



## **Advanced Pipe Inspection (UK) Ltd**

**NDT Testing report produced on behalf of:  
SAMPLE REPORT**

### **NDT Testing Inspection Project Scope**

An NDT testing survey was undertaken on a pipe sample to confirm pipe condition and remaining wall thickness utilising an ultrasonic probe unit.

Additional laboratory analysis and soil testing was undertaken to determine reason for sample failure investigation.

# NDT Pipe Inspection Report

## Equipment Testing Details:

|                                               |              |
|-----------------------------------------------|--------------|
| <b>Calibration and Testing undertaken by:</b> | S Leuthwaite |
|-----------------------------------------------|--------------|

## Equipment Information:

|                         |                             |                       |                 |
|-------------------------|-----------------------------|-----------------------|-----------------|
| <b>System Used:</b>     | Benetech / GM100            | <b>Visual Check:</b>  | 02-08-22        |
| <b>ID Number:</b>       | API UTG_10                  | <b>Sanitised:</b>     | N/A Pipe Sample |
| <b>Purpose Used:</b>    | NDT Ultrasonic Pipe Surveys | <b>Pat Test Date:</b> | 01-06-22        |
| <b>Pressure Tested:</b> | N/A                         | <b>Pat Test Due:</b>  | 01-12-22        |

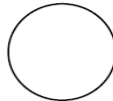
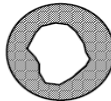
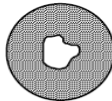
## NDT Pipe Inspection Report

|                         |              |                              |         |
|-------------------------|--------------|------------------------------|---------|
| <b>Location:</b>        | SAMPLE       | <b>Testing Date:</b>         | 2022    |
| <b>Client:</b>          | SAMPLE       |                              |         |
| <b>Client contact:</b>  | SAMPLE       | <b>Location Reference ID</b> | SAMPLE  |
| <b>API Team Leader:</b> | Josh Hammond |                              | -API-01 |

### Pipe Details:

|                          |           |                           |                             |
|--------------------------|-----------|---------------------------|-----------------------------|
| <b>Pipe Material:</b>    | Cast Iron | <b>Pipe Coating:</b>      | None                        |
| <b>OD (Nominal):</b>     | 350mm     | <b>Internal Lining:</b>   | None                        |
| <b>Age:</b>              | 1925      | <b>Reason for Survey:</b> | NDT Pipe Thickness Analysis |
| <b>Average Pressure:</b> | 11 bar    | <b>Velocity Scan:</b>     | 4550 m/s                    |

### Location Grading:

|                           |                  |                                                                                     |                                                                                      |                                                                                       |                                                                                       |                                                                                       |
|---------------------------|------------------|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| <b>Grade:</b>             | 3                | <b>Grade 1</b>                                                                      | <b>Grade 2 Slight</b>                                                                | <b>Grade 3 0-20%</b>                                                                  | <b>Grade 4 20-40%</b>                                                                 | <b>Grade 5 &gt;40%</b>                                                                |
| <b>Asset Condition:</b>   | Poorly fractured |  |  |  |  |  |
| <b>Coating thickness:</b> | N/A none present |                                                                                     |                                                                                      |                                                                                       |                                                                                       |                                                                                       |

### Supporting Photo information:



Asset:



Asset:

## NDT Pipe Inspection Report

### Pipe wall images internal

**Title 1**



Pipe wall image tuberculation identified

**Title 2**



Pipe wall image tuberculation identified

### Pipe wall macro images external

**Title 3**



Pipe wall image

**Title 4**



Pipe wall image

**Title 5**



Pipe wall image pitting

**Title 6**



Pipe wall image fracture

## NDT Pipe Inspection Report

### Inspection Comments:

A pipe sample was received from a client to test and assess condition. Numerous measurements were obtained see table below:

- Sample is in a poor general condition
- Fracture identified on sample received (assumed to be caused by external forces)
- Visual surface defects and corrosion identified on section tested
- Internal tuberculation identified (unlined)
- Pipeline maximum pit depth identified is at 2.0mm

### NDT Scan Data

| External NDT Calculations |                                              |
|---------------------------|----------------------------------------------|
| 03/08/2018                | Red Cow DMA, Welsh Water                     |
| Work Reference Details    | NDT Ultrasonic Testing Pipe Sample RC-API-01 |

#### Input Parameters:

| Wall Thickness (mm)         | External Pit Depth (mm)    | Internal Pit Depth est(mm) |
|-----------------------------|----------------------------|----------------------------|
| 12.5                        | 1                          | 1                          |
| 13                          | 0.5                        | 1                          |
| 12.8                        | 2                          | 0.5                        |
| 14                          | 0.5                        | 0.8                        |
| 10                          | 0.5                        | 0.5                        |
| 8                           | 1                          | 1                          |
| 8.5                         | 2                          | 1                          |
| 7                           | 2                          | 0.5                        |
| 9                           | 0.5                        | 0.6                        |
| 11                          | 0.8                        | 1                          |
| Average Wall thickness (mm) | Average Ext Pit depth (mm) | Average Int Pit depth (mm) |
| <b>10.58</b>                | <b>1.08</b>                | <b>0.05</b>                |
| Standard Deviation          | Standard Deviation         | Standard Deviation         |
| <b>2.43</b>                 | <b>0.66</b>                | <b>0.24</b>                |
| Min Wall thickness (mm)     | Max Ext Pit depth (mm)     | Max Int Pit depth (mm)     |
| <b>7.00</b>                 | <b>2.00</b>                | <b>1.00</b>                |
| O/D (mm)                    |                            | 350.00                     |

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|                                                             |  |        |
|-------------------------------------------------------------|--|--------|
| I/D Calculated from O/D - average wall thicknessx2 (mm)     |  | 328.84 |
| Pressure estimated by client data supplied (Bar)            |  | 11.00  |
| Yield Stress (CI-20, SPUN I-23, D1-45, STEEL-70)            |  | 20     |
| Pipe Age estimated (Years)                                  |  | 93     |
| Minimum Wall thickness necessary to sustain system pressure |  | 6.04   |
| Minimum Remaining Life (years)                              |  | 0      |
| Min Remaining Life if Internal Corrosion Arrested (years)   |  | 0      |
| Median Remaining Life (years)                               |  | 33     |
| Median Remaining Life if internal arrested (years)          |  | 35     |

### Analysis results:

Sample was tested for wall thickness and visual corrosion.

Pipeline sample 10 point sections were tested (see table above).

A standard temperature ultrasonic probe was utilised for the inspection.

The overall thickness results, run alongside the pit depths and corrosion line are deemed to indicate that the pipe structure is generally corroded to a level of failure. This is in no way a guarantee of the system, but a calculative estimation based on data.

The system age and pressure estimate is based on information supplied by client.

# NDT Pipe Inspection Report

## LABORATORY TECHNICAL REPORT

### EXAMINATION OF

### API-RED COW DMA CRACKED PIPE SECTION

#### SYNOPSIS

The pipe sample received was heavily corroded on both surfaces particularly the outside surface, the depth of corrosion on both sides was varied. In some areas the variations of both sides correspond and thus drastically decrease the wall thickness.

The crack through the section of pipe provided was established to have cracked in a brittle manner from the outside surface inward suggesting an overload event due to elevated hoop stress or an external impact.

#### INTRODUCTION

API Laboratory SS received a portion of cracked pipe and were asked to establish the mechanism of failure. The position of the cracked portion provided in relation to the overall crack length was unknown and so the investigation was limited.

The sample provided was received with the following reference: **API-Red Cow DMA.**

The sample can be seen in its as received condition in figure 1.

#### SECTIONING AND VISUAL EXAMINATION

The crack (figure 2) was sectioned from the pipe section and cleaned using a 30% hydrochloric acid in water solution. This removed the surface contamination and enhanced the fractographic features that had not been compromised by corrosion.

The crack face was examined under the stereo microscope at magnifications up to X40. This showed no indication of areas of fracture initiation. A macroscopic examination (figure 3) shows the portion of the fracture provided to have failed in a brittle manner.

A cross section was taken through the entire width of the pipe wall to assess oxide thickness (figure 4). This showed a relatively even depth of oxide on the internal surfaces of nominally 1.5mm. The external surface shows a consistent layer of oxide as well as deep pits which have considerably reduced the pipe

## NDT Pipe Inspection Report

wall thickness a portion of the cross section showed the wall thickness to have been reduced to 6mm (figure 5)

### METALLOGRAPHIC EXAMINATION

A portion of an area highlighted in figure 3 (a) was sectioned from the crack and mounted in phenolic resin and successively ground and polished to a 1-micron finish. The examination revealed a grey iron flake structure with a type B rosette form (figure 6). The sample was etched in 2% nitric acid in methanol to reveal the microstructure. This revealed a predominantly ferritic structure with a phosphide eutectic phase. This material is typical of centrifugally cast iron (figure 7).

### HARDNESS TESTING

Hardness impressions were carried out using a Brinell 2mm ball indenter exerting a 40kg load. Hardness values were calculated from three impressions. Results are shown below:

| 1     | 2     | 3     | Average |
|-------|-------|-------|---------|
| 165HB | 165HB | 167HB | 166HB   |

Due to the range of graphite forms within cast iron a reliable conversion to ultimate tensile strength cannot be made.

### DISCUSSION

The section provided appears to have fractured from the external surface in a brittle manner. The changes in fracture path indicated multiple crack initiation points with coalescence of the advancing crack fronts into one major crack.

A cross-section through the wall revealed areas of significant loss in wall thickness by corrosion that reduced the cross-sectional thickness in isolated areas which would have created stress concentrations.

The portion of the crack provided propagated from the external to the internal surface which may have been due to overload, from internal pressure, at an area of reduced wall thickness. However, there was no evidence to corroborate this.

The microstructure exhibited phosphide eutectic, not uncommon in spun-cast pipes, which increases the hardness of the material, but also the degree of brittleness. It may therefore, have contributed in some small way to the fracture, although the localised reduction in wall thickness from corrosion, and the flake graphite in the structure, which is inherently brittle were considered to be the dominant factors in the fracture. The source of the loading to cause fracture could not be established from examination of the supplied sample.

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### CONCLUSIONS

1. The pipe fractured by a brittle mechanism and shows the nominal propagation to be from the outside surface inwards.
2. Corrosion of the wall surfaces had markedly reduced the wall thickness particularly in isolated areas.
3. The microstructure is as expected although no specification has been provided.
4. A portion of the cross section taken showed corrosion to have reduced the wall thickness to 6mm.

### FIGURES

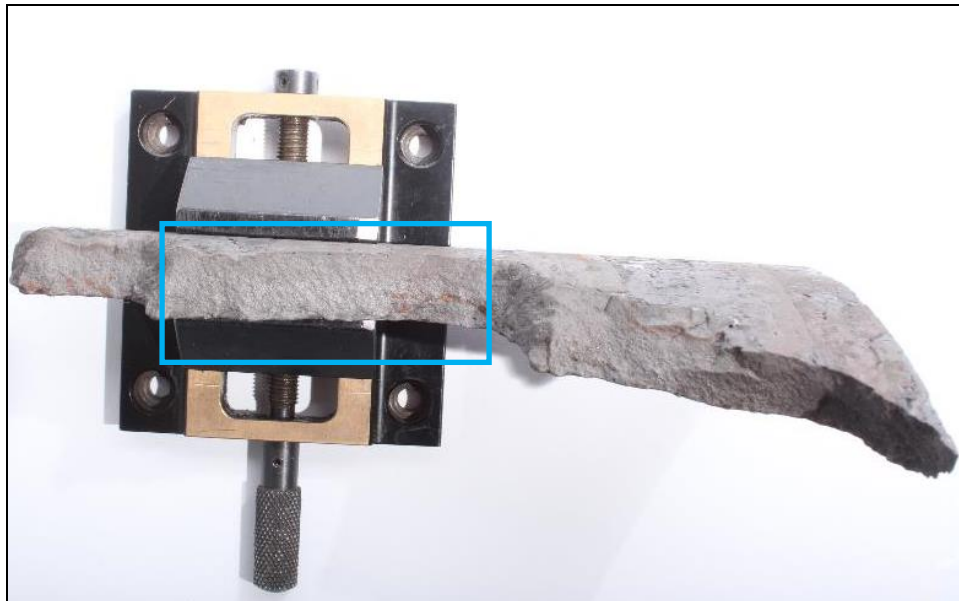


*Figure 1: The pipe as received.*

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*Figure 2: The main crack through the section of pipe provided.*

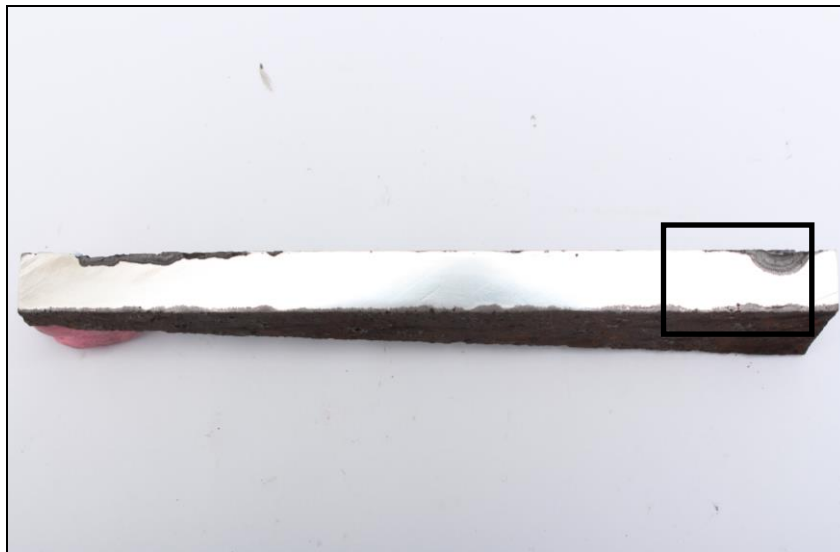


*Figure 3 (a): The cleaned crack face.*

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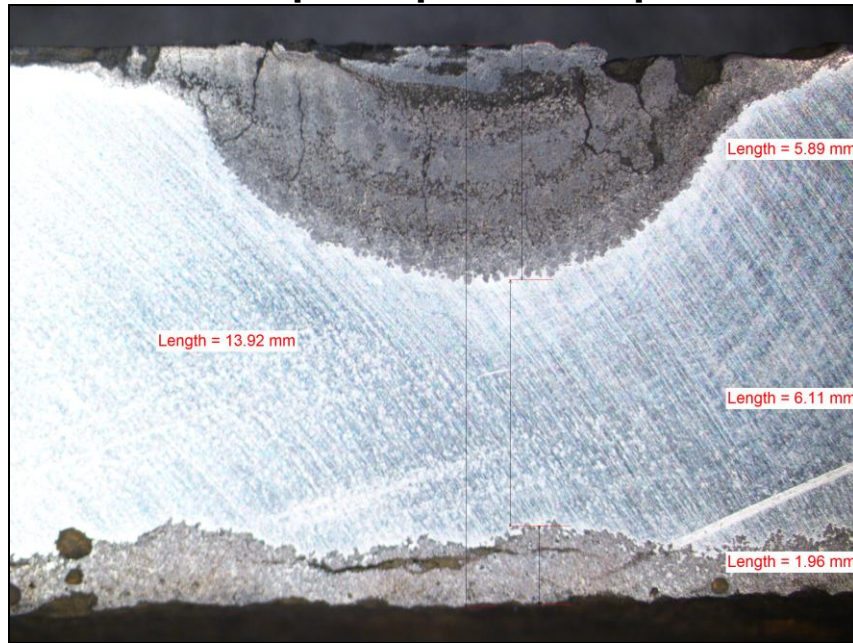


*Figure 3 (b): Expanded area gathered from Figure 3 (a) displaying the direction of crack propagation.*

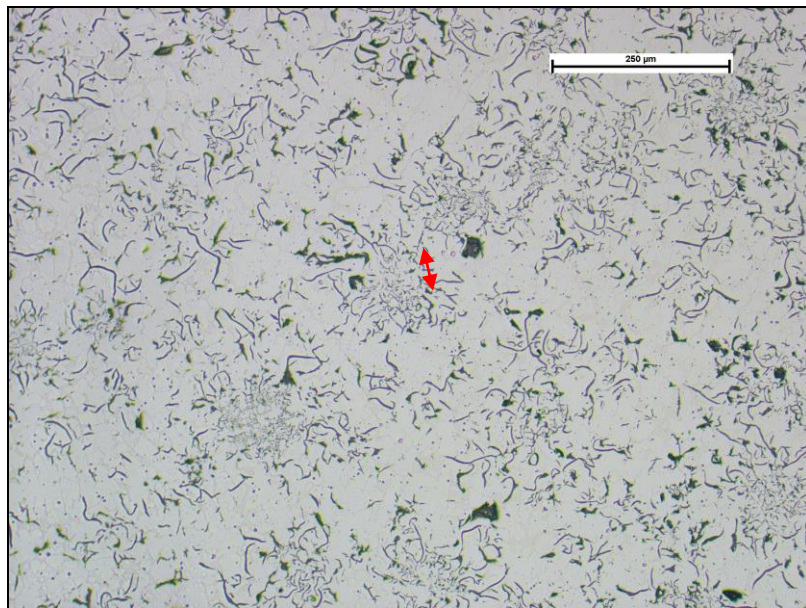


*Figure 4: A cross section of the entire pipe width provided.*

## NDT Pipe Inspection Report

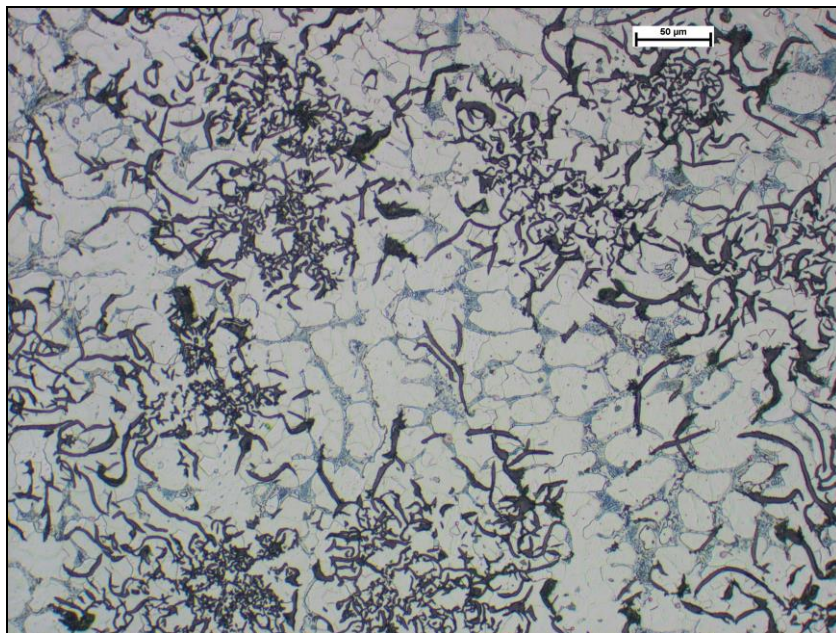


*Figure 5: Macroscopic image of the area shown in figure 4 with most wall thickness reduction. Image taken at X6.*

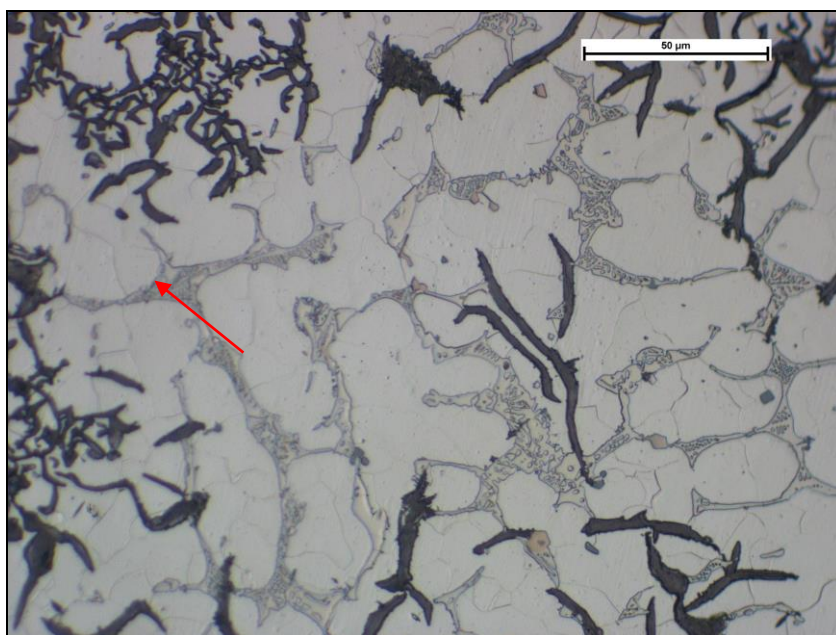


*Figure 6: As polished sample displaying type B graphite. Image taken at X100.*

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*Figure 7 (a): Photomicrograph displaying ferrite grains, graphite flakes, and phosphide eutectic. Image taken at X200.*



*Figure 7 (b): Photomicrograph displaying ferrite grains and phosphide eutectic (arrowed). Image taken at X500.*

# NDT Pipe Inspection Report

## TECHNICAL LABORATORY REPORT

### EXAMINATION & ANALYSIS OF SOIL SAMPLE

#### SAMPLE REF: SAMPLE

#### INTRODUCTION

API received a soil sample for analysis. The samples were provided with the sample reference 'SAMPLE' and the unique number 94729858. A scope of work was agreed which consisted of examination and hardness testing of the pipe, and analysis of the soil sample to determine the pH, chloride content and sulphate content.

This short report details the findings of the examinations and analysis conducted and provides a brief discussion of the findings of the work.

#### SOIL ANALYSIS

Approximately 3kg of sample was received and analysis of the soil sample provided was conducted by an approved subcontractor. Samples were submitted for testing to determine the pH, water soluble chloride content and the water soluble sulphate content. The testing was conducted in accordance with BS 1377: Part 3: 1990 using a UKAS accredited method. The results were as follows:

| Analyte                                                 | Result |
|---------------------------------------------------------|--------|
| pH                                                      | 4      |
| Water Soluble Sulphate content as SO <sub>3</sub> (g/l) | 0.95*  |
| Water Soluble Chloride content (%)                      | 0.01   |

\*The result quoted above should be multiplied by a factor of 1.2 in order to be expressed as SO<sub>4</sub>.

#### DISCUSSION

The pipe has suffered from extensive corrosion of the outer surface along one longitudinal area of the pipe, with several full thickness holes identified. The results of the analysis identify that the soil the pipe was in contact with is acidic, and the presence of water soluble sulphate signifies a potentially corrosive environment capable of causing the corrosion seen on the outer surface i.e. the test results indicate that corrosion of the pipe has been caused by the corrosive nature of the soil.

## NDT Pipe Inspection Report

-End of Inspection Report-

|                     |           |              |          |
|---------------------|-----------|--------------|----------|
| <b>Reviewed By:</b> | J Hammond |              |          |
| <b>Ref:</b>         | JH_001    | <b>Date:</b> | 03-08-22 |
| <b>Approved By:</b> | F Orlandi |              |          |
| <b>Ref:</b>         | FO_001    | <b>Date:</b> | 03-08-22 |

## NDT Pipe Inspection Report



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