Types of Defects:

- Mill/Constr. defects
- Old joints
- AC corrosion
- Landslide
- Corrosion
- Lightning
- Weld defects
Ensure Integrity by Assessment of Defects

- Weld defects
- Cracks
- Gouges from External Damage
- Metal Loss caused by Corrosion
- Dents
- (Puncture)
Assessment Criteria defined in Company Standard

- 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.
Non-Destructive Testing and Evaluation of Defect Geometry
Defect Measurement Using OPTO-CAM (3D Scanning)

Corrosion damage

Measurement of corrosion using light/laser scanning

Digital reproduction (3D point cloud)

Calculation of stress distribution in surface using FEM
Finite Element Analysis

- Vibration analysis
- Unstable slopes
- Bending
- Corrosion feature assessment
- Crack assessment
- Buckling
- Eigenvalue
On-Site Material Analysis

Hardness test
UCI method

Micrograph at surface

Chemical analysis
Spark spectrometry
Monitoring – Field Measurements

- Vibrations
- Strain
Online monitoring

Temperature-induced stress

Trend in strain following stress relief

Stress relief following mining subsidence
PIA² - Assessment of Old Joints

Theoretical Load + Real Behaviour

Usage factor = $f(\text{type of joint, diameter, pressure, wall thickness, grade, ...})$
Metallography in Defect Analysis

Analysis with SEM and EDX

Failure analysis
Excavation Procedure (Corrosion Investigation)

- Decision for excavation of MFL pig run feature
- GPS localisation of feature
- Conduction of intensive measurement at feature position +/- 50 m
- Excavation
- Corrosion study (considering soil type, soil chemistry, type of coating, coating condition, corrosion products, pH at coating defect and underneath coating, scale formation, CP operational parameters etc.)
Contents

- OGE at a Glance, OGE Pipelines in Germany
- Integrated Management System
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- Corrosion Control
- Hydrostatic and Tightness Testing
- Inline Inspection Techniques
- Defect and Failure Investigation
- Troubleshooting & Repair-Techniques
- Conclusions
- Repair of Small Defects
  → Grinding, Welding Patches, Welding

- Securing of Old Joints
  → Welding sphercial caps

- Repair of Severe Defects
  → Split sleeve, hot sleeve, pipe replacement
Repairing by Split Sleeve

X 80 Pipe
T-Joint
Gas flow: $10^6$ m$^3$/h

Same Good Behaviour of Welding X 70 and X 80 in Service
Testing of New Repair Method ("Hot Sleeve"), Example

Numeric simulation indicates insufficient safety level

Installation of "hot sleeve"

Data transmission
For online monitoring

"Hot sleeve"
Temporary Repair Methods

- Low Internal Pressure → Type „Ruhrgas“
- High Internal Pressure → Type „Plidco“
- High Internal Pressure and Coated Pipe → Type „Manibs“
Repair Techniques

- Cutting Pipeline in Areas of Ground Movement
- Inliner in Pipeline
Special Repair Techniques

Closure of Filter or Pigging traps

Construction with Screws

Cracks at Welds

Repairing in Workshop

Repairing by Grinding

Repairing in Operation
Special Repair Techniques

Cracks at Combustor

Thermography in Operation

Simulation and Analysis

3-dimensional Construction

Repairing in Workshop

Pressure Testing of New Combustor
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Conclusions

- Different Pipeline Standards Existing at OGE
- Pipelines became older but are fully operational
- Operation of pipeline for much more than 90 years is possible
- Expert KnowHow for maintenance is very important
- Intelligent strategies for operation of old and new pipelines are available at OGE
- The DVGW technical rules (and the referenced standards) provide the framework for construction, operation and maintenance of approx. 12,000 km of Transmission pipelines