



*Energiegase:  
Methan, Biogas, Wasserstoff, Synthesegase.*

## **TEIL 7 – Pipelines: Maintenance, Operation & Dispatching**

WS 2023/24

Ruhruniversität Bochum

Lehrstuhl für Energieanlagen und Energieprozesstechnik

# Teil 7 – Pipelines

Maintenance

Operation & Dispatching

- 1 Risks pipelines are exposed to
- 2 Inspection and repair methods
- 3 PIMS
- 4 Dispatching and emergency response
- 5 Valves and valve spacing

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# Operation of Pipelines

Safety devices, monitoring (grid control), maintenance, patrolling

## Quality control

Operation → Monitoring → Maintenance



Surveillance by walking



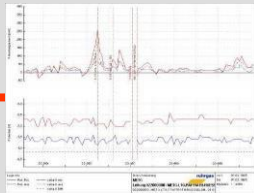
... by car



... by helicopter



Tracing of observations



Intelligent pigging



Repair/  
rehabilitation

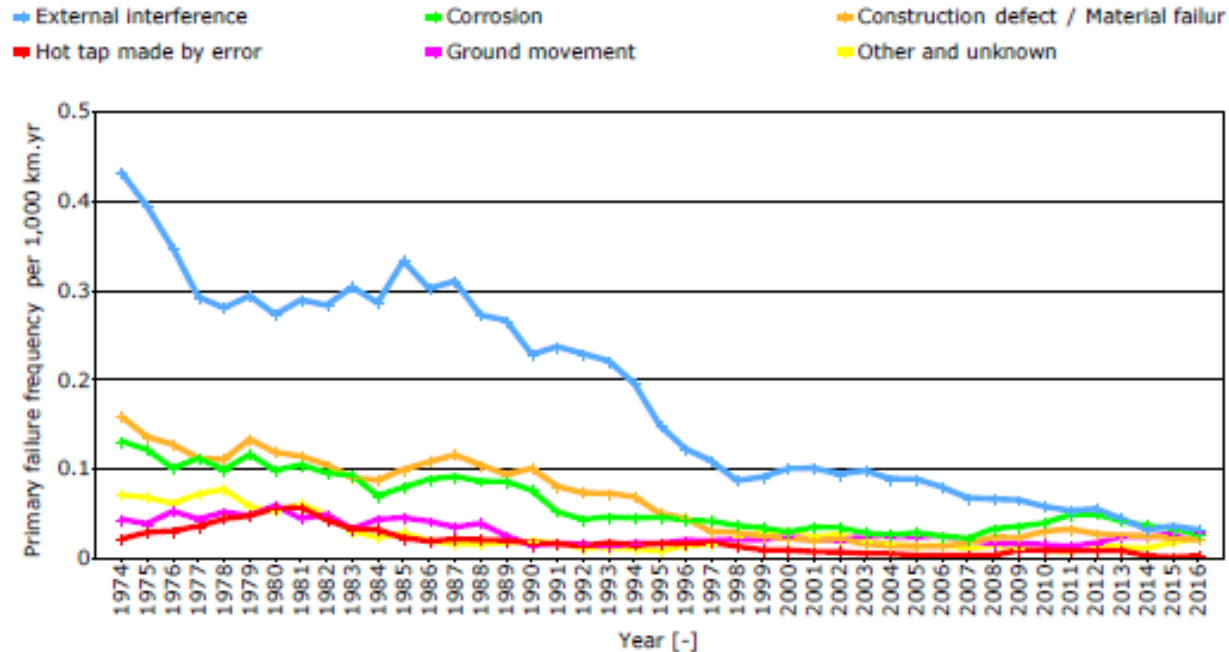
# Operation of Pipelines

Safety devices, monitoring (grid control), maintenance, patrolling



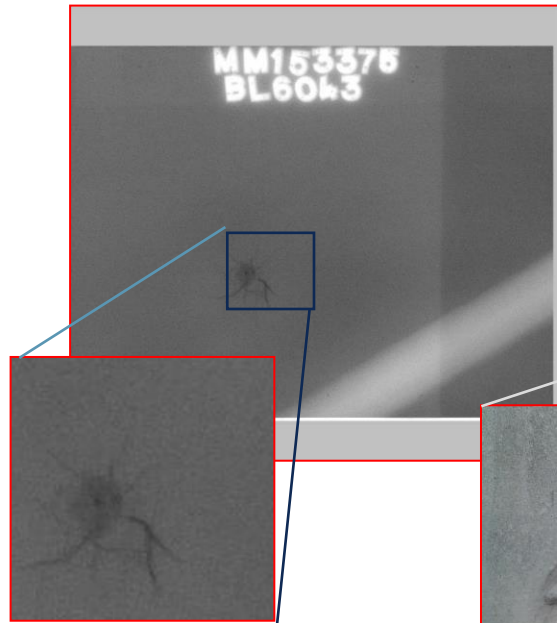
# Pipelines are exposed to threats

See EGIG statistics and findings from the 2018 report:



# Defects from external interference

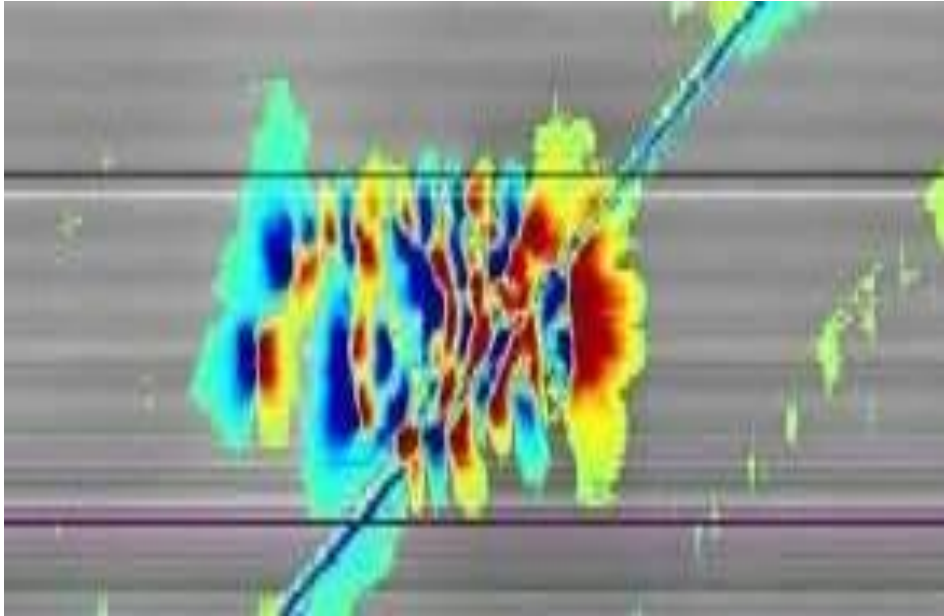
Internal crack



Gouges due to TPI



# Corrosion defects





# Disbonding defects



Wrapped double layer

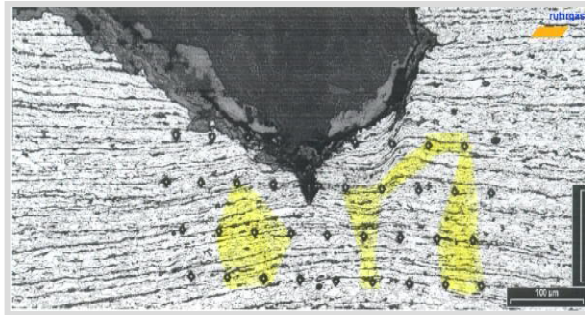
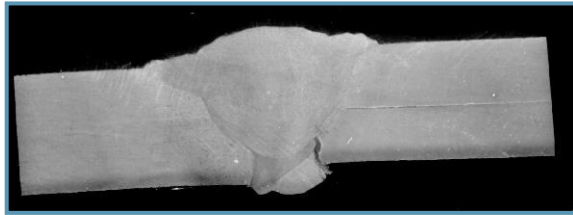


Mud in between layers



Corrosion due to disbonding

## Failure Analysis

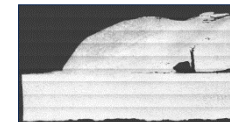
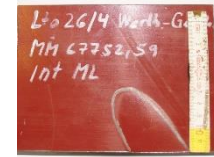


Analysis of failure of important components to find defects with

- Microstructure  
(here: crack in girth weld with lamination in base material)
- Hardness testing  
(here: crack tip after stress test)

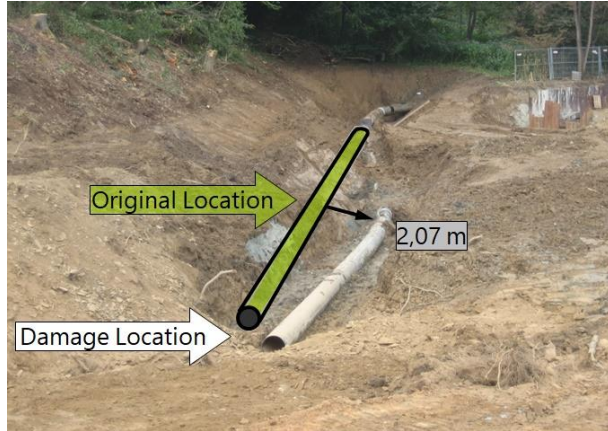
# Typical mill defects

- Inclusions
- Laminations
- Rolling Defects
- Surface Defects
- Grindings
- Indentations
- Hard Spots / Cracks
- Welds Defects



# Other damages

## Landslide



## Lightning strike



## Eccentricity in casings



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# Operation of Pipelines: Inspections Methods

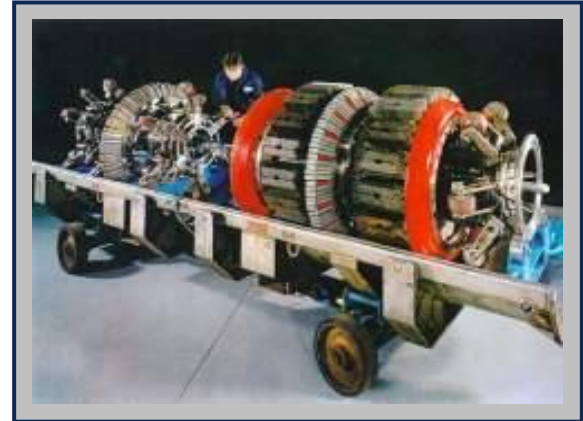
Inline inspection with intelligent “pig”



**Cleaning Pig**



**Calipper Pig** (inst. of Dummy)



**MFL Pig**

# Operation of Pipelines: Inspections Methods

Type of Inspection	Baseline	Operation	Integrity Aspects
Geometry (Calliper)	✓	✓	<ul style="list-style-type: none"><li>▪ Dents</li><li>▪ Ovalities</li><li>▪ Expansions</li></ul>
MFL	✓	✓	<ul style="list-style-type: none"><li>▪ Corrosion</li><li>▪ External damage</li><li>▪ (Weld Anomalies)</li><li>▪ (Mill Defects)</li></ul>
IMU (Mapping)	✓	✓	<ul style="list-style-type: none"><li>▪ Position</li></ul>
IMU (Strain)	✓	✓	<ul style="list-style-type: none"><li>▪ Displacements</li><li>▪ Additional Stress/Strain</li></ul>
Interval	1 x	15 – 25 Years	

# Operation of Pipelines: Inspections Methods

## Non-destructive Testing on Pipeline on site



Non-destructive testing of girth welds – especially welding under operating conditions:

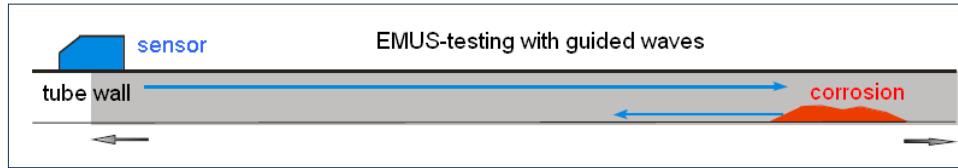
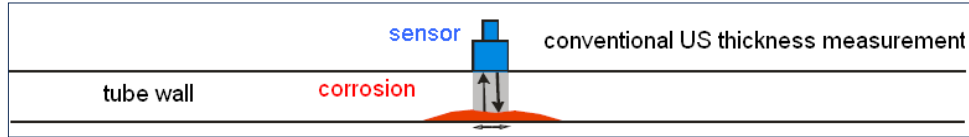
- Ultrasonic testing
- X-ray testing
- Magnetic inspection
- Liquid sustain testing
- Eddy current testing
- Visual testing



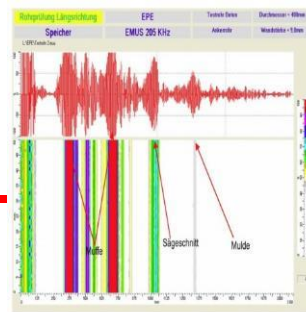
# Operation of Pipelines: Inspections Methods

## EMUS electro magnetic induced ultra sound

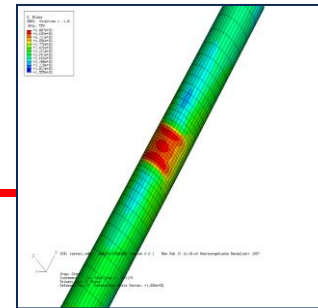
### 1. System test EON ruhrgas



2. Measurement



3. Results

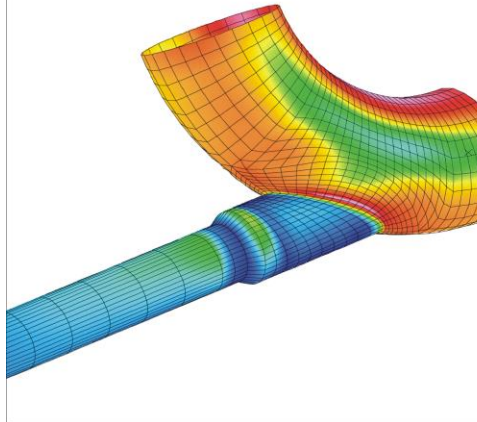
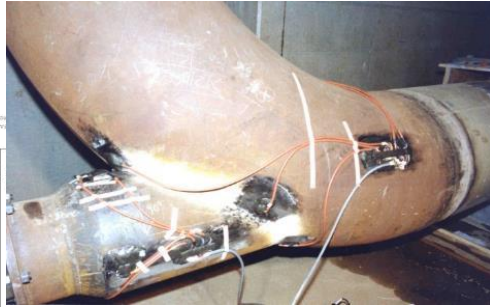


4. Assessment- FE-analysis

Integrity

# Operation of Pipelines: Stress measuring & assessment

## Estimation of Stress/Strain of Component under Operation



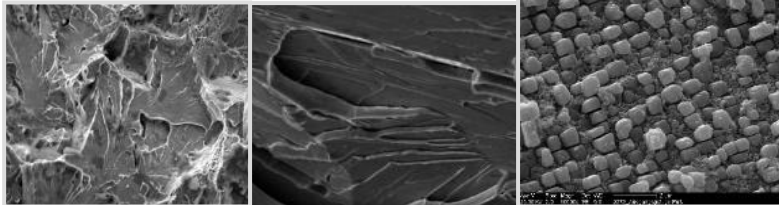
Numerical simulation to calculate stress/strain of components

Measuring stress/strain by strain gauges

Example:

Bend with Support under Operation

# Operation of Pipelines: Investigation Methods defect colonies and failure analysis



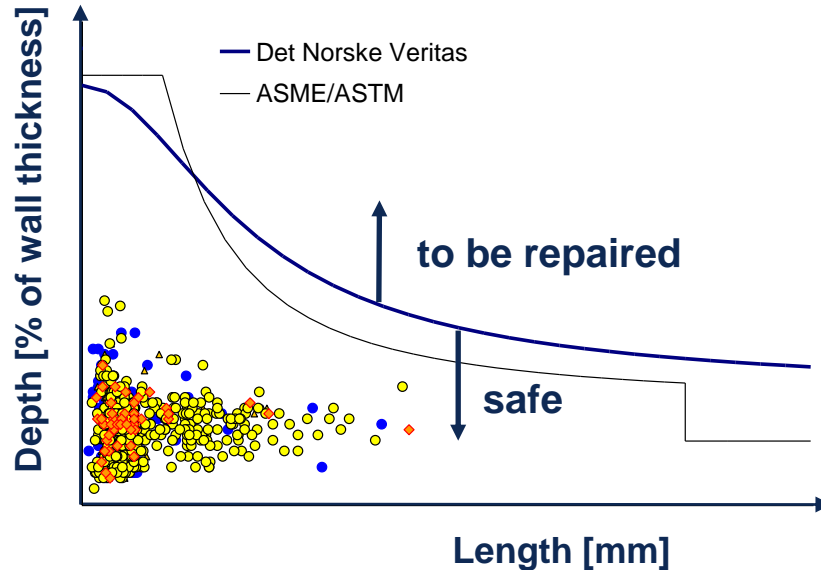
Analysis of failure of important components to find defects with

- Scanning electron microscope (fracture surface)
- EDX (chemical analysis)

# Operation of Pipelines: Investigation Methods defect colonies

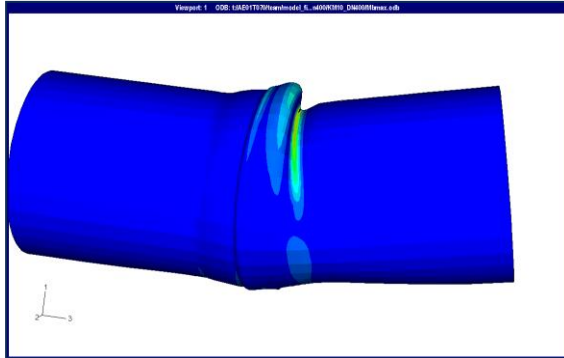
## Assessment Methods – Metal Loss with DNV-RP 101

Result of assessing integrity of Pipe with metal loss caused by external corrosion



# Operation of Pipelines: Investigation methods for joints

## Simulation by FEM of complex loading



Numerical simulation of complex components to assess the behaviour under special conditions:



Example:

Special old joints with gas welded seam under operating pressure and bending

# Operation of Pipelines: Investigation Method Finite Element Analysis

## Step 1

Scanning the surface of the defect

- direct scan
- scan of a cast model
- (negative shape)

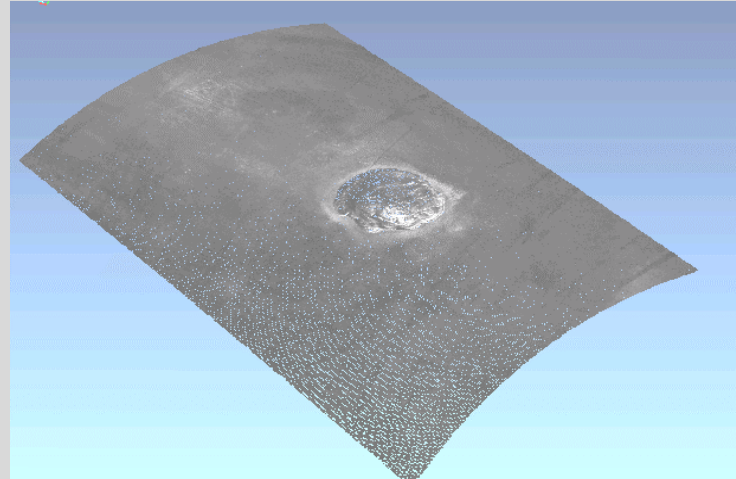
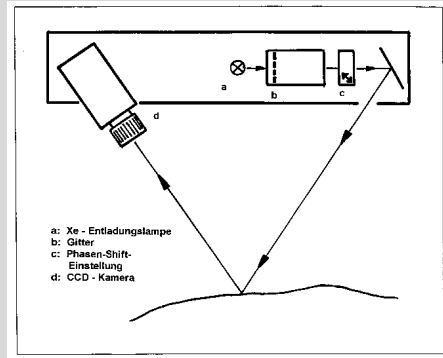
The cast consists of plastics moulding material and can be easily moulded by the NDT-personnel on site



# Operation of Pipelines: Investigation Method Finite Element Analysis

## Step 1

The result of the measurement is a 3-dimensional cloud of up to 1,3 Mio. points with the coordinates  $x, y, z$

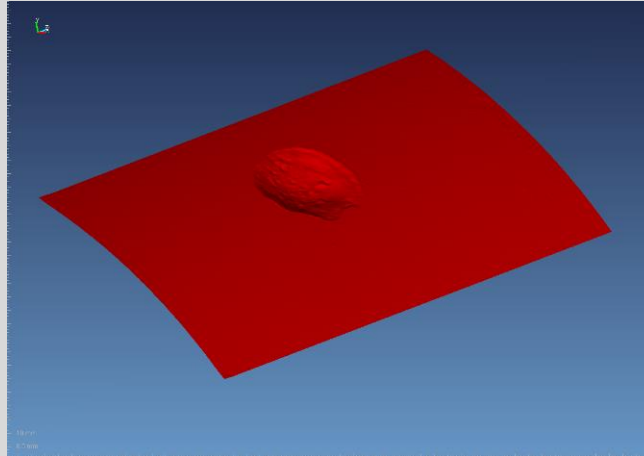


Point cloud generated by optoCAM

## Step 2

### Computing the Surface

All geometric details of the surface are taken into account for the evaluation

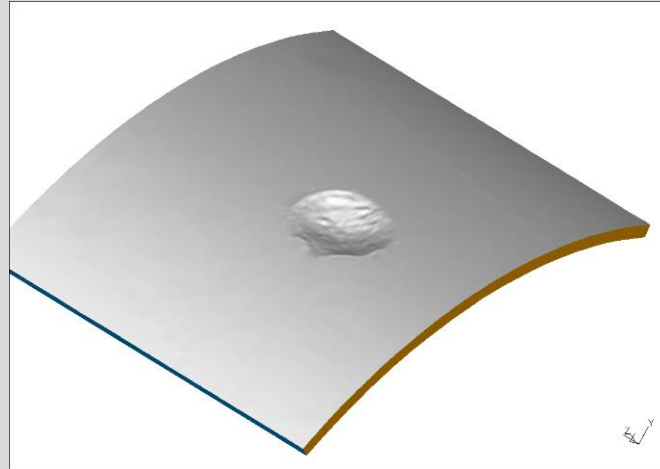


**Surface computed and mathematically defined using Freeform Modeller**



## Step 3

**The interface transfers the surface to the CAD system which generates a volume model**



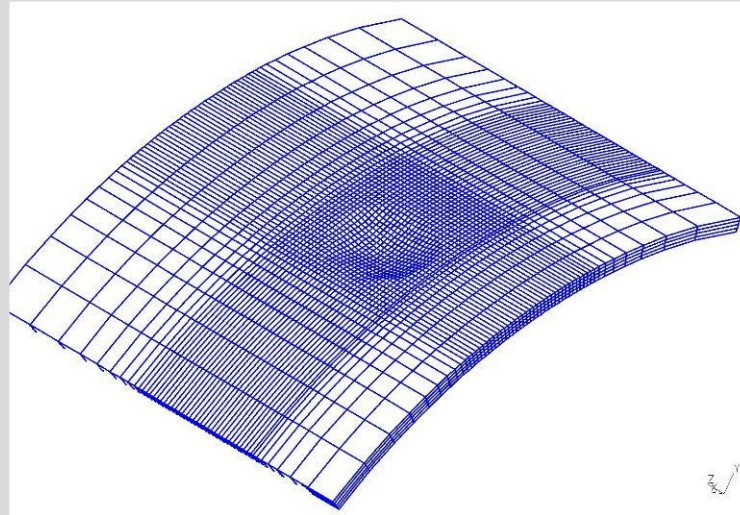
**CAD model – Volume model**

# Operation of Pipelines: Investigation Method Finite Element Analysis

## Step 4

Generating the  
Finite-Element-Model

Using the FEM software  
I-DEAS & ABAQUS,  
a computation model  
is developed from  
the pipe surface



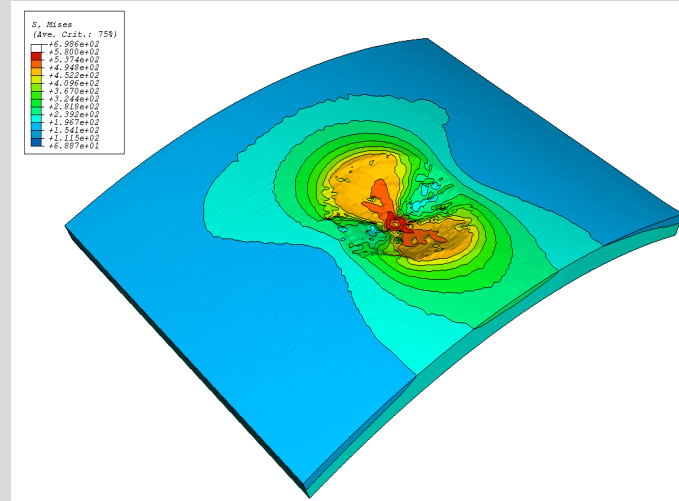
Finite element computation model

## Step 5

### Compute Stress & Strains

Result of finite element analysis:

The maximum stresses occurring in the pipe have been determined and can be analysed in terms of reliability

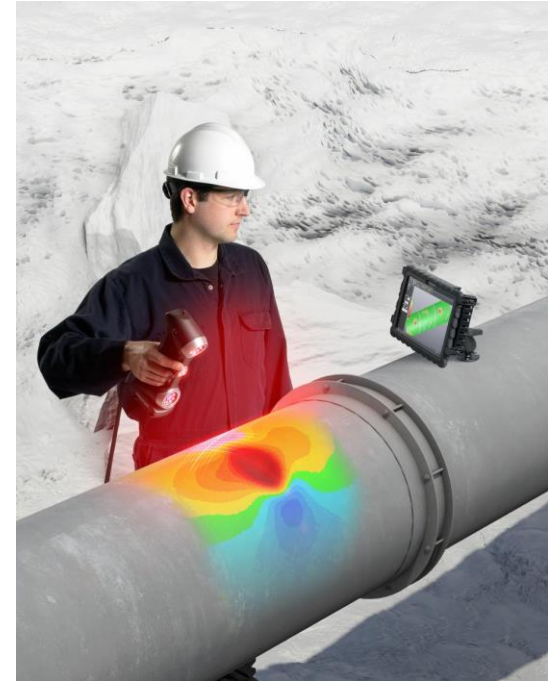


Equivalent stresses according to von Mises

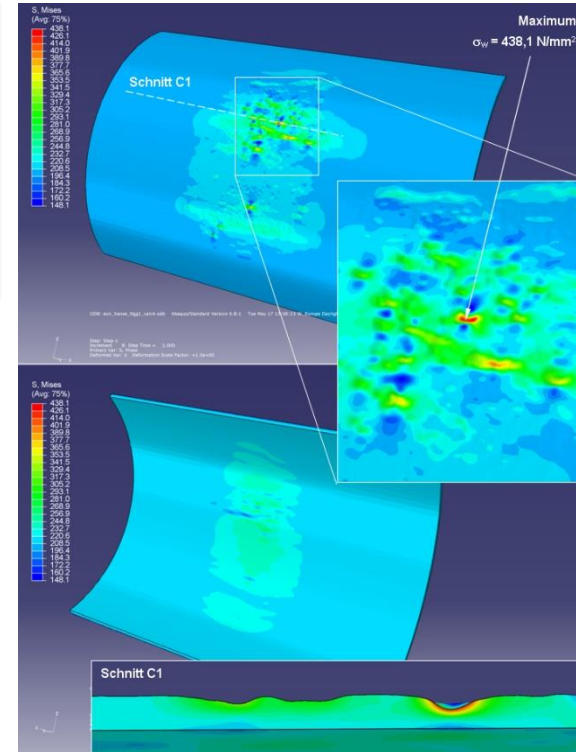
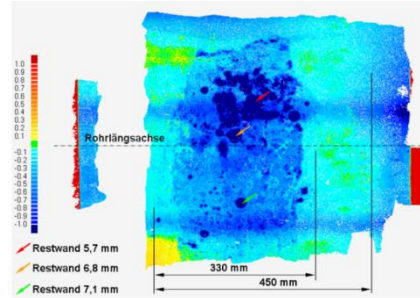
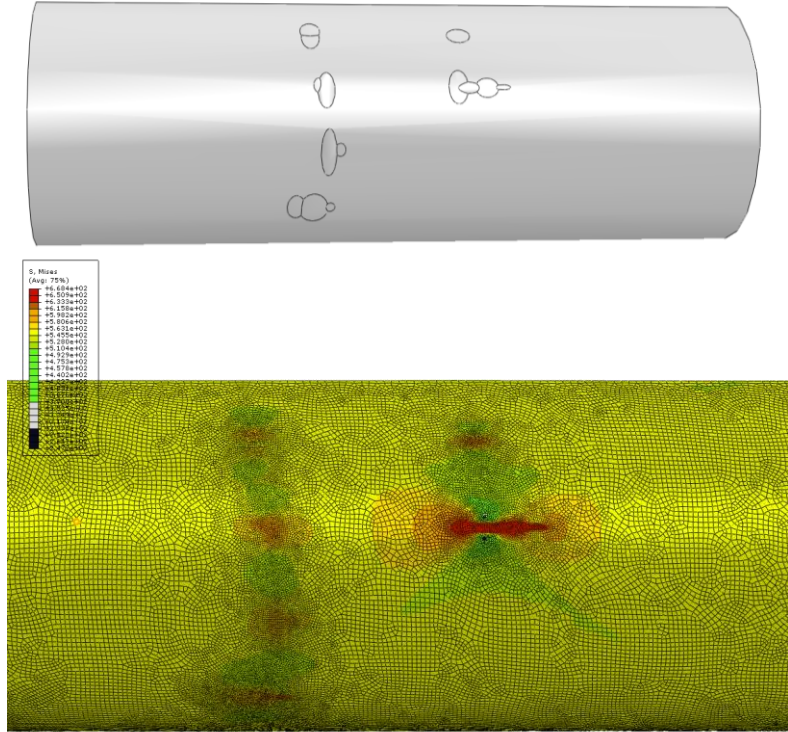
Today, the whole measurement process is done with modern applications like “HandySCAN” that sends the data to the FEM computer



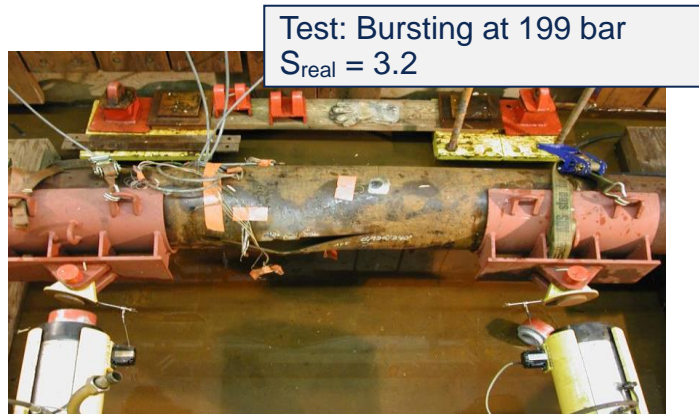
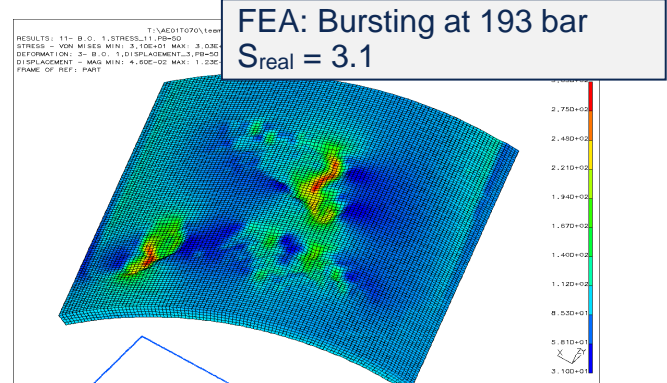
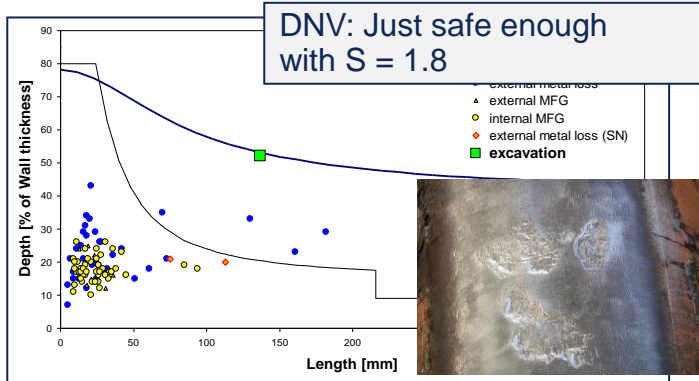
HandySCAN 3D professional scanner



# Operation of Pipelines: Investigation Method Finite Element Analysis



# Comparison of simple integrity formula, of FEA and of burst tests



Pig 52%, 137 mm long  
Excavation 69%, 150 mm long

**Calculation is conservative compared to real pipe behaviour**

# Pipelines: Repair Methods



Smooth Grinding of Corrosion or Gouge

Welding Patches at small Pittings/Leaks caused by Corrosion (only soft steel)



Split Sleeves with Hot Formed Ends for Repairing Large Metal Loss, Dents, Gouges



Knuckle Joints for Protection of Old Joints



# Pipelines: Repair Methods: Different sleeves

## Repair of severe defects

- Split sleeve
- Temporary sleeve
- Replacement
- Non-Metallic Composite Repair Systems (no standard method for OGE)



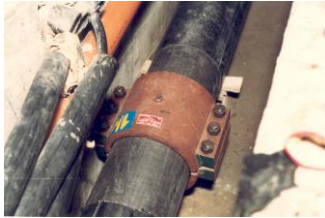


# Pipelines: Repair Methods



Temporary Repairing Methods

- for Low Pressure



- Plidco for High Pressure



- Manibs for Coated Pipe



Cutting Pipeline resulting in Decreasing of Stress/Strain in Area of Coal Mining

Inliner inside the Original Pipeline

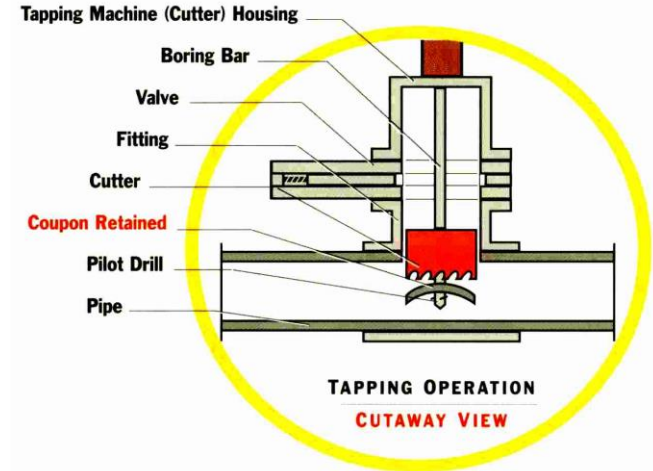
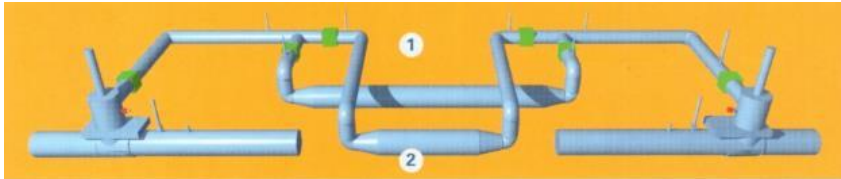


# Pipelines: Repair Methods

## Hot tapping & plugging:

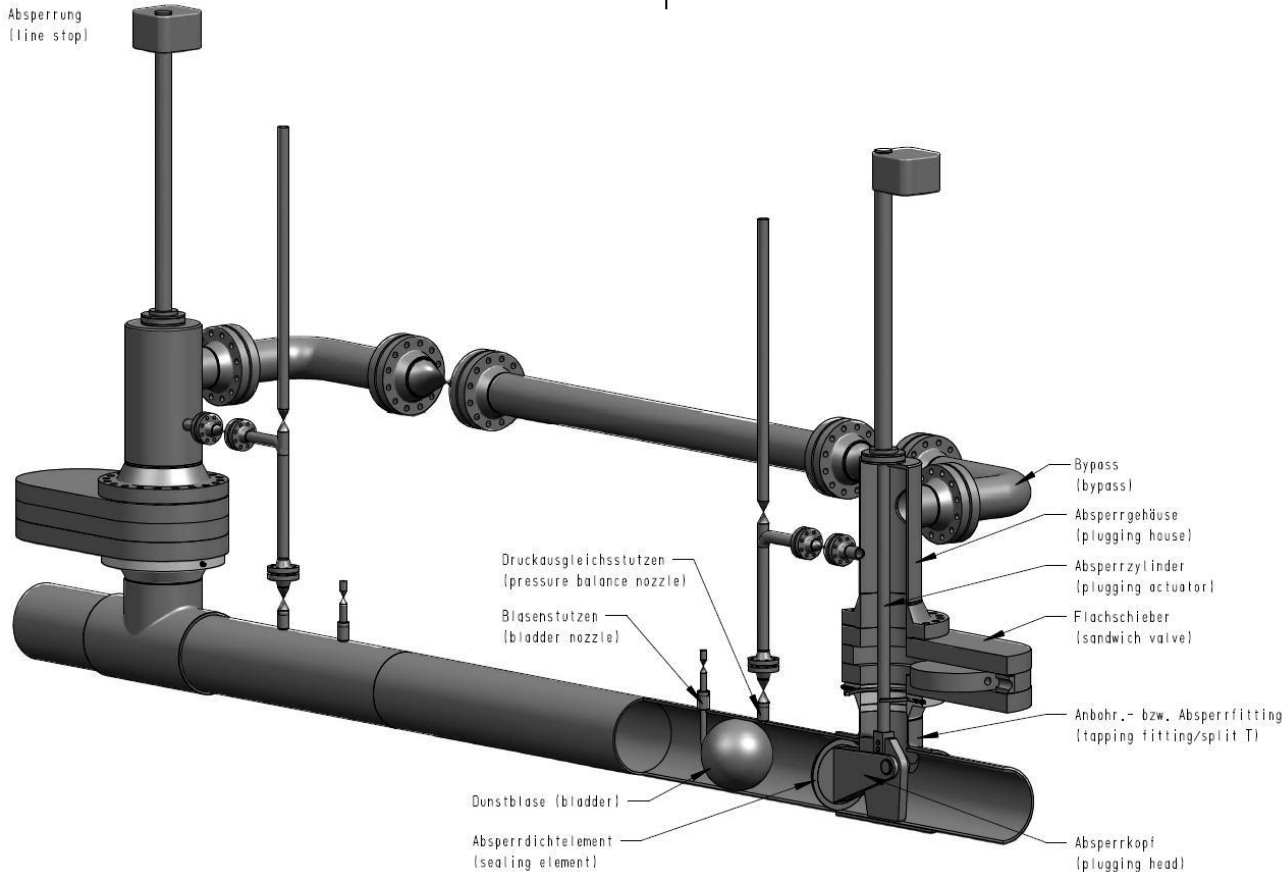
Hot tapping is a method for accessing the inside of an operating pipeline, using either a drill or a circular cutter to remove a coupon from the pipeline.

Plugging it consists of hot tapping the live pipeline, bypassing the product and replacing the defect pipe section with new material



# Pipelines: Creating a bypass (principle)

Absperrung  
(line stop)

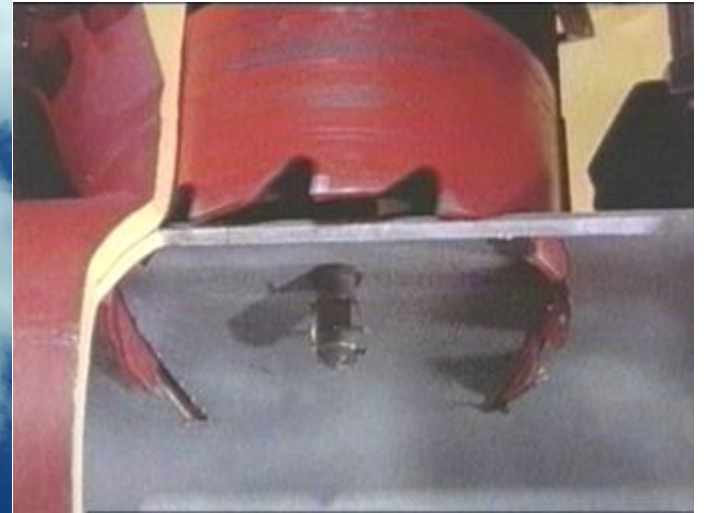


# Pipelines: hot tapping of a DN 800 pipeline



Photos of a construction site  
(Source: Open Grid Europe, 2020)

# Pipelines: hot tapping of a DN 800 pipeline



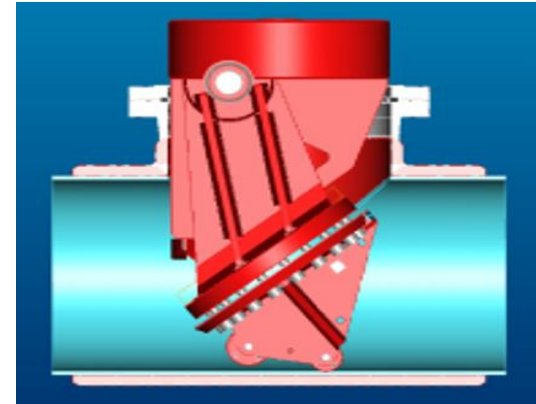
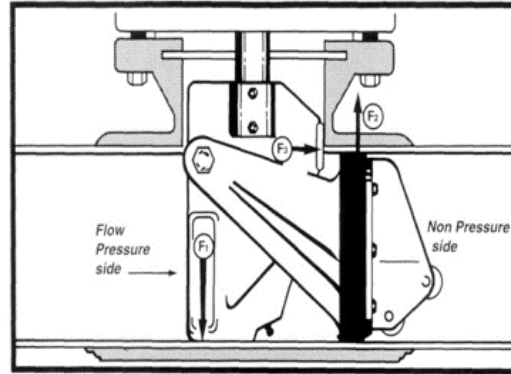
Drilling machine and drilled plate (Source: Open Grid Europe, 2020)

# Pipelines: Plugging (big calliper equipment and principle)



Photos Open Grid Europe, 2020

### STOPPLE PLUGGING HEAD FORCES



# Decompression of a pipeline section using a mobile compressor unit



Mobile compressor (Source: Open Grid Europe, 2020)

# Decompression of a pipeline section using a mobile flaring system



Mobile flaring unit (Source: Open Grid Europe, 2020)



# Teil 7 – Pipelines

Maintenance

Operation & Dispatching

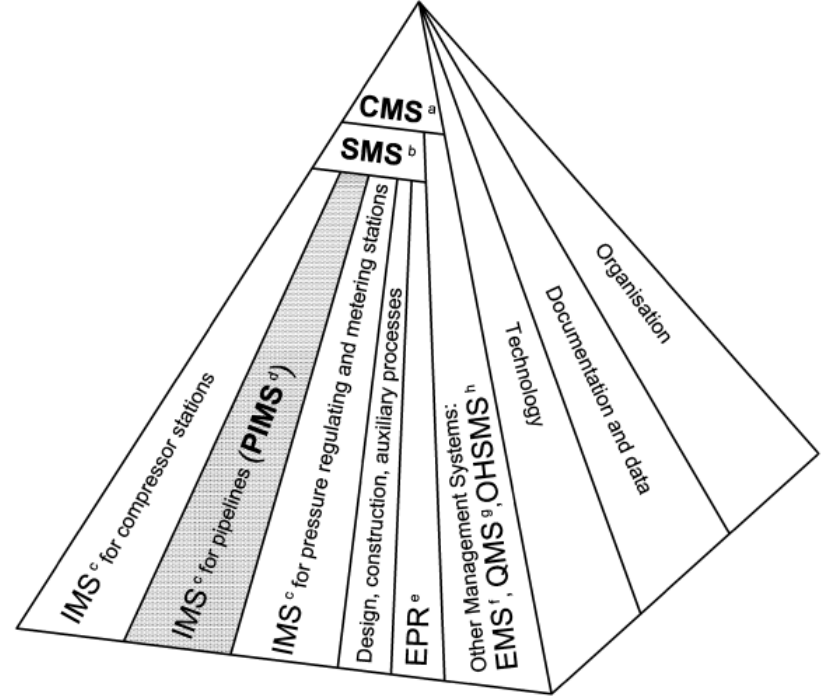
- 1 Risks pipelines are exposed to
- 2 Inspection and repair methods
- 3 **PIMS**
- 4 Dispatching and emergency response
- 5 Valves and valve spacing

## Pipeline Integrity Management System – a decisive part of a company management system

see **DIN EN 16384**

### Key

- a – CMS - Company Management System
- b – SMS - Safety Management System (for gas transmission infrastructure)
- c – IMS - Integrity Management System
- d – PIMS - Pipeline Integrity Management System
- e – EPR – Emergency Preparedness and Response Procedure
- f – EMS - Environment Management System
- g – QMS - Quality Management System
- h – OHSMS - Occupational Health and Safety Management System



## Objective:

- Technical infrastructure safety and asset preservation

## How to reach the objective:

- Systematic, quality-controlled as-built documentation; access to primary data
- Standardised methods and procedures for condition assessments, evaluation criteria and action to be taken
- Quality-assured procedures based on specific deadlines
- High level of information about the technical integrity of the pipeline systems
- Support for decision-makers when it comes to deciding on repair or replacement measures



disbonded coating



coating crack



bent pipe joint with a lip



corrosion damage



dents and gouges

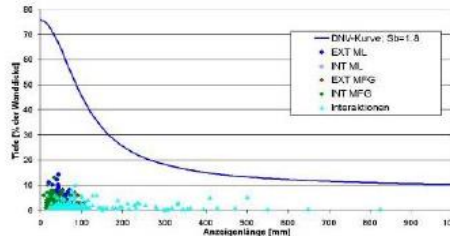


pitting corrosion

- PIMS contains methods, criteria and procedures for the integrity assessment of pipelines
- PIMS specifies, describes, organises and documents the whole assessment and restoration process
- PIMS provides full transparency about ...
  1. **Technical Integrity**
  2. **Data- and Informational Integrity**
  3. **Organisational Integrity**

## PIMS standard:

- Defines the rules for providing evidence on technical pipeline integrity
- Describes the methods for condition assessment incl. acceptance criteria
- Describes the type, scope and frequency of assessments
- Lists possible remedial actions
- Is created and maintained by the PIMS group of experts

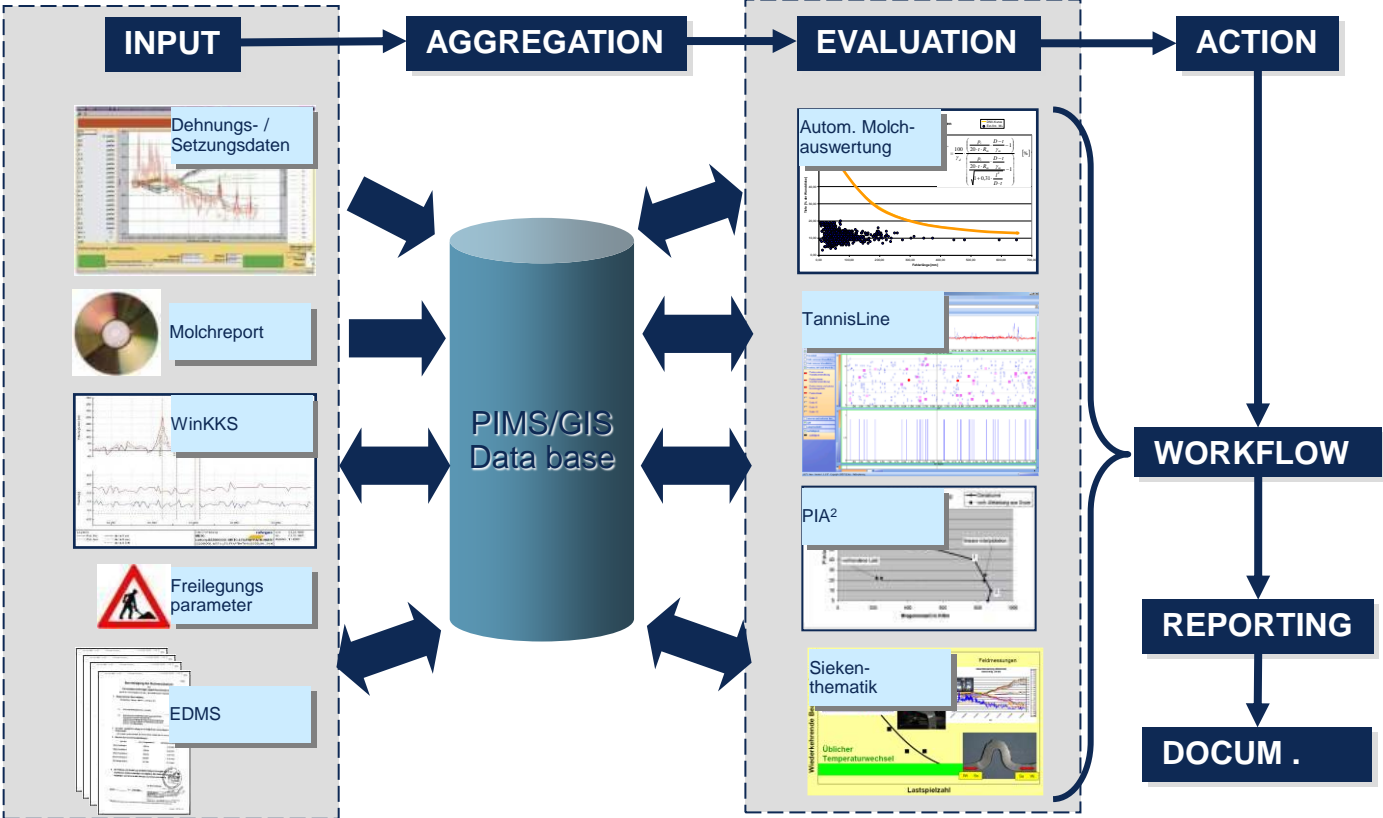


- Fundamentals of Pipeline Integrity: Design, Construction, Additional / External Loads, Operation, Supervision, CP
- Integrity Assessment Fundamentals
- Assessment Process, Follow-Up and Documentation
- Assessment of Piggable Pipelines:
  - Time of Inspection and Assessment, First Assessment, Inspection Interval
  - Mechanical Assessment of Defects
    - **Manufacturing Defects, Construction Defects, Third Party Damage, Bending Strain, Corrosion Related Metal Loss, Dents, Expansions, Ovalities, Seam Weld Anomalies, Cracks, Other Defects**
  - Corrosion Assessment of Defects
    - Integrity Assessment based on the Safety Factor / Load Factor
    - Metal Loss Features in Casing Pipes
    - **AC Corrosion Assessment**
    - **Corrosion Progress and Prognosis of Defect Depth**
- Assessment of Non-Piggable Pipelines



- **Metal Loss Features** due to corrosion or grinding repair of other features (corrosion, manufacturing, cracks, ...) acc. to DNV RP-F101 with a safety factor against failure of  $S = 1,8$  min.
- **Weld Defects** acc. to DVGW GW 350 and DIN EN 12732 App. G2
- **Dents** in base material (not near seam weld) acc. to DVGW G 473
- **Cracks** without grinding repair acc. to ASTM STD 536 or BS 7910 (cracks repaired by grinding are treated as metal loss features)
- **Expansions** acc. to internal standards
- **Bending Strain** e.g. due to dislocations acc. to DIN EN 1594 – App. B to F, verification against max. strain and denting, limits acc. to DIN EN 1594: 2000 – App. G
- **Defects near Seam Welds or Combination of Multiple Defects** – Individual Assessment

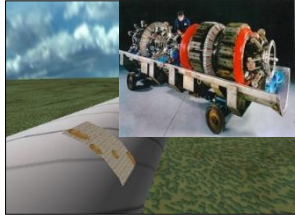
# PIMS – how a IT-based PIMS system should look like



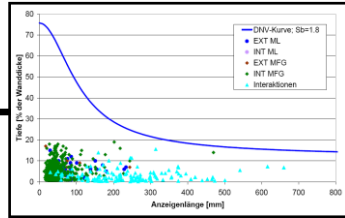


# PIMS – running the process

## ILI



## Assessment DNV RP-F 101 Part A



## Excavation and NDT



## EN 1594 or DNV RP-F101 Part B

Errechnung der Mindestwanddicke nach DIN EN1594  
(Sicherheitsbewertung entsprechend DIVGW 4463)  
**Berechnung für gerade Rohre**

Nenndruck	PN	67,5 bar
Außendurchmesser	Da	914,4 mm
Streckgrenze	Rm 5	415,00 Mpa
Sicherheitsbeiwert	S	1,60

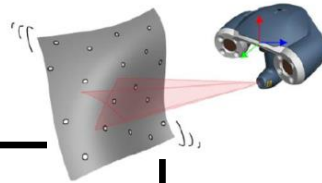
<b>Mindestwanddicke</b>	<b>Tmin</b>	<b>11,9 mm</b>
-------------------------	-------------	----------------

Bewertung nach DNV RP-F101 (Part B)

Nenndruck	PN	67,5 bar
Außendurchmesser	Da	914,4 mm
Wanddicke (Nom. oder Meßwert)	t	12,00 mm
Fehleriefe	a	3,00 mm
Fehlerlänge	L	60,00 mm
Zugfestigkeit	Rm	550 Mpa
Verhältnis	dt	0,24 -

Berstdruck nominal	P0	153,69 bar
Berstdruck lokal	Pb	151,55 bar
Faktor d. Schwächung	Rs	0,99 -
Modulfaktor	F1	0,90
<b>Sicherheit (Bersten)</b>	<b>S</b>	<b>2,02</b>

## Handscan (if needed)



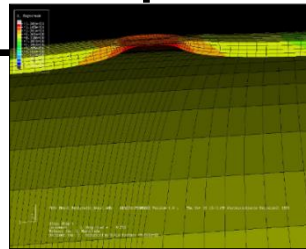
## Grinding



## Repair (if needed)



## Modelling CAD and FE-Calculation



TZL, integrier Leistungen

**TZIL - Berechnungsbericht**

Bestand: 01/2018

Open Grid Experten  
The Gas World

Abgefragter: **Winkel, Angelförderung**

Abfrage LZ: **Leistungsumfang: 402100000000**  
**Leistungsumfang: Messung + Rechnen**  
 Netzplan: **402100000000**  
 Wanddicke: **8,8 mm (Nennwert gemessen)**  
 Nennwert: **8,8 mm**  
 Fehlerort: **8,8 mm**  
 Bohrer: **M8**  
 Bohrer: **M8**

Ort: **Angelförderung**  
 Bauwerk: **402100000000**  
 Koordinatensystem: **WGS 1984 UTM 32Q UTM Zone 32Q**  
 Koordinatensystem: **WGS 1984 UTM 32Q UTM Zone 32Q**

Anteil: **Bestand: 01/2018**  
 Bestand: **01/2018**  
 Bestand: **01/2018**

Übersicht:  
 Es sollte eine bei der Maßung 2006 detaillierte Detail in Wandstärkenbereichen erstellt werden.  
 Berechnungsgrundlage: **GGK\_FIG-40511073** Freilegung  
 Das bei der Freilegung vorzufindende Bauteil und Vorhand  
 Regelwerke **DIN EN 10217** und **DIN EN 10217** sind zu berücksichtigen.  
 Es sind keine Sicherheitsmaßnahmen erforderlich.

Sachverständigenbescheinigung erforderlich: **Ja**

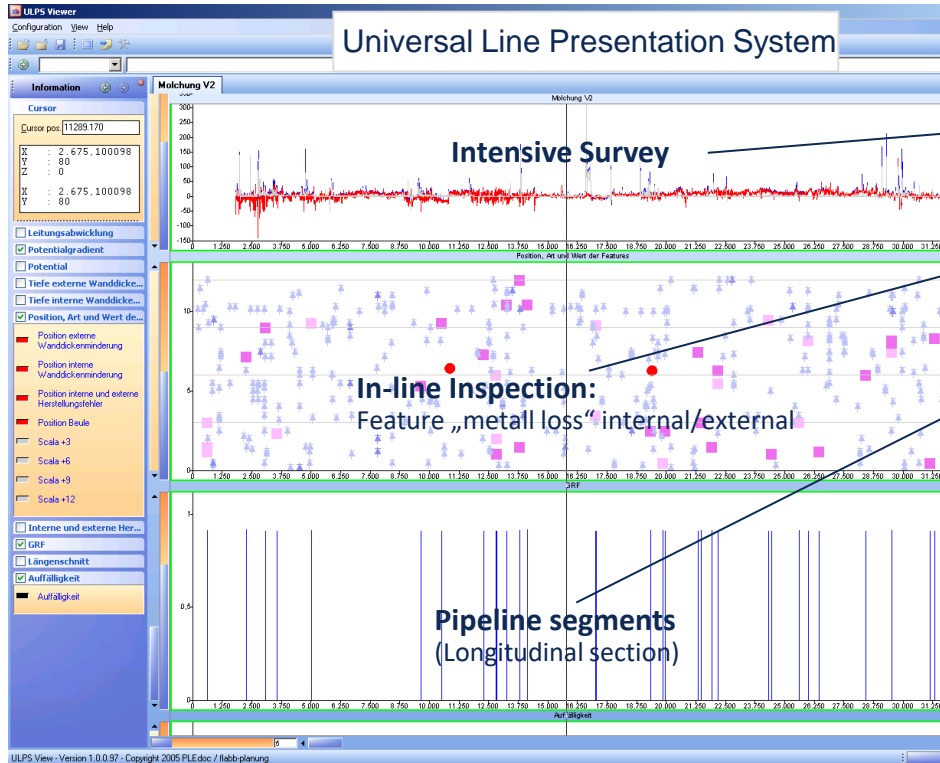
geprüft: Winkel, TZL  
 Datum: 29.06.2018

gezeichnet: **Winkel**  
 Datum: 29.06.2018

2. Gegenstand der Änderung  
 Im Rahmen der von PIMS im August 2006 durchgeführten MFL-Maßung Nr. 100818\_242 im Bereich von 840 87278,173 bis 840 87342,813 zuziehende Wandstärkenmessungen (bis zu einer Tiefe von 30%) im Rohrwandbereich des Bauteils.

In Rahmen der Bewertung des Maßstabes wurde diese Position aufgrund des Vorhandenseins von Korrosionserscheinungen zur Freilegung empfohlen.

Assessment, certified experts statement and documentation

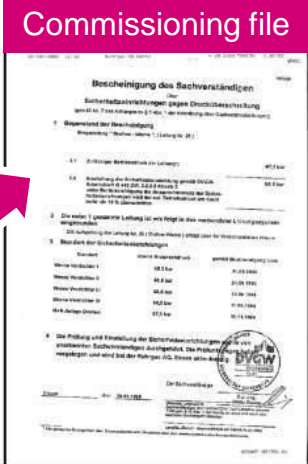
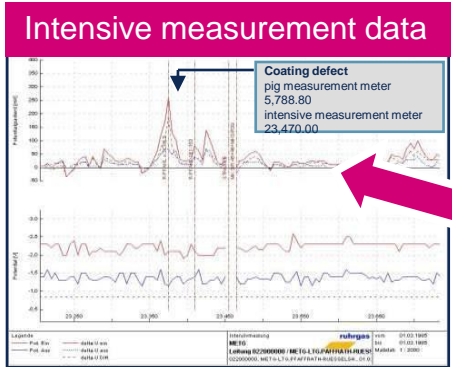


## Compilation and presentation of different measurement data

- pipeline
- potential gradient
- potential
- depth of ext. wall defect
- depth of int. wall defect
- position and type
- manufacturing defect
- ERF
- longitudinal section
- other distinctive feature
- ...

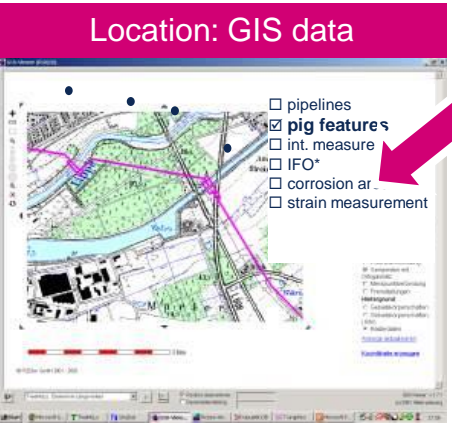
Assessment by material and corrosion experts

# PIMS – data access and administration



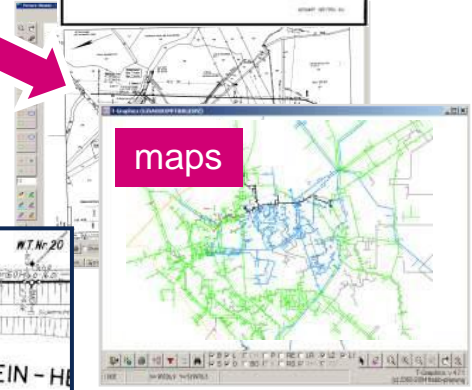
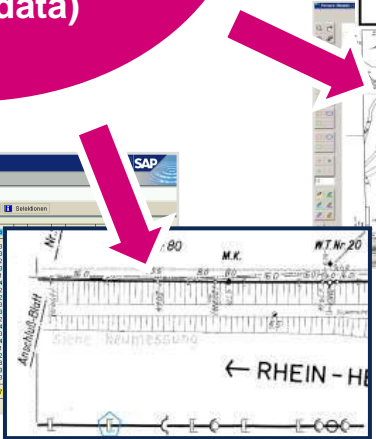
Access to measurement data (operational data)

Access to pipeline documentation (design data)



### SAP

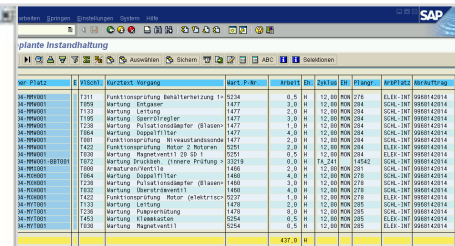
Fachbereich	PLatz	WISSEN	Werkstat	Wart.Nr.	Wart.
WERK-REGIO-MER001	1311		Punkttest	1029	
WERK-REGIO-MER001	1089		Wartung Ein	1477	
WERK-REGIO-MER001	1153		Wartung La	1478	
WERK-REGIO-MER001	1195		Wartung Sen	1477	
WERK-REGIO-MER001	1238		Wartung Pulskondensap (Blasen	1478	
WERK-REGIO-MER001	1064		Wartung Dopplert	1477	
WERK-REGIO-MER001	1101		Punkttestprüfung Motor (elektrisch)	1478	
WERK-REGIO-MER001	1442		Punkttestprüfung Motor 2 Motoren	1477	
WERK-REGIO-MER001	1030		Wartung Magnetkl 20 10 1	1029	
WERK-REGIO-MER001	1032		Wartung Brückens. Comex Prüfung	1029	
WERK-REGIO-MER001	1090		Konstruktion	1495	
WERK-REGIO-MER001	1064		Wartung Spindelhub	1495	
WERK-REGIO-MER001	1238		Wartung Pulskondensap (Blasen	1495	
WERK-REGIO-MER001	1032		Wartung Überdruckst	1495	
WERK-REGIO-MER001	1442		Punkttestprüfung Motor (elektrisch)	1029	
WERK-REGIO-MER001	1195		Wartung Leitungs	1478	
WERK-REGIO-MER001	1236		Wartung Pulskondensap	1478	
WERK-REGIO-MER001	1450		Wartung Klappen	1029	
WERK-REGIO-MER001	1030		Wartung Magnetkl1	1029	



# PIMS – data access and administration

PIMS is used to document and/or systematically track pipeline-specific data:

- Pipe book
- Certifications and technical approvals
- Graphs and drawings
- Maps and plans
- SAP PM (Plant Maintenance)



# Teil 7 – Pipelines

Maintenance

Operation & Dispatching

- 1 Risks pipelines are exposed to
- 2 Inspection and repair methods
- 3 PIMS
- 4 Dispatching and emergency response
- 5 Valves and valve spacing

# Pipelines: Dispatching, grid control (and emergency preparedness) centre

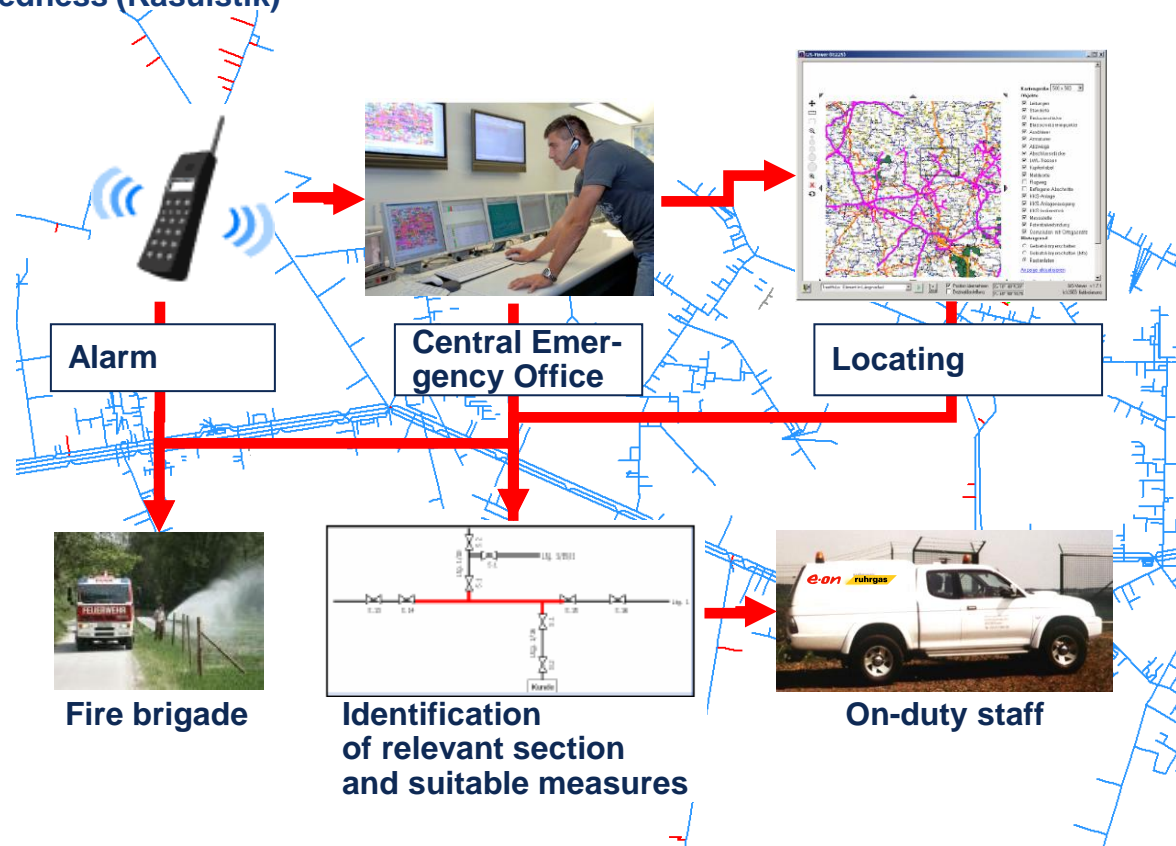


# Work space in a dispatching centre



# Pipelines: Emergency preparedness

## Emergency preparedness (Kasuistik)





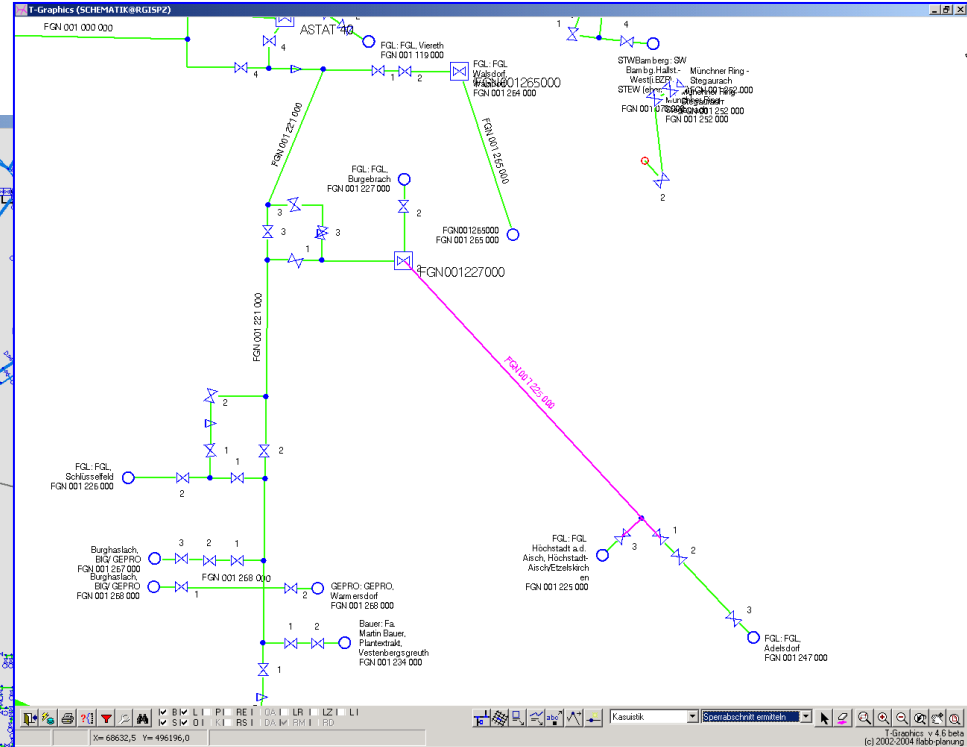
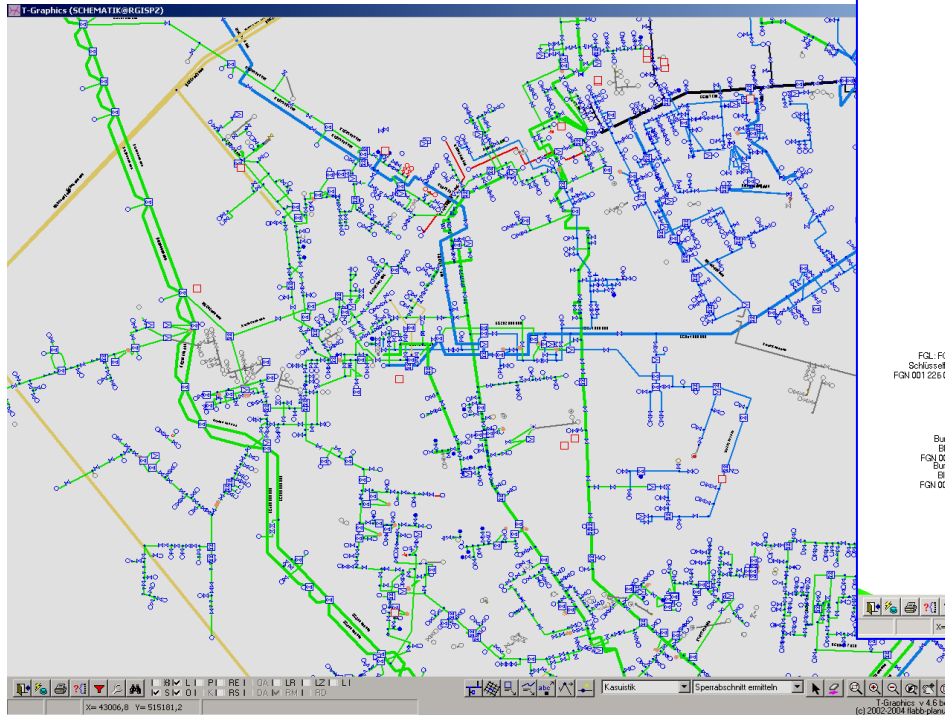
## Emergency preparedness (Kasuistik)

### Questions in connection with a reported pipeline failure

- Where exactly is the failure ?
- Which pipeline is affected ?
- Between which valves is the failure ?
- How does the failure affect the supply ?
- Is it possible to close the adjacent valves ?
- How can the supply be continued ?
- Which customers are in the section to be closed ?
- Can the customer stop his supply at the specific point ?
- What is the contractual situation ?
- What is the relevant partners address ?

# Pipelines: Features of a Kasuistik

## Emergency preparedness (Kasuistik) Tools and Instruments



# Pipelines: Features of a Kasuistik

## Emergency preparedness (Kasuistik) Tools and Instruments

From GIS to Schematic View

- Schematic grid visualisation to enable the user to observe and assess the entire supply situation
- Simple switch between geographic and schematic view
- Fast access to documentation: detailed listings and maps

The screenshot displays three windows from a GIS application:

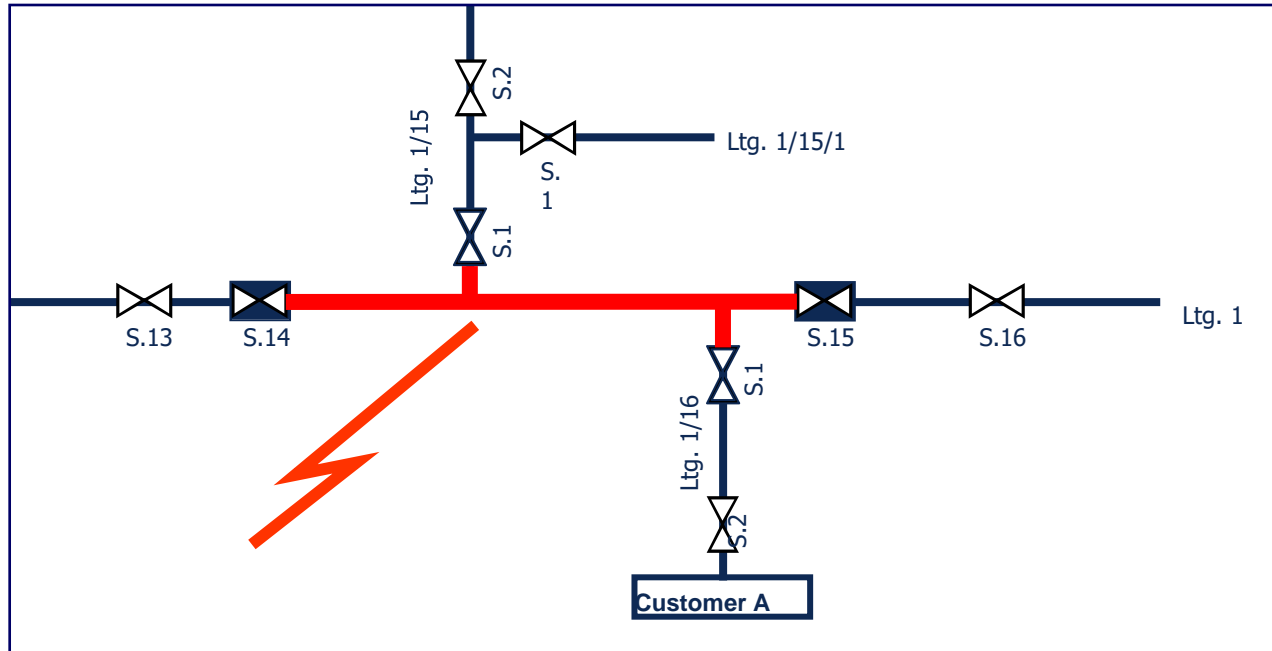
- GIS Viewer (RG018):** Shows a topographic map with a red and blue pipeline network overlaid. A scale bar indicates 1 km.
- Graphics (Lohndorf@RG018):** Shows a schematic grid of the pipeline network with nodes and lines. A blue circle highlights a specific node.
- Dokumente:** A table listing documents related to the pipeline system.

Art	Datum	Info	Prüf.
Dokument		Dokumente zum Objekt	
		Dokumente zur Leitung RG0400000	
FAHNE	LNR_16_2_KOPPEL_WESTFALENWITTE.PDF	ASTAT 1	VSESSN03
FAHNE	LNR_202_ENGPASS_HOSEL.F. BAYER LERDING.PDF	ASTAT 1	VSESSN03
FAHNE	LNR_LNR_12_UA_ENGPASSVERB_HOSEL_FÜR_WÄPPERTAL		VSESSN03
FAHNE	LNR_M_WERNE_DUSBURG_TEL_1.PDF	ASTAT 1	VSESSN03
FAHNE	LNR_M4_WERNE_DUSBURG_TEL_2.PDF	ASTAT 1	VSESSN03
FAHNE	LNR_M4_S_LND_LNR_M4_S_2.PDF	ASTAT 1	VSESSN03
FAHNE	skizze_L1.skp	Duisburg-Rosenroth	Vsew0274
Dokument		Dokumente zu allen Standorten der Leitung RG0400000	
SKIZZE	skizze_IL103_M-STATION-DUSBURG-SUD.pdf	Duisburg Süd	VSESSN03
SKIZZE	skizze_IL115_M_IL114_in_Bereich_Mündelheim.pdf	Mündelheim	VSESSN03
SKIZZE	skizze_IL142-SITUA_3_STAT_10_MIT_ANGSCH_MUND_IL.pdf	Mündelheim	VSESSN03

The schematic grid window shows a network of nodes and lines. A blue circle highlights a node, and an arrow points from this node to a detailed schematic diagram in the 'Dokumente' window. The detailed diagram shows a complex network of pipes, valves, and electrical components, with a legend and technical specifications.

# Pipelines: Kasuistik - a method to react within minutes by shutting down the right valves

## Emergency preparedness (Kasuistik) Tools and Instruments



# Pipelines: Kasuistik - a method to react within minutes by informing customers and staff on duty

## Emergency preparedness (Kasuistik) Tools and Instruments

**Kasuistik-DB GISAUSKUNFT@RGISPZ - [Sperrabschnitt]**

Sperrabschnitt der Leitung(en): FGN001225000, FGN001227000, FGN001247000

Betroffene Schieber / Massnahme				Betroffene Kundenans			
STANDORT	ANLAGEN_NAME	LEITUNG_ID	MASSNAHME	ABM	KUNDE	STATION_NAME	LEITUNG_ID
ASTAT 2		FGN001225000	Normale Aufspeisung		Fränkische Gaslieferungsgesellschaft	FGL Höchststadt a.d	FGN001225000
ASTAT 3		FGN001225000	Keine Aufspeisung mögl				
ASTAT 1		FGN001247000	Keine Aufspeisung mögl				
ASTAT 2		FGN001227000	Aufspeisung über Doppele				

NAME	TEL1	TEL2	FAX
H.Büterich	0921/75711-316		
Schiebler (GF)	0921/ 757 11 200	0921/ 757 11 0	0921/75
Olfrum, H.Heinz, H.Vogel	0921/600-363	0921/600-352	0921/75
Störungsdienst	0921/ 580 51	0921/ 600 380	
Vermittlung	(09 21) - 7 57 11 - 0		

**... visualize all results in the schematic grid view or in a map**

... valves

... shortest section

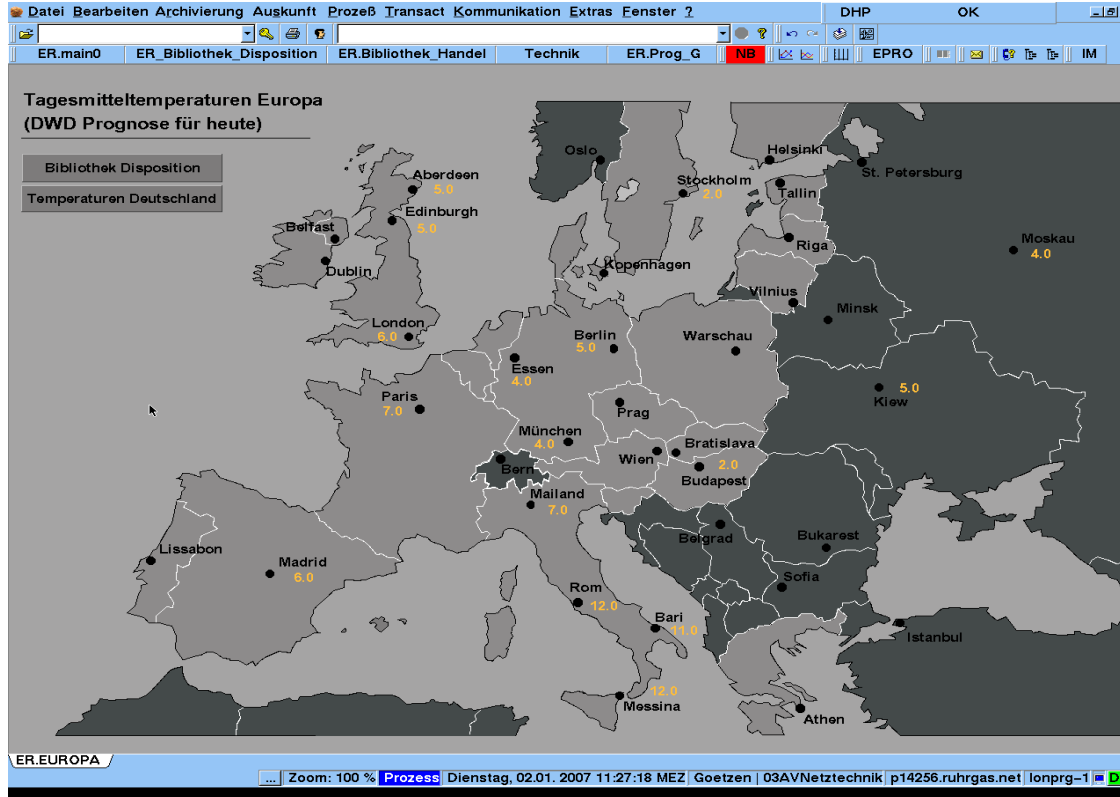
... customers

Gesamten Sperrabschnitt highlighten

# Pipelines: Grid Control and Network Operation

## SCADA systems and GIS applications

The SCADA system is used to monitor and control the gas grid. Flows, quantities, gas qualities and pressures are visualised. In addition, commands can be sent out to start or stop a compressor, to close valves and to operation other technical equipment.

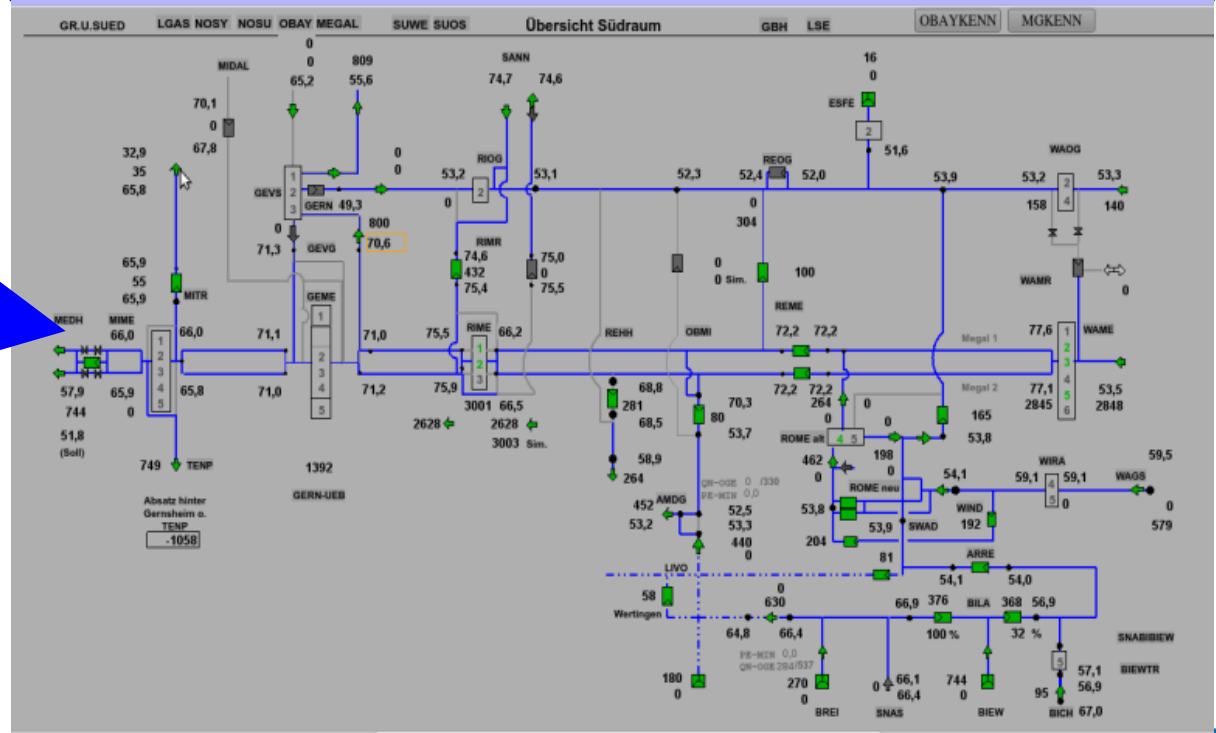


# A SCADA System monitors and controls a pipeline grid

Topographic view



Schematic view

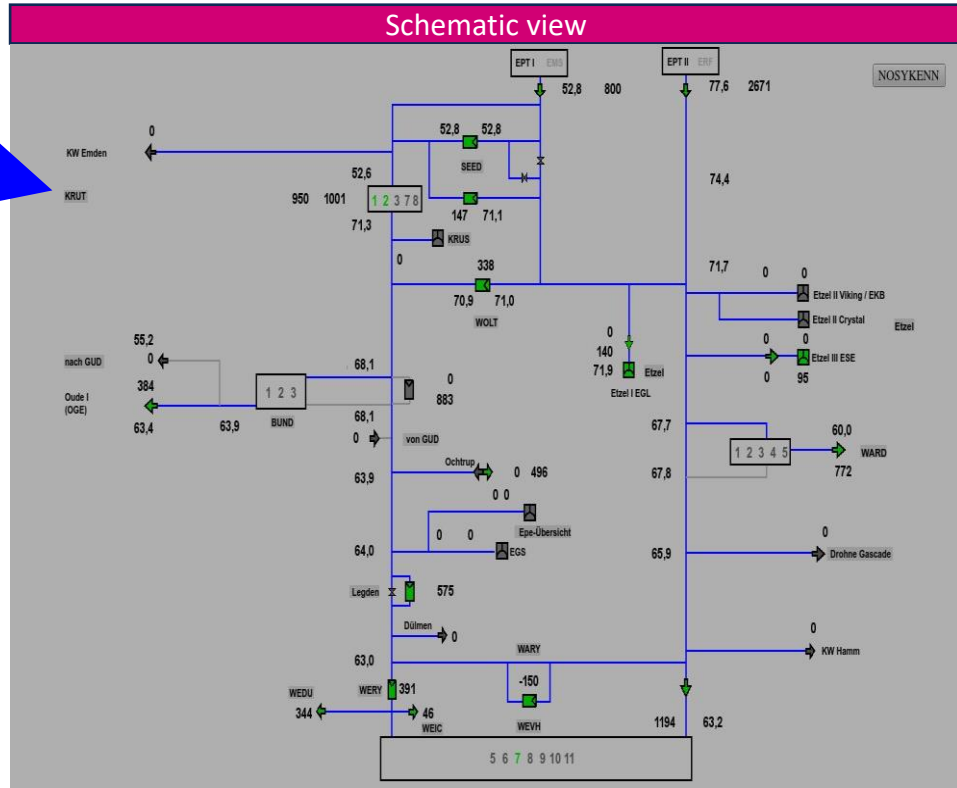


# A SCADA System monitors and controls a pipeline grid

Topographic view



Schematic view





# A SCADA System monitors and controls a pipeline grid

The operator can zoom into a frame with more details and down to each individual engine. It is possible to start and stop compressors and shut down valves.

The screenshot displays a SCADA interface for a pipeline grid. The main window on the left, titled 'Übersicht Nordsystem', shows a network of pipelines with various valves and compressor stations. The interface is divided into several panes:

- Main Overview:** A map showing the pipeline network with stations like SEED, KRUT, KRUS, Laybacht, Engerhave, BEB>, Oude, BEB<, KW Emsl, Ochtrup, H\_GA, Düken, and Walbach. Data points for pressure and flow are visible at various nodes.
- TECHNIK Rechner\_UE:** A table showing technical data for various components. The table has columns for 'GR.T.TENP', 'TENP\_TAB', 'Temp-Delta', and 'Teilnetz TENP-System'.

GR.T.TENP	TENP_TAB	Temp-Delta	Teilnetz TENP-System
BOCXZ	1360 1362 1318	52.2	0 Verh.2/3 Rauen
BOCXZ_QN_H	1362 Rauen	196	0 Verh.4 Rauen
SOB	1332	51.3	0 Verh.1 TC
		64.7	0
		64.3 66.5	64.3 66.5 1483
		51.9	51.9 1483
		64.7	68.6 1436
		51.9	55.2 1753
		67.1	66.3 1407
		64.8 51.9	59.1 59.1 1628
		60.2	59.1 0
		60.2	63.9 1555
		54.6	53.1 1575
		64.3	63.9 1555
		60.5	1580 1540
			1588 Soll
- Gasbeschaffungen:** A detailed view of gas supply options, including 'Hessenbach TG', 'Waltbühler Höhe GVE', 'Zingheim TG', 'Schönbach EVM', 'Waller EVM', 'AM SFG', 'Sohren RWE', and 'Benschenbach SFG'. It includes a list of 'Einsparpotential' and 'Einspar' measures.
- Mittel:** A detailed view of a compressor station (Mittel) showing technical parameters like 'Maschinenleistung', 'Auf', 'PVT %', 'PE-E', 'GN MAX', 'GN', 'SW GN', 'VNGE', 'WB', 'PE-A', and 'RSB'. It also shows a status table for various components.
- Stolberg:** A detailed view of a compressor station (Stolberg) showing technical parameters like 'VNGE', 'WB', 'PE-E', and 'RSB'. It also shows a status table for various components.

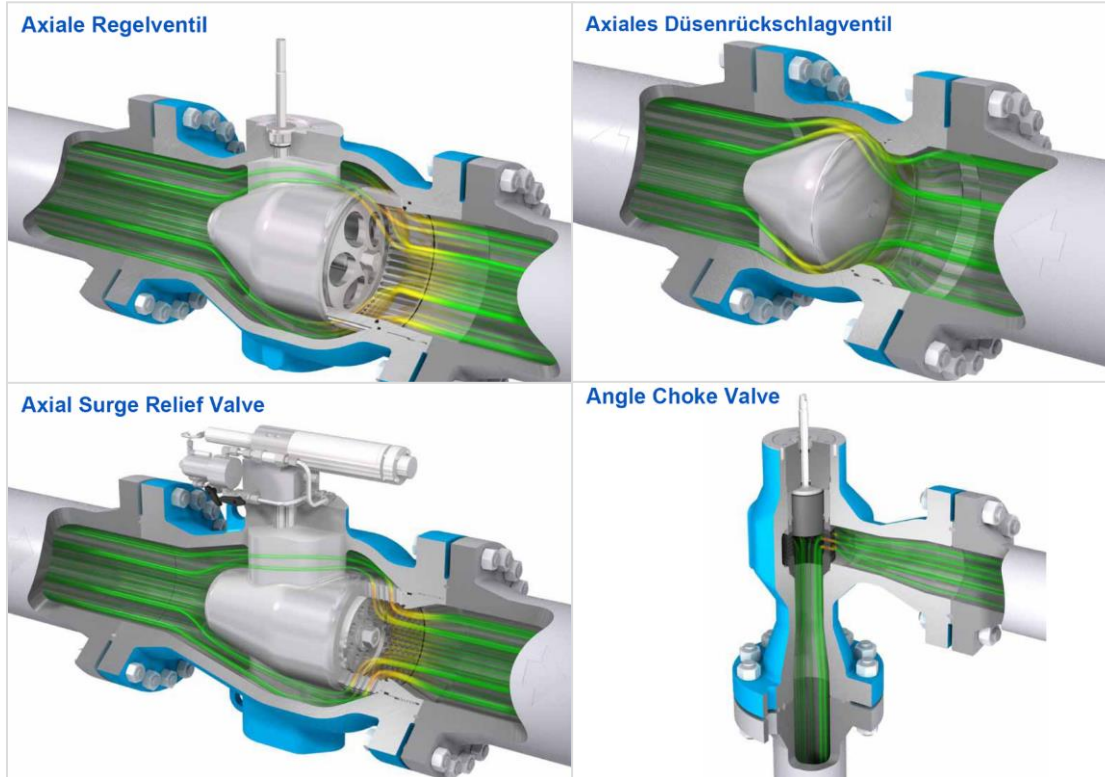
The interface includes a menu bar at the top with options like 'Datei', 'Bearbeiten', 'Archivierung', 'Auskunft', 'Prozeß', 'Simulation', 'Transport', 'Kommunikation', and 'Extras'. The status bar at the bottom shows the current zoom level (100%), process status (Prozess), and date/time information.

# Teil 7 – Pipelines

Maintenance

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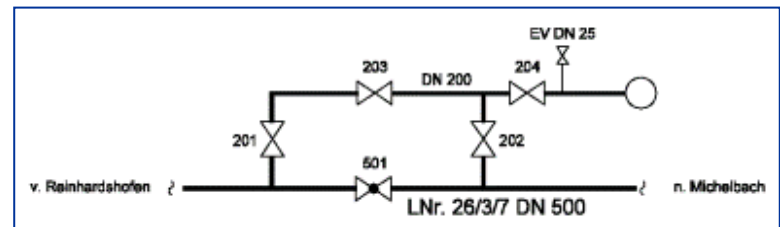


The high-quality shut-off valves installed in the pipelines are usually ball valves



Thanks to the ball valve shut-off principle repair and welding work on modern transportation pipelines can be performed in a gas-free atmosphere.

Tightness test via block-and-bleed shut-off function in open and closed positions!



## Spacing distances of valves: Comparison of spacing distances in different countries

Germany		France		Danmark			
D <sub>min</sub> = 10 km	D <sub>max</sub> = 18 km	D <sub>min</sub> = 10 km	D <sub>max</sub> = 20 km	D <sub>max</sub> = 4 km	D <sub>max</sub> = 6.4 km	D <sub>max</sub> = 12 km	D <sub>max</sub> = 16 km
				Class 4	Class 3	Class 2	Class 1
Swissgas	Norway	Italy		Netherlands			
D <sub>max</sub> = 20 km	not explicitly given	D <sub>min</sub> = 2 km	D <sub>max</sub> = 10. km	Distance is derived from volume of gas enclosed between two valves = 700.000 normal m3.			
sitespecific but remote control	Distance is determined on the basis of safety studies	pressure-dependent					
Spain				Canada			
D <sub>max</sub> =5 km	D <sub>max</sub> = 10 km	D <sub>max</sub> =20 km	D <sub>max</sub> =30 km	D <sub>max</sub> = 8 km	D <sub>max</sub> = 13 km	D <sub>max</sub> =25 km	D <sub>max</sub> =not req.
Class 4	Class 3	Class 2	Class 1	Class 4	Class 3	Class 2	Class 1