Inspection Report

Project: Inspection of 20" Gasoline – Loading line

Client: 

Date: 2003/08/12

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# Inspection Report

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1. Introduction

The subject of this Report is the ultrasonic online inspection of the

20" Gasoline – Loading line

on behalf of:


The inspection was accomplished with the special OPTIMESS Ultrasonic Tool

ROM2000.

The ultrasound data gathered during this inspection were analysed by the

OPTIMESS Engineering GmbH and the results are enclosed in the present

Inspection Report.
1.1. Details of the Pipeline

Location : ...........................................
Pipeline name : 20” Gasoline – loading line
Length in meter : 3,200m
Diameter : 20”
Wall thickness : 0.5”
Material : CS, API 5lx X-42.
Type of pipeline : longitudinal welded
Internal coating : no internal coating
Internal Diameter : 19”
Year of construction: 1975
Cathodic protection: no cathodic protection
Water depth at end: 26m
Situation at end of pipeline? PLEM (Pipeline end manifold)
2. Description of the Inspection Tool

2.1. General Information

Internal inspection of “unpiggable” pipelines (e.g. loading lines, connecting lines between platforms, water injection pipes) are often impossible and not economically attractive due to the enormous costs associated with this. Internal inspection also brings some problems with it. We know the problems and we have gained many experiences in this area in the last many years. Along with OPTIMESS expertise, the inspection of unpiggable pipelines is no longer a problem.

OPTIMESS is specialised in the construction and use of cable-operated pipeline inspection systems. We have extensive experience in inspecting single-sided access pipelines without launch/receive traps.

With the ageing of pipelines and an increased awareness of environmental risks, there is a growing interest in this type of inspection. Pipelines that are considered unpiggable can be safely inspected by our system. We can provide a tailor-made solution, either for onshore or offshore applications.

Our equipment is motor driven and operates in liquid filled pipelines. We use an ultrasonic and/or a CCTV system to determine the integrity of the pipeline. As the inspection system is equipped with an umbilical, the quantitative results are displayed online (real-time). The equipment can be adapted to suit special conditions and customer’s requirements. We can be inspected at present pipeline diameters between 6” and 48”. Distances of up to 15,000 m (under certain conditions to 20,000m) can be covered; a number of bends are included. The equipment is capable of passing bend radii of up to 1.5D and angles of up to 90 degrees, depending on the pipeline diameter.
Features of the OPTIMESS Pipeline Inspection System ROM 2000 are:

- Single-sided access
- No launch/receive traps necessary
- Passage of bends and dents possible
- No speed effect
- Rotary sensors for a highly exact measurement
- Variable resolution by controlling of the speed
- Real time data presentation
- Safe operation with adapted cable
- Very exact results
2.2. Measuring principle

For the measuring of the wall thickness and the distance to the pipe wall we use the ultrasound running time measuring technique.

The ultrasound echo time measurement is performed by perpendicular incidence according to the echo technique. The ultrasonic pulse from the sensor is triggered by the transmitter pulse, travels across the stand-off distance (distance between Sensor and pipe wall) through the coupling medium, is partially reflected from the inner pipeline wall surface, and returns to the sensor. The remaining sound energy penetrates the pipeline wall, is for the major part reflected from the outer pipeline wall surface, and returns also to the sensor. Depending on sound damping, multiple reflections inside the pipeline wall are possible. The signal echo time across the stand-off distance and the time difference between inner pipe wall echo and rear wall echo are stored as a multiple of a constant time...
base. The distance measured between sensor and pipe wall (stand-off) allows a
general statement regarding the location of the corrosion:

- If this distance increases and the wall thickness decreases, internal metal loss is indicated.
- If it remains unchanged and the wall thickness decreases, the defect is located on the outer wall surface.

In order to avoid invalidated time measurement values of stand-off and/or wall thickness which may be caused by multiple reflections, only pulses within a specified time interval are interpreted by the electronics system. During technical preparation of the inspection tool, these time intervals can be selected according to the stand-off distance feasible with the sensor carrier used or the nominal wall thickness.

The technical parameters of the used ultrasonic sensors provides the performance of the whole system. Therefore we only use own developed sensors. These sensors are optimum balanced on the current inspection.

We use special so called “diving” sensors. The distance between the sensor and the wall of the pipe is 30 to 75 mm. These sensors have the following advantages:

- It is easy to fade out the primary pulse. That means, this pulse has no influence on the secondary pulses.
- The sensors are adjusted through optimisation of the frequency, the absorption and the layer thickness of the respective situation of inspection.
- The sensor works near the natural focus. Therefore we have an optimum signal-noise ratio.
- Because of suitable mechanical constructions robust ultrasonic sensors can be manufactured.

The achievable resolution depends on the diameter, the suppression and the frequency. These parameters influence themselves mutually. Therefore a suitable compromise must be found for each inspection. In accordance with our experiences we used in the existing case sensors with a frequency of 4 MHz and a diameter of 15 mm.
2.2.1. Structure of the ultrasonic sensors

The next illustration shows the principle construction of the used ultrasound sensors.

Sensors, which are used in fluids, are used adaption layers with a layer thickness of $\lambda/4$. To guarantee an optimum constancy of the sensors facing aggressive media, these adaption layer is made of foil of stainless steel and plastic. This impedance transformation produces a noticeable mechanical absorption, which is necessary for the attainment of short impulses with high axial resolution. The advantage of this acoustic adjustment is the high effectiveness of the sensor with simultaneous absorption of the mechanical system.

The most important component of the used transformers are the special Piezo ceramics. These convert the short electric impulses in mechanical oscillations. The ceramics are joined firmly with the absorption body. The used transformers dispose of a strong rear absorption of approx. 6-8 MRayl.
The entire sensor system is isolated acoustically opposite the sensor casing by means of a special plastic mixture. Thereby the disturb level is suppressed in the close field effectively.

### 2.2.2. Sensor electronics

The fundamental construction of the sensor electronics is presented in following picture.

#### 2.2.3. Mode of action

**2.2.3.1. High voltage generator**

The high voltage is produced with special DC/DC converters. To realize an optimum excitation of the sensor, the high voltage must be adjustable. In our case the voltage can be regulated in the area between 200 to 1000 volts. The regulation of the voltage is realized through the micro controller unit (MCU).

**2.2.3.2. Pulse generator**

The generation of the pulse for the respective sensor is steered in dependence on the position of the sensor through the micro controller. Only in this way a clear spatial assignment of the measurement signal is possible. Subsequently the impulse is shortened in dependence on the used frequency of the sensor on the optimum pulse length by approx. T/2.
2.2.3.3. Amplifier
The amplifier consists of a low-noise initial stage with a reinforcement of factor one to two. It is mainly used to improve the signal-noise relationship. Besides, it is responsible for the optimum adjustment of the couple of the sensors.

2.2.3.4. TGC amplifier
The TGC (Time-Gain-Control) amplifier belongs to the class of the VGA's (Variable-Gain-Amplifier). The dynamics-area of the system is widened considerably by it. In order to process signals up to a size of 1µV, this dynamic area has to include approx. 80 to 100dB.
The TGC amplifier is built up two stage and every stage has an adjustable reinforcement of max. 80 dB, i.e. there are enough resources regarding the possible reinforcement.
Since the temporal function (exponential reduction) is known, an optimum signal curve by the control of the reinforcement via micro controller (time-dependent reinforcements curve).

2.2.4. Main focuses
The main emphasis at the development of the electronic components is the creation of a signal noise ratio as optimum as possible. Only through this it is possible to use also smallest echo signals (to 1 µ V) for the evaluation of measurement data’s.

2.2.5. Signal evaluation (Time measurement)
The regulation of the terms of the single echo pulses is regarded as current procedure in the material examination with ultrasonic. Several timers are synchronized with the echo pulses over a gate. As result, you receive the terms of the single echo pulses in the respective media. With known spread speed, you can immediately infer from it to the respective material strengths.
The following illustration shows a typical pulse spectrum in a liquid (pulse between transducer and first body layer).
Running time spectrum in the liquid

The following illustration shows the typical impulse spectrum which is caused by a steel body. The exponential intensity decay can clearly be recognized.

Running time spectrum in a steel body

The average distance of the material peaks is 2 µs.
### 2.3. Design of the used tool

The following illustration shows the principle construction of the used inspection unit.

The first part consists of the drive units, the sensor block and the camera module. The drive units are braced pneumatically in the pipe. The battery units then follow. During this inspection 3 battery units were used. The last part of the inspection tool is the electronic unit. The next illustration shows the inspection tool shortly in front of the beginning inspection.
The cable drum with 8,000m fibre optic cable and the control unit were integrated in a special inspection vehicle.
2.4. **Technical Data of the used Tool**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of sensors</td>
<td>24 rotating ultrasonic sensors</td>
</tr>
<tr>
<td>Driving direction</td>
<td>bi-directional driving</td>
</tr>
<tr>
<td>Operation range</td>
<td>16”-24”</td>
</tr>
<tr>
<td>Measurable damages</td>
<td>dents, corrosion, lamination, deflections</td>
</tr>
<tr>
<td>Duration of impulse</td>
<td>125ns</td>
</tr>
<tr>
<td>Frequency of impulse</td>
<td>10kHz</td>
</tr>
<tr>
<td>Sensor frequency</td>
<td>4MHz</td>
</tr>
<tr>
<td>Weight</td>
<td>350kg</td>
</tr>
<tr>
<td>Total length</td>
<td>4,500 mm</td>
</tr>
<tr>
<td>Speed of operation</td>
<td>2-10m/min</td>
</tr>
<tr>
<td>Water depth</td>
<td>100m</td>
</tr>
<tr>
<td>Permissible medium temperature</td>
<td>+5 °C to +45 °C</td>
</tr>
<tr>
<td>Range of inspection</td>
<td>up to 7,500 m</td>
</tr>
<tr>
<td>Bend radius</td>
<td>there are no bends in the line</td>
</tr>
<tr>
<td>Range of wall thickness</td>
<td>2 - 25mm</td>
</tr>
<tr>
<td>Accuracy of thickness measure</td>
<td>+/- 0.1mm</td>
</tr>
<tr>
<td>Accuracy of corrosion depth</td>
<td>+/- 0.5 mm</td>
</tr>
<tr>
<td>Resolution along axis</td>
<td>continuously adjustable – (5mm)</td>
</tr>
<tr>
<td>Circumferential resolution</td>
<td>continuously adjustable – (5mm)</td>
</tr>
<tr>
<td>Defect location accuracy</td>
<td>0.1 m</td>
</tr>
<tr>
<td>Coupling medium during inspection</td>
<td>Salt water</td>
</tr>
</tbody>
</table>
3. Survey Procedures

An excavation was made on the beach. The client submitted the pipeline filled with saltwater. The line was cut open and temporary pig traps were installed.

3.1. Cleaning of the pipeline

At first a connection should be made to the parallel regular pipeline with a “Chinese lamp”. This wasn't possible due to the floor conditions (rock) at the end of the pipeline. Therefore only a flexible connection was made between the two pipelines. For this reason we are used for cleaning bi-directional pigs.

The following picture shows the excavation on the beach side.
3.1.1. Cleaning runs

Due to the relatively high age and the unknown condition of the pipeline we decided to carry out cleaning with foam pigs.

*first cleaning run*

We carried out the first cleaning run with a Wire Brush Polly Pig.

The following illustration shows how cleaning with a Polly pig in principle works.

The cleaning action of the Polly-Pig is created by the frictional drag provided by the oversize diameter. In addition, the pressure created by the fluid on the rear of the pig compresses the pig longitudinally. This increases the frictional drag on the walls of the pipe and the pig's scraping action.

Some fluid passes around and through the foam body creating a high velocity, low volume jetting bypass. This bypass flushes debris ahead of the pig, suspending some of the debris in solution and sweeping it out of the line.
The pig was pumped with a speed of 1.0 to 1.5 m/s up to the PLEM. The direction was changed and the pig was pumped back to the pig trap. This cleaning run had the following aims:

- Examination whether the line is blocked
- Loosening of possible available solid deposits

After the cleaning run some steel bolts were in the pig.
second cleaning run

We carried out the second cleaning run with a Foam Disc Pig.

With the help of this disc pig we removed the loose deposits (sand, mud, corrosion material, etc.) from the pipeline.
**Third cleaning run**

We carried out the third cleaning run with a Steel Mandrel Disc Pig.

This additional cleaning run had the aim of removing solid deposits, steel bolds and weld electrodes.
3.1.2. Results of cleaning

Cleaning of the line provided the following results:

1. It was removed approx. 1.5 m³ of deposits and debris (approx. 85% sand, approx. 10% corrosion material).
2. Steel bolts and weld electrodes were found in the removed deposit/debris.
3. The pipeline isn’t blocked.

3.2. Inspection of the Pipeline

3.2.1. Pipeline preparation

After cleaning the temporary pig traps were removed. A special ramp were then added.

3.2.2. Preparation of the Inspection equipment

In our temporary workshop, all ultrasound sensors were calibrated individually. The electronic and mechanical components were checked both by a functional test and a continuous test. After them, the individual inspection modules were connected to a “inspection train”. The connection to the control unit was made over the fibre optic cable. The whole system were checked again.
After this the data transmission and the data recording were checked. The permitted inspection speed was adjusted. Then a test measurement was made at a known pipe segment.

3.2.3. Inspection run

The inspection was started on 2003/07/11 at 9.00 p.m.. The middle inspection speed was 0.125 m/s. The inspection unit reached the PLEM after 3,174m on 2003/07/12 at 4.05 a.m.

All inspection data were recorded successfully.

3.2.4. handling after the run

The inspection unit was driven back with a middle speed of 0.25 m/s. The inspection modules were removed from the pipeline at 9.00 a.m.. Then they were cleaned and packed.
3.3. **Survey schedule**

<table>
<thead>
<tr>
<th>Date Range</th>
<th>Date</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>27.06 –</td>
<td>05.07.2003</td>
<td>Setting up construction site</td>
</tr>
<tr>
<td></td>
<td>05.07.2003</td>
<td>Handing over of the line by the client</td>
</tr>
<tr>
<td></td>
<td>05.07.2003</td>
<td>Cutting the line</td>
</tr>
<tr>
<td>06.07. –</td>
<td>10.07.2003</td>
<td>Cleaning of the pipeline</td>
</tr>
<tr>
<td>11.07. –</td>
<td>12.07. 2003</td>
<td>Inspection run</td>
</tr>
<tr>
<td></td>
<td>12.07.2003</td>
<td>Closing the line</td>
</tr>
<tr>
<td></td>
<td>13.07.2003</td>
<td>Handing over of the line at the client</td>
</tr>
<tr>
<td>13.07. –</td>
<td>20.07.2003</td>
<td>Removing construction site</td>
</tr>
</tbody>
</table>
4. Evaluation of the Measurement Data’s

4.1. Evaluation Procedure

The ultrasonic data’s collected during the inspection of the pipeline were systematically evaluated in the our Analysis Department.

The individual results are enclosed in the Appendix of this report. Refer to Chapter 6 for the "Features List", the "Documented Features" and the "Pipe Book".

4.2. Evaluation Criteria

The criteria for features to be entered into the Features List were applied as follows:

**metal losses** -
- minimum depth: 2.5 mm (20% wall thickness reduction)
- minimum length: 20 mm
- minimum width: 20 mm

**inclusions** - if detected in concentrated form

**laminations** -
- minimum length: 100 mm
- minimum width: 25 mm
  - generally:
    - if the lamination is not parallel to the surface
    - if the lamination has contact to a weld

**dents** -
- every visible deformation greater than 2 mm
- minimum length: 50 mm
- minimum width: 50 mm

**installations** - No installations are in the line section to be inspected.

These criteria were fixed together with the client. Since the inspections are always carried out with the highest measuring resolution, these criteria can be adapted again later.
The following illustrations describe the coordinates used in the report.
### 4.3. Remarks on the Features List

The results of the interpretation work done by our Analysis Department are collected in the Features List (see Appendix 6.1).

#### Example Features List:

<table>
<thead>
<tr>
<th>No.</th>
<th>Comment</th>
<th>distance (m)</th>
<th>wt (mm)</th>
<th>depth (mm)</th>
<th>length (mm)</th>
<th>width (mm)</th>
<th>position (°)</th>
<th>type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ml</td>
<td>96.3</td>
<td>6.5</td>
<td>6.0</td>
<td>60</td>
<td>50</td>
<td>290</td>
<td>int</td>
</tr>
<tr>
<td>2</td>
<td>ml</td>
<td>101.4</td>
<td>6.4</td>
<td>6.1</td>
<td>95</td>
<td>20</td>
<td>300</td>
<td>int</td>
</tr>
<tr>
<td>3</td>
<td>ml</td>
<td>112.8</td>
<td>8.1</td>
<td>4.4</td>
<td>80</td>
<td>70</td>
<td>180</td>
<td>ext</td>
</tr>
<tr>
<td>4</td>
<td>de</td>
<td>123.5</td>
<td>12.5</td>
<td>1,230</td>
<td>115</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>dR = -15mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>wt-ch</td>
<td>256.0</td>
<td>10.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>12.5mm → 10.0mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>wt-ch</td>
<td>352.3</td>
<td>12.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>10.0mm → 12.5mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>ml</td>
<td>648.4</td>
<td>7.6</td>
<td>4.9</td>
<td>45</td>
<td>25</td>
<td>45</td>
<td>ext</td>
</tr>
</tbody>
</table>

**Description of the feature list:**

- **no.** Number of the feature
- **comment** description of the detected feature;
  - the following abbreviations are used:
    - `ml` = metal loss
    - `lam` = lamination
    - `de` = dent (dR = maximum change of radius)
    - `df` = deflection (dR = maximum change of radius)
    - `be` = bend
    - `wt-ch` = wall thickness change
    - `gw` = grid weld
    - `lw` = longitudinal weld
    - `sw` = spiral weld
- **distance** Distance value which is measured on the cable drum;
  - this value designates the position where the related feature begins.
wt       local wall thickness value
depth    measured deepest area of this feature
length   measured length of this feature
width    measured width of this feature
position circumferential position of this feature;
          $0^\circ = 12 \text{o'clock position; counting clockwise when looking downstream}$
type     basic type of feature:
          int = internal
          ext = external
          mid = mid-wall
          i/e = internal and external
4.3.1. **Explanation of terms used for the description of features:**

**metal loss** is any reduction in wall thickness, for example due to internal or external corrosion.
dent describes the location of a dent.

Note: The dimensions given for dents are the actual dimensions of the dent.

lamination describes a mid-wall mill defect which usually occurs when the plate is rolled and which is mostly at 50% of the actual wall thickness.
4.4. Remarks on the Pipebook

The Pipebook (see Appendix 6.2) lists all pipe joints in consecutive order.

It is generated by girth weld detection.

**Example Pipebook:**

<table>
<thead>
<tr>
<th>No.</th>
<th>Start (m)</th>
<th>End (m)</th>
<th>Pipe length (m)</th>
<th>wt (mm)</th>
<th>comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>11.95</td>
<td>11.95</td>
<td>12.2</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>11.95</td>
<td>23.80</td>
<td>11.85</td>
<td>12.2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>23.80</td>
<td>35.70</td>
<td>11.90</td>
<td>12.3</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>35.70</td>
<td>47.67</td>
<td>11.99</td>
<td>12.4</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>47.67</td>
<td>59.56</td>
<td>11.89</td>
<td>12.3</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>59.56</td>
<td>71.56</td>
<td>12.00</td>
<td>12.3</td>
<td></td>
</tr>
</tbody>
</table>

- **no.** pipe number in consecutive order, beginning with no. 1.
- **start** distance of the up-stream girth weld of the pipe joint, relative to the zero point; distance values which is measured on the cable drum
- **end** distance of the down-stream girth weld of the pipe joint, relative to the zero point; distance values which is measured on the cable drum
- **pipe length** length of the pipe joint, difference between "start" and "end" distance;
- **wt.** average wall thickness of the related pipe
- **comment** additional information.
5. Discussion of Results

5.1. Summary of Results

The ultrasonic data generated during this inspection clearly depict the present condition of the pipeline. The following table gives an overview of the features detected by the ROM 2000 inspection tool:

<table>
<thead>
<tr>
<th>feature type</th>
<th>quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>metal lost</td>
<td>5</td>
</tr>
<tr>
<td>lamination areas</td>
<td>-</td>
</tr>
<tr>
<td>dents</td>
<td>3</td>
</tr>
<tr>
<td>installations</td>
<td>-</td>
</tr>
</tbody>
</table>

The results can be summarized as follows:

- Large general metal loss areas were not detected.
- No concentration of certain defect types were found in individual pipe sections.
- The defect type that occur most frequently are external metal lost.

The detected **external metal loss features** are summarized in the following table:

<table>
<thead>
<tr>
<th>depth</th>
<th>quantity</th>
</tr>
</thead>
<tbody>
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<td>-</td>
</tr>
<tr>
<td>2.0 – 2.9mm</td>
<td>-</td>
</tr>
<tr>
<td>3.0 – 3.9mm</td>
<td>4</td>
</tr>
<tr>
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</tr>
<tr>
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</tr>
<tr>
<td>6.0 – 6.9mm</td>
<td></td>
</tr>
<tr>
<td>7.0 – 7.9mm</td>
<td></td>
</tr>
<tr>
<td>8.0 – 8.9mm</td>
<td></td>
</tr>
<tr>
<td><strong>total:</strong></td>
<td><strong>5</strong></td>
</tr>
</tbody>
</table>
No internal metal lost features were found.

The pipe is altogether into a very good condition. The found features can be repaired easily.

5.2. Histograms

The following histograms normally are prepared:

- Distribution of Internal Metal Loss Features – Depth Values in mm
- Distribution of External Metal Loss Features – Depth Values in mm
- Distribution of Internal Metal Loss Features – Depth Values as % of Wall Thickness
- Distribution of External Metal Loss Features – Depth Values as % of Wall Thickness
- Distribution of Internal Metal Loss Features on the Circumference
- Distribution of External Metal Loss Features on the Circumference
- Distribution of Dents
5.2.1. Distribution of Internal Metal Loss Features

5.2.2. Distribution of External Metal Loss Features
5.2.3. Distribution of Internal Metal Loss Features

5.2.4. Distribution of External Metal Loss Features
5.2.5. Distribution of Internal Metal Loss Features on the Circumference

5.2.6. Distribution of External Metal Loss Features on the Circumference
5.2.7. Distribution of Dents
6. Appendix

6.1. Features list

<table>
<thead>
<tr>
<th>No.</th>
<th>Comment</th>
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<th>wt</th>
<th>depth</th>
<th>length</th>
<th>width</th>
<th>position</th>
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</thead>
<tbody>
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<td>de dR = -35mm</td>
<td>81.15</td>
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<td>280</td>
<td>135</td>
<td>249 - 280</td>
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<td>de dR = -40mm</td>
<td>214.00</td>
<td>11.5</td>
<td></td>
<td>1,000</td>
<td>220</td>
<td>330 - 20</td>
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<td>3</td>
<td>de dR = -40mm</td>
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<td>8.0</td>
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<td>70</td>
<td>65</td>
<td>171 - 185</td>
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<td>ml</td>
<td>409.21</td>
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<td>3.8</td>
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<td>95</td>
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<td>9.0</td>
<td>3.5</td>
<td>50</td>
<td>10</td>
<td>136 - 139</td>
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<tr>
<td>6</td>
<td>ml</td>
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<td>9.2</td>
<td>3.3</td>
<td>70</td>
<td>10</td>
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<tr>
<td>7</td>
<td>ml</td>
<td>475.19</td>
<td>8.5</td>
<td>4.0</td>
<td>900</td>
<td>950</td>
<td>51 - 267</td>
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<tr>
<td>8</td>
<td>ml</td>
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<td>3.9</td>
<td>170</td>
<td>155</td>
<td>157 - 196</td>
<td>ext</td>
</tr>
</tbody>
</table>
6.2. **Color charts**

6.2.1. **Dent at 81.15m**

![Color chart diagram showing dent at 81.15m with values: Distance [m] = 61.43, Angle [°] = 105, Radius [mm] = 240, Thickness [mm] = 6.7]
6.2.2. Dent at 214.00m

![Diagram of dent location and measurements]
6.2.3. Dent at 273.21m
6.2.4. external metal lost at 409.21m
6.2.5. external metal lost at 417.22m
6.2.6. external metal lost at 417.31m
6.2.7. **external metal lost at 475.19m**

external corrosion in the area of the welded seam, with a high probability the outer corrosion protection is damaged
6.2.8. **external metal lost at 522.49m**

Even more small external corrosion areas are in this pipe section.