163.89	(1.82)	0.00
box start	EML-0410-1	165.72	0.00	1.82
Tmm	EML-0410-1	165.84	0.12	1.95
box end	EML-0410-1	166.45	0.73	2.56
DSW 1	GW420	174.94	9.23	11.05
Bend	BND	175.59	9.88	11.70
DSW 2	GW430	176.25	10.54	12.36
DSW 3	GW440	179.29	13.58	15.40
DSW 4	GW450	180.68	14.96	16.79
Tee	TEE-01370-2	618.17	452.46	454.28



Defect Location Sheet

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System Risk Assessment - Conclusions

The system assessment validated that the operational integrity and reliability of the existing pipework could be restored using the correct repair and maintenance strategy.

Further monitoring of the pipework system by inline inspection to map corrosion growth was recognized as a future assurance measure and is scheduled for 2026.

Implementation of the integrity plan incorporated within maintenance procedures safeguarding future operations.

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Close Out - Value Benefit Analysis

Operational Impact Minimized

Downtime for inline inspection of only three days minimizing end-user inconvenience and restricting commercial impact.

Operational Confidence Restored

A clear understanding of the condition of the network before and after repairs and maintenance.

Financial Accountability

When compared to replacement, the operator realized fiscal savings of approximately 85%. A significant saving demonstrating the ‘true value’ of Inspection being well received by senior corporate management.

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