Standardised Integrity Assessment

- Internal Company Standard
- Basis for Assessment of Pipeline Integrity
- Describes basic principles of pipeline integrity
- Describes methods and procedures for assessment of pipeline condition
- Describes type, extent and frequency of testing and assessment
- Contains assessment criteria and limit values
- Describes possible mitigating measures.

Based on EN 16348
Integrity Risks

General Corrosion
- Under shielding coatings
- Due to insufficient cp
- Within casings
- Under concrete saddles

Corrosion by Interference
- AC corrosion
- DC stray current corrosion

Cracks
- Stress corrosion cracking
- ...

Mechanical Damage
(Third party interference)
- By trenching machines
- Drilling
- Dents
- ...

Milling defects
- Material defects
- Inclusions
- Laminations
- Rolling defect
- Grindings

Geometrical Defects
- Expansions
- Dents

Routing and Strain
- Pipeline displacement
- Additional strain

Miscellaneous
- Girth weld anomalies
- Lightning puncture
- ...

Pipeline Operation and Maintenance | 10.4.2014
Pipeline Classification for Integrity Assessment

Pipeline Category I
- Not piggable
- Gas or electrically welded
- Old pipe joints
- Long operational period without CP

Pipeline Category II
- Not piggable
- Electrically welded
- CP almost since construction

Pipeline Category III
- Piggable
  - (sections ≥ 20 km, > DN 200)
  - Electrically welded
  - CP since construction

Main Tool for Integrity Assessment
- Inline Inspection (Intelligent Pigging)
- Intensive measurement
- Casing survey
- Joint assessment (PIA²)
- Intensive measurement
- Casing survey

Based on EN 16348
Integrity Assessment Process

Pipeline category I
Sleeve sockets
1912 – 1958

Pipeline category II
Not piggable
BJ 1959 - today

Pipeline category III
Piggable
1963 - today

Priorisation and determination of assessment method

- Sleeve sockets (PIA²)
- Inline inspection
  - Intensive measurement
  - Assessment of casing pipes
  - High voltage assessment

Assessment and detail assessment
(corrosion protection, materials)

Measures
(Repair, securing, refurbishment, replacement)

Verification of Pipeline Integrity
(Documentation, definition of expiry date)

Based on EN 16348
# Integrity Measures and Intervals

<table>
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<th>Integrity Measure or Element</th>
<th>Interval</th>
<th>Reference</th>
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<tbody>
<tr>
<td>As-built documentation</td>
<td>once</td>
<td>G 463</td>
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<tr>
<td>Pressure test / stress test</td>
<td>once</td>
<td>G 463</td>
</tr>
<tr>
<td>Verification of CP effectiveness (e.g. by intensive measurement)</td>
<td>once</td>
<td>GW 10</td>
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<tr>
<td>Check of pressure safeguarding</td>
<td>every four years</td>
<td>G 495</td>
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<tr>
<td>CP remote monitoring</td>
<td>every two months</td>
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<td>Check of CP, off-potential measurements</td>
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<td>Check of AC interference situation</td>
<td>every five years</td>
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<td>Pipeline monitoring and maintenance (incl. tightness testing)</td>
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<td>Inline inspection</td>
<td>acc. to ILI strategy (15 – 25 y)</td>
<td>G 466-1, RN 210-001</td>
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<tr>
<td>Assessment of old joints</td>
<td>typically once</td>
<td>RN 210-001</td>
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<tr>
<td>Strategy in the case of previous damage</td>
<td>Case-by-case</td>
<td>...</td>
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<tr>
<td>Excavation, NDT, check for corrosion, ...</td>
<td>Case-by-case</td>
<td>...</td>
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</tbody>
</table>
Contents

- OGE at a Glance, OGE Pipelines in Germany
- Integrated Management System
- Pipeline Design & Safety Philosophy
- Pipeline Integrity Management System
- Corrosion Control
- Hydrostatic and Tightness Testing
- Inline Inspection Techniques
- Defect and Failure Investigation
- Troubleshooting & Repair-Techniques
- Conclusions
CP-Tools/Methods and Intervals

<table>
<thead>
<tr>
<th>CP-Tool / Method</th>
<th>Example</th>
<th>Reference</th>
<th>Interval</th>
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<tbody>
<tr>
<td>Verification of cp effectiveness</td>
<td>e.g. Intensive measurement</td>
<td>GW 10</td>
<td>once</td>
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<tr>
<td>CP remote monitoring</td>
<td></td>
<td>GW 16</td>
<td>2 month</td>
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<td>Off-potential measurement at selected test stations</td>
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<td>GW 10</td>
<td>3 years</td>
</tr>
<tr>
<td>CP survey measurements at casings</td>
<td></td>
<td>GW 10, AfK 1</td>
<td>3 years</td>
</tr>
<tr>
<td>Review and check of AC interference situation</td>
<td></td>
<td>AfK 3, GL 718-079</td>
<td>5 years</td>
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<tr>
<td>Intensive measurement</td>
<td>Integrity assessment</td>
<td>G 466-1, RN 210-001</td>
<td>15 – 25 years ¹</td>
</tr>
<tr>
<td>Intensive fault detection</td>
<td>Location of defects within warranty period</td>
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<td>Mobile cp probe</td>
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<tr>
<td></td>
<td>Integrity assessment</td>
<td>G 466-1, RN 210-001</td>
<td></td>
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</tbody>
</table>

¹) Depending on condition of pipeline
Corrosion Protection of Burried Pipelines

Burried pipelines are protected against corrosion by a combination of electrochemical protection (cathodic corrosion protection) and an electrically insulating coating (passive corrosion protection).
Prerequisites for Installation of CP (EN 12954, GW12)

- Electrical separation from grounded installations
  (e.g. Metering- and compressor stations, grounding systems, e-valves)
  → Use of unsulating couplings or flanges

- Longitudinal electrical conductivity
  → fullfilled for continuously welded pipelines

- Electrically insulating coating
  → factory and field coating of all installations
Typical Corrosion Risks on Pipelines

- Corrosion under disbanded coatings
- Corrosion due to insufficient CP
- Corrosion within casings
- Corrosion under concrete saddles
- AC corrosion
Quality Assurance by Corrosion Protection Measurements

- Coating insulation test (at construction stage)
- Drainage test (at construction stage)
- Intensive defect detection survey (within warranty period)
- Intensive measurement survey (existing pipelines)
Intensive Measurement (CIPS + DCVG)

Reference electrode
Potential measurement
Voltage gradient measurement
Cable connection
CP protected, coated pipeline
Coating defect

AfK No. 10 → DVGW GW 27, EN 13509
Assessment of Casings (Resistance Comparison Method)

\[ R_{mi} > R_{a,\text{min}} \Rightarrow \text{CP is effective} \]
\[ R_{mi} < R_{a,\text{min}} \Rightarrow \text{Assessment not possible} \]

\( R_{mi} \) = Calculated spread resistance of coating defects within the casing pipe
\( R_{a,\text{min}} \) = Spread resistance of a coating defect that can just be protected

(AfK Recommendation No. 1)
High-Voltage Interference

High-voltage power line

Coating defect with AC corrosion

max. touch voltage

Calculated voltage \textit{without} grounding systems

Calculated voltage \textit{with} grounding systems

AC corrosion
New approach for pipeline protection against external damage

TPI detection by CP measurement technique
The Idea
The Idea
Realtest 11.03.2009, Test Scenario

TestPipeline DN 300, Length 12 m

Gaspipeline
DN 1200
PN 100

1 m
Real Test

Test Pipeline before Backfilling

Minidigger

22 ton Chain Dredger

Beyond DVGW GW ...
Real Tests

Test 2

Test 4
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Stress Test = Hydrostatic Test close to yield strength to identify and eliminate pipe with serious defects, e.g. weld defects, out of spec material; but no minor defects (VDTÜV Working sheet No. 1060)
Mill Defects found by Stress Test (at / after Construction)

Inclusion & Lamination

Overlapping from Plate rolling
Cracks & Gouges found by Stress Test (Rehabilitation)

SCC

External Interference

Fatigue Crack

Girth Weld Defects