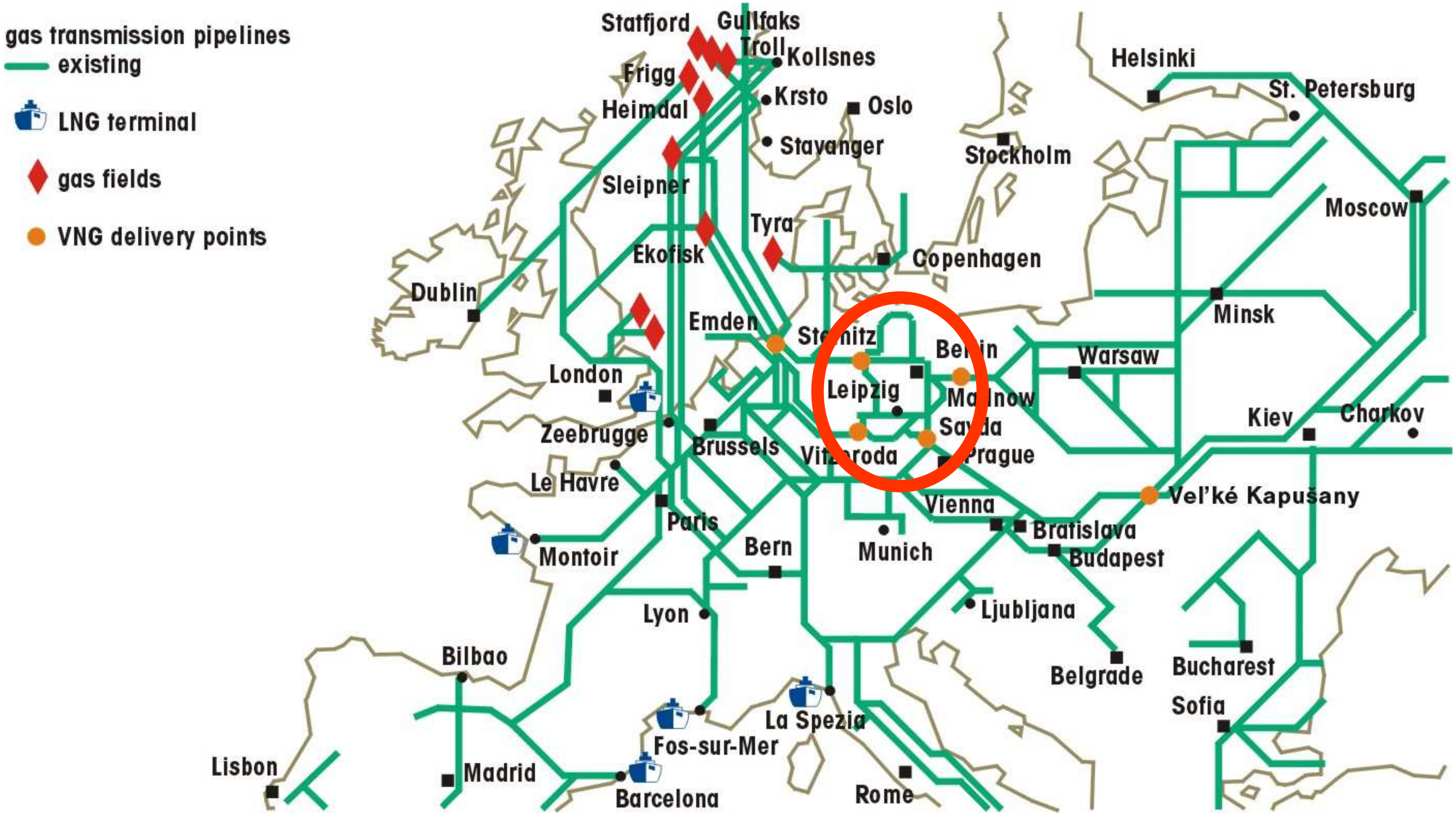
The Pipeline Integrity Management System of VNG Verbundnetz Gas AG

Referent: Dr. Volker Busack, Operation / Technology

1. Introduction VNG
- VNG in the European gas transmission grid -



1. Introduction VNG
- Technical infrastructure at VNG -

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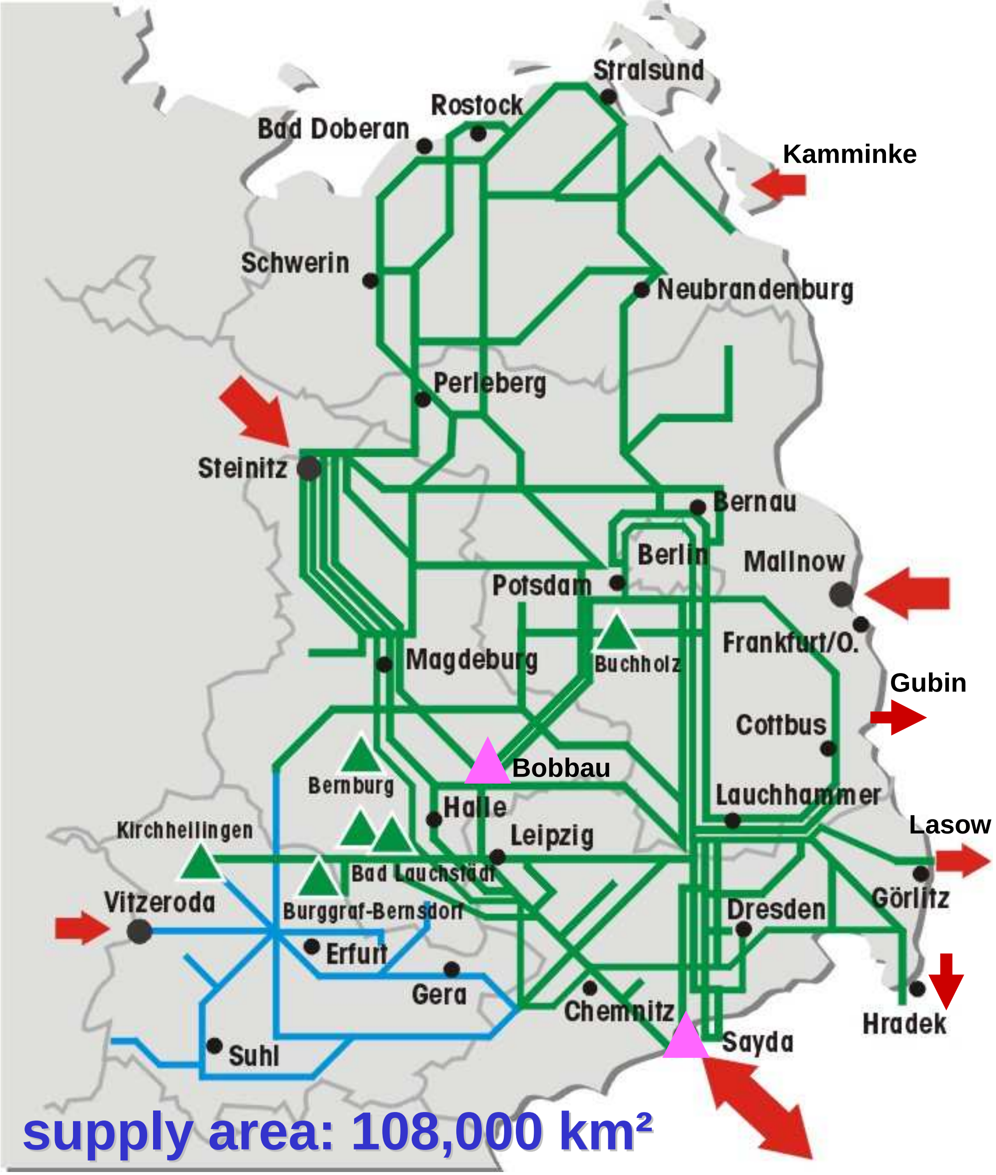
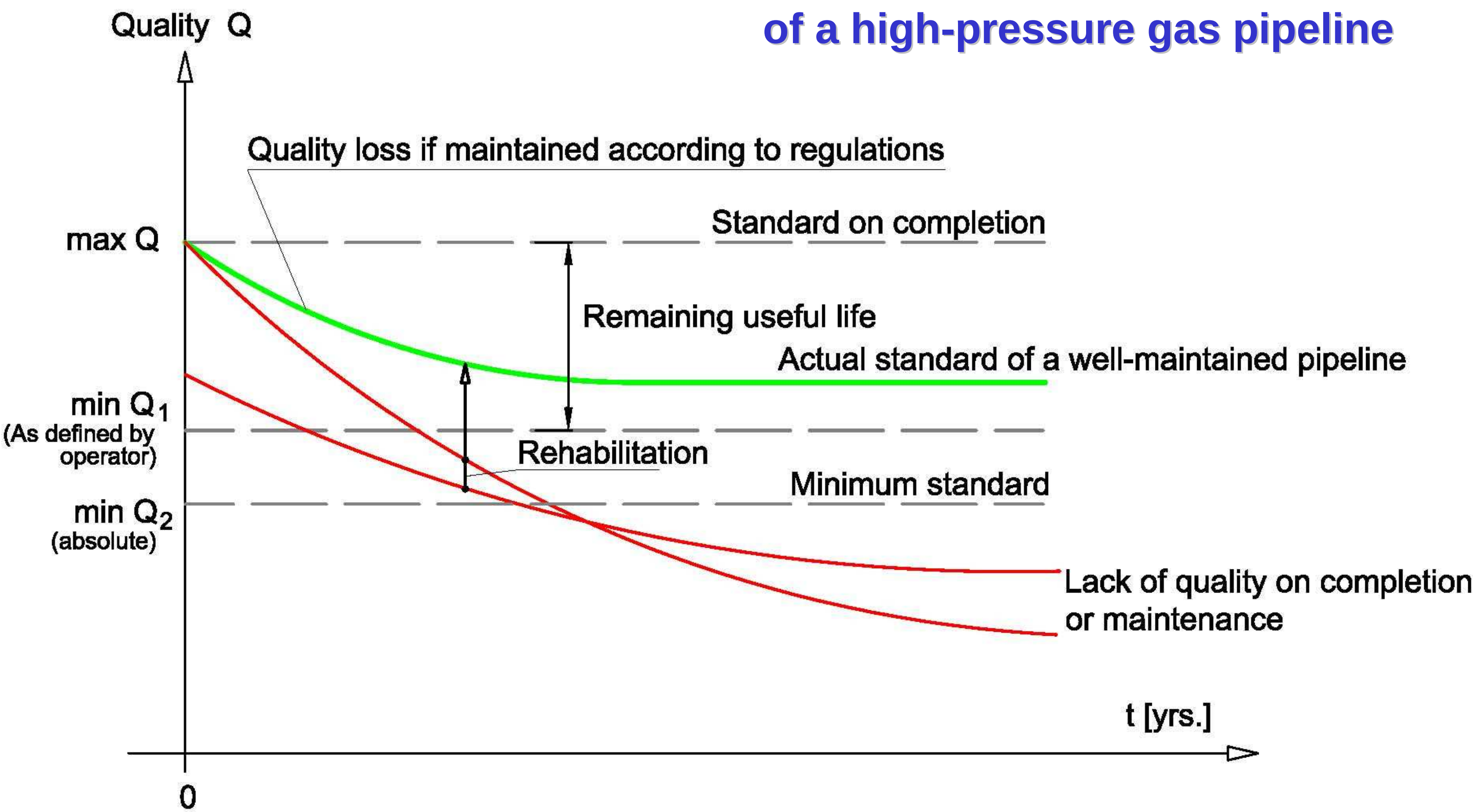


supply area: 108,000 km²

- **Length of pipelines:**
  7,279 km
- **Underground gas storages:** ▲
  6 (at overall 5 sites)
- **Total work gas capacity:**
  2.3 billion m³
- **Compressor stations:** ▲
  2 (+ 4 compressor units UGS)
- **Total compression capacity:**
  77.8 MW (8 piston compressors
  7 turbo compressors)
- **Delivery stations / links: 8** ➔
- **Metering and pressure regulating stations: 36**
- **Cathodic corrosion protection installations: 727**

Reserve in the bearing capacity of a high-pressure gas pipeline



3. Aims, elements and methods of PIMS
- Aims and requirements -

Specific aims of PIMS at VNG - Verbundnetz Gas AG:

- Evaluation of results of inspection pigging by neuronal networks (FEM), incl. corrosion forecast with assessment program “COP” (Corrosion On Pipelines)
- Technical condition analysis of pipelines by probabilistic assessment criteria / parameters
- Evaluation of possible service life
- Identification of failures / weak spots with following prioritization of needed actions / measures
- Optimization and Processing of needed rehabilitation measures
- Data management and providing a pipeline information system

3. Aims, elements and methods of PIMS
- Pipeline failure probability, QRA and SRA -

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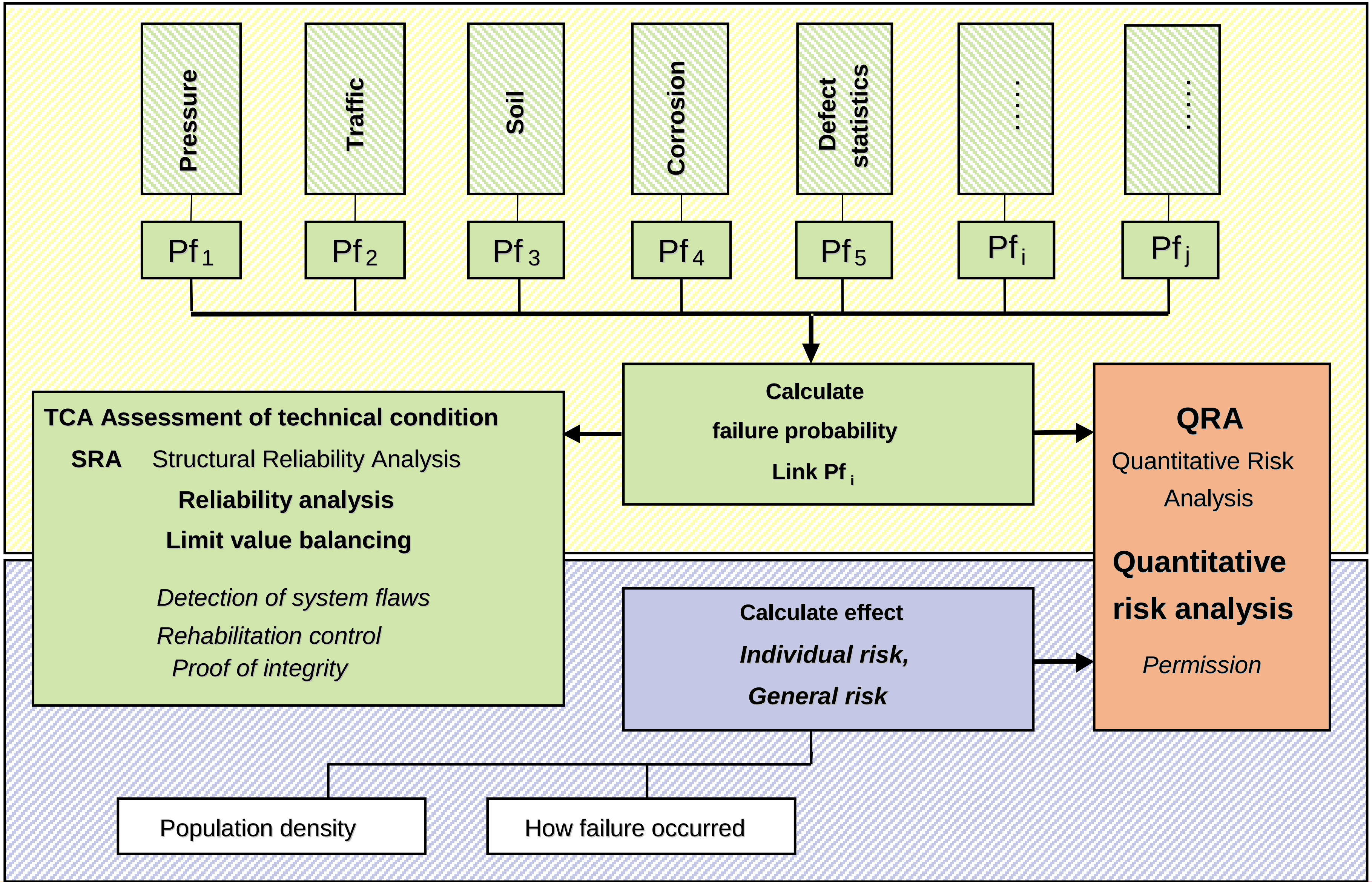
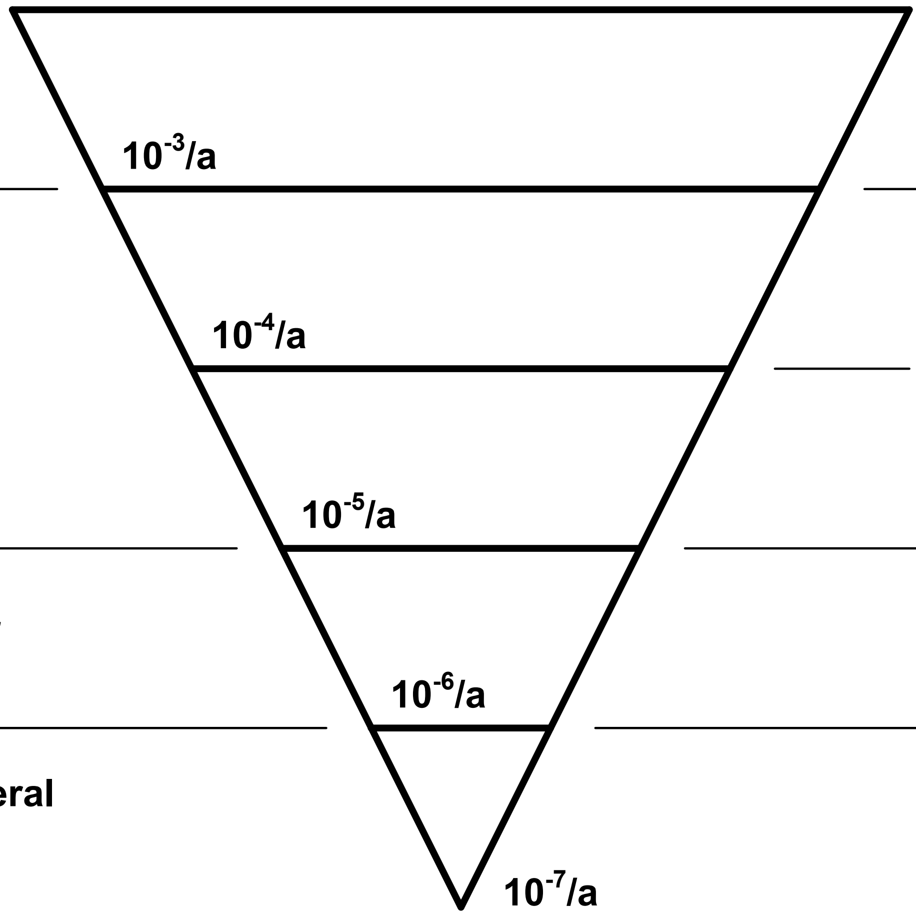
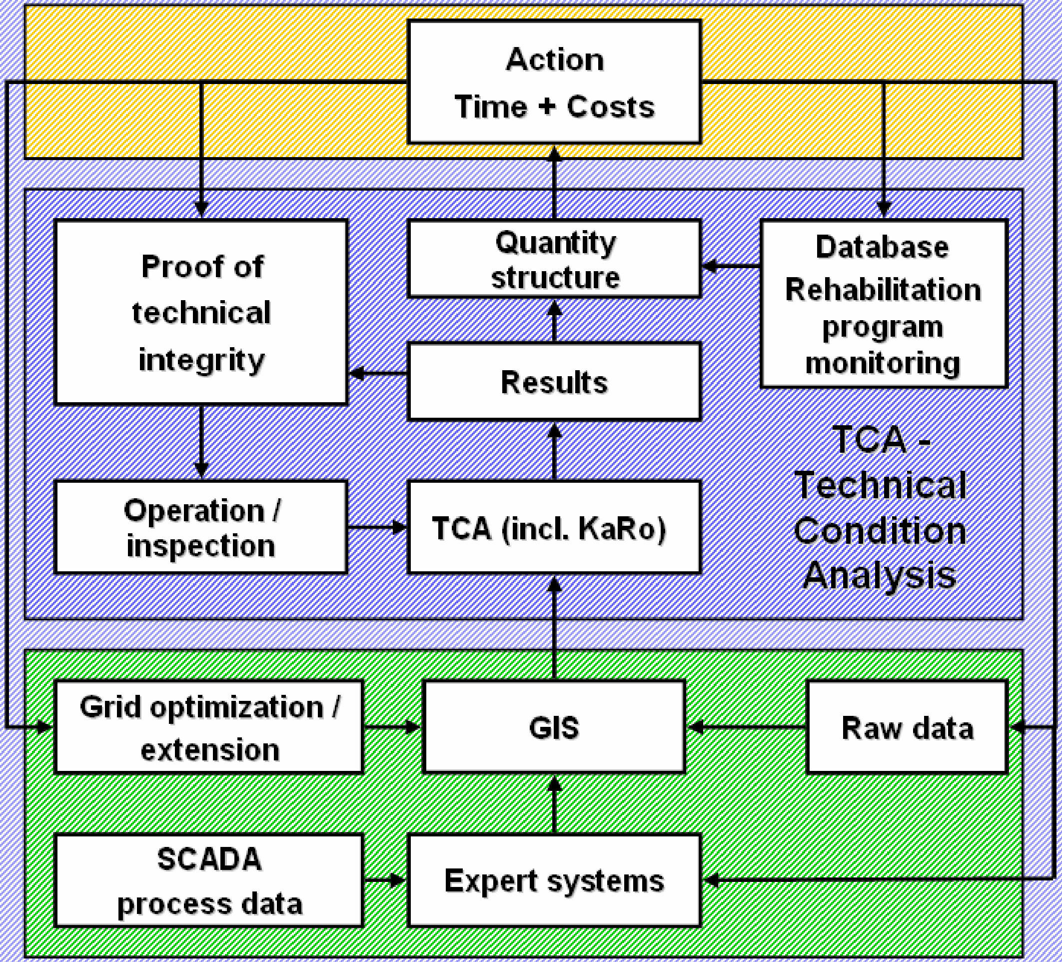




Risk	Remarks
not acceptable	too high: major improvements reqd.
alarming	very high: look for alternatives/ major improvements
	high: find improvements
acceptable to staff	low: find most economical solution
acceptable to general public	negligible: take normal precautions

PIMS elements at VNG

Technical Integrity



Process Integrity

Company strategies

- Quality standard
- Economic targets
- Social aims

Processes

- Operation
- Contingency planning
- Training
- Responsibilities
- Group standards

Quality assurance and performance review

- Error assessment
- Audits
- Inspection standards (e.g. ISO 9000)

3. Aims, elements and methods of PIMS
- Modern and efficient methods of PIMS -

- **Methods and techniques for pipeline assessment / inspection:**
  - **Pipeline Integrity Management System (PIMS)**
    - **Technical Condition Analysis (TCA)**

      → specific expert systems
    - **Intelligent / Inspection pigging**
    - **Program "KaRo" for corrosion assessment / forecasting**
    - **Program "FAD" for evaluation of old welding seams**
    - **Cathodic corrosion protection "CCP"**

4. TCA and Inspection pigging
- Technical condition analysis TCA -

Technical Condition Analysis for high-pressure gas pipelines

Non-piggable pipelines: 3,195 km

TCA

- Assess linear section (pipeline data, ambient conditions, etc.) and specific features (valves, fittings, special structures, etc.) acc. to probabilistic criteria (failure probability)
- Prioritize weak points

Piggable pipelines: 4,121 km

Inspection Pigs

- Assess wall thickness deterioration using Finite Element Method (FEM)
- For calculation use neural networks with KaRo (pipeline corrosion) program
- Estimate remaining service life by making corrosion forecast

Identify immediate steps, derive multi-stage plan for weak point rehabilitation

5. Content and results of TCA

- List of raw data – Selection of parameters -

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Priority: must (1)

1	Year of construction
2	Culvert
3	Diameter
4	Casing pipe
5	Design pressure
6	Settling pressures
7	Coverage
8	Wall thickness

Priority: must (2)

1	As-built quality, ZfP-test
2	Operating pressure
3	Empirical values at pipeline, damage statistics
4	Above ground pipeline
5	Slope
6	Medium
7	Proximity seam of a secure connection
8	Insufficient distance from structure
9	Type of seam
10	Seam fracture on this pipeline
11	Hollow
12	Mining pressures
13	Temperature
14	Type of connection
15	Traffic route (rail, road)
16	Material

Priority: should

1	Pipeline construction details (Bends etc.)
2	Cathodic Corrosion Protection
3	Pigging data
4	Damages
5	Repairs
	...

Priority: can

1	Coating
2	Groundwater
3	Ground utilization
4	Dynamic stresses
5	Soil aggressiveness
6	Electrical external voltage
	...

Priority: Information

1	Manufacturer
2	Documentation
	...

5. Content and results of TCA
- Example for pipeline assessment (I) -

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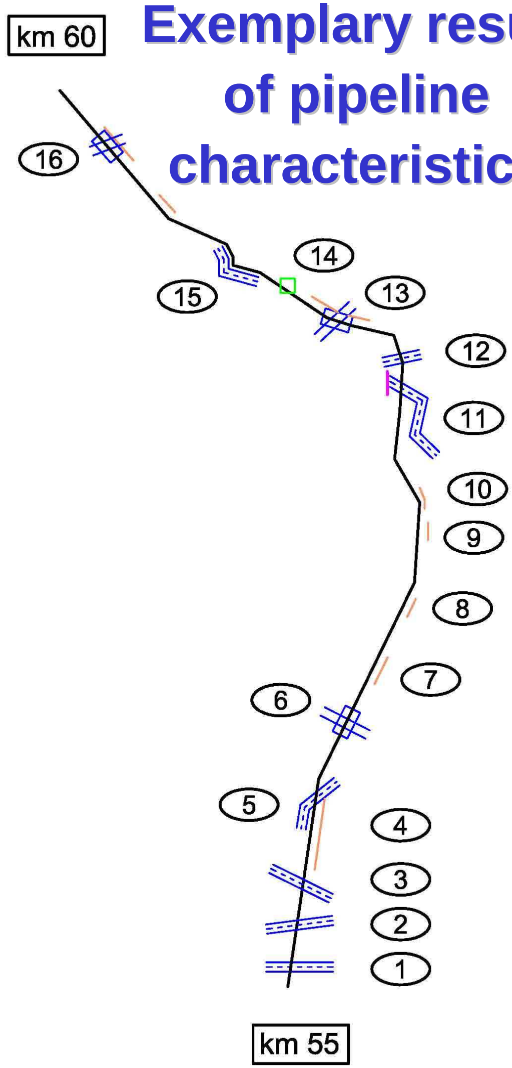
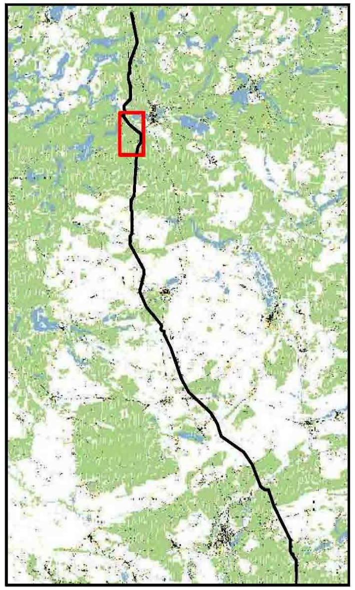
Exemplary result of pipeline characteristics





Pipeline view

No.	Cause	Cover [m]
1	Crossing with traffic route, no casing pipe	0.80
2	Crossing with traffic route, no casing pipe	0.80
3	Crossing with traffic route, no casing pipe	1.01
4	Insufficient cover	0.54
5	Structure erected over pipe	0.64
6	Crossing with traffic route, casing pipe	0.63
7	Insufficient cover	0.69
8	Insufficient cover	0.68
9	Insufficient cover	0.45
10	Insufficient cover	0.64
11	Insufficient distance from parallel traffic route	0.70
12	Crossing with traffic route, no casing pipe	0.81
13	Crossing with traffic route, casing pipe	0.58
14	Structure erected over pipe	0.83
15	Insufficient distance from parallel traffic route	0.80
16	Crossing with traffic route, casing pipe	0.80

Insufficient cover

Traffic route

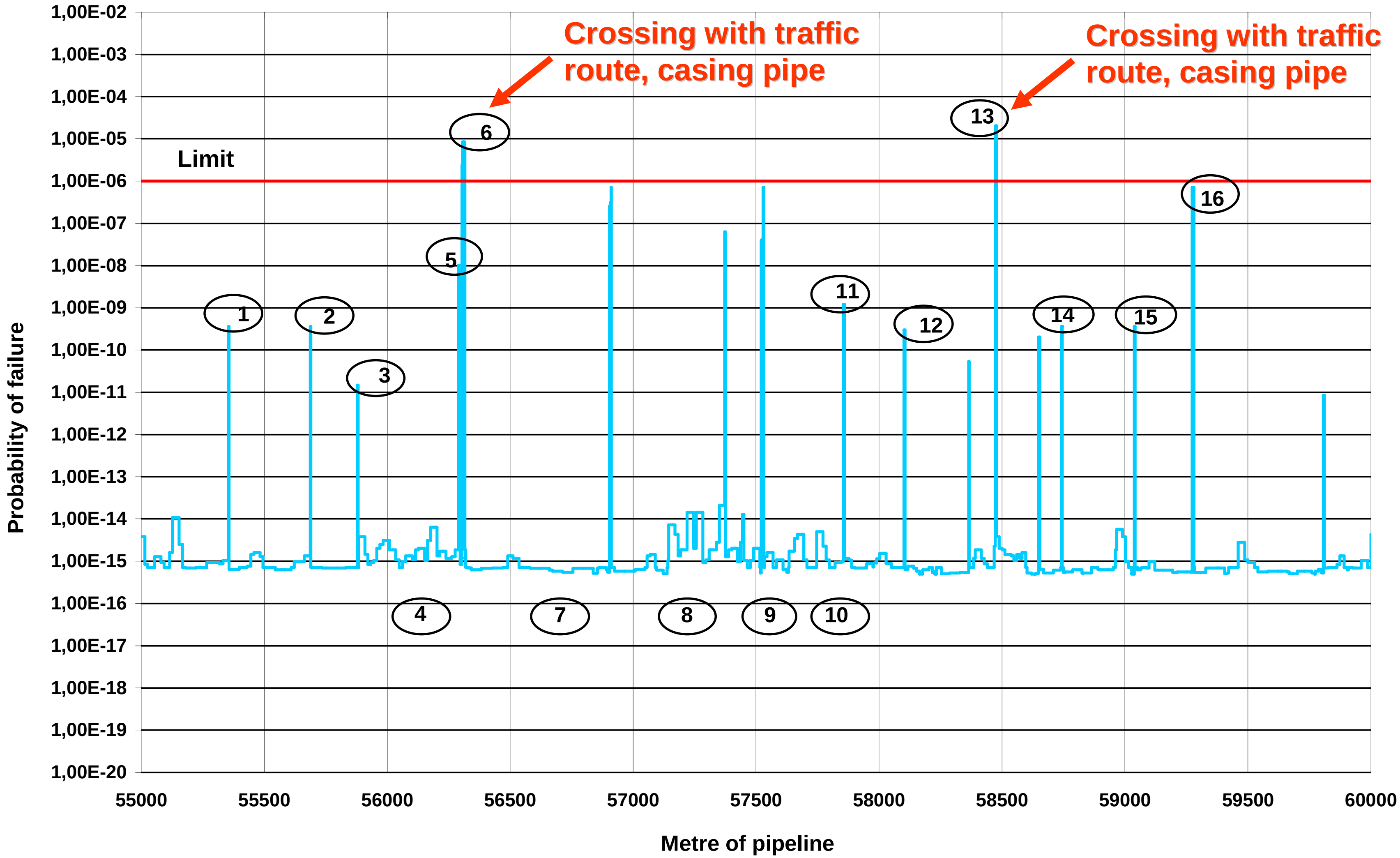
Structure

Crossing with traffic route, casing pipe

Soil endangered by settlement

Explanation of the marked locations
HP gas pipeline, PN 25, DN 400
Year of construction 1969
Overal lenght 73,27

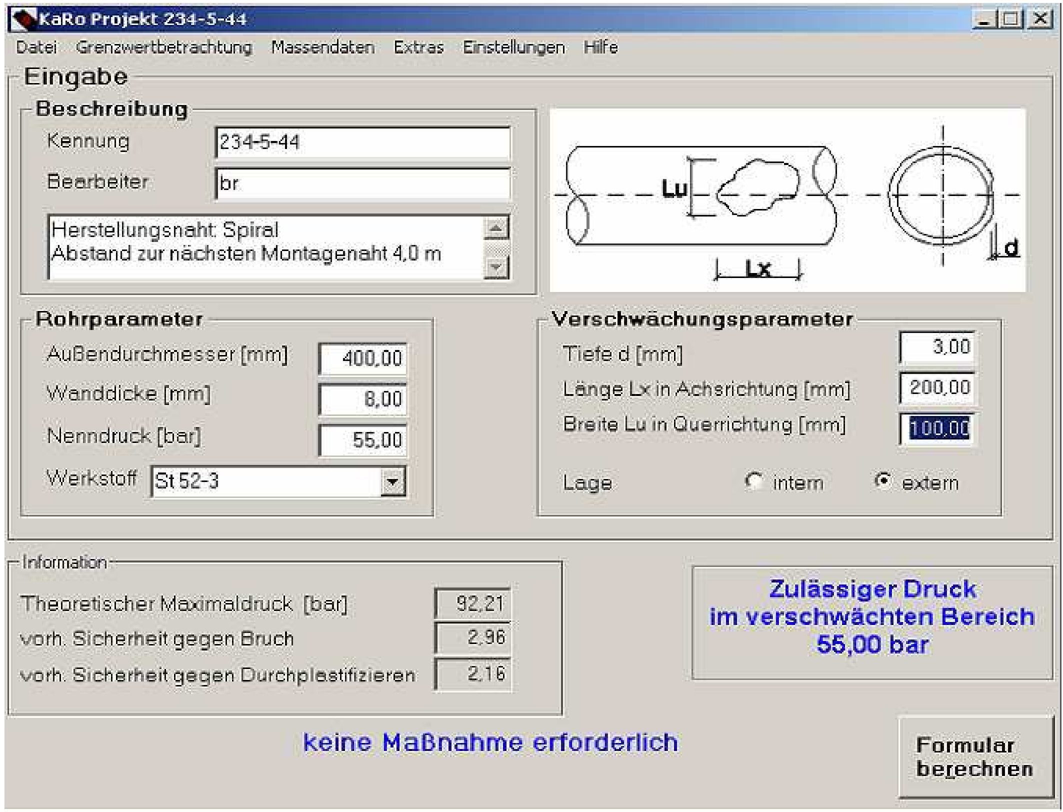
Exemplary result for design pressure PN 25 bar



KaRo - program for corrosion assessment

Evaluate large data quantities from inspection pigging:

- **Assess / classify defective places**
- **Derive immediate steps (e.g. safeguarding program, pressure reduction)**



Assess local defects (digging):

- **Determine defect parameters (wall thickness reductions) on site (length, width, depth)**
- **Recalculate operating pressure, identify repair method**

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Corrosion forecast

Aims:

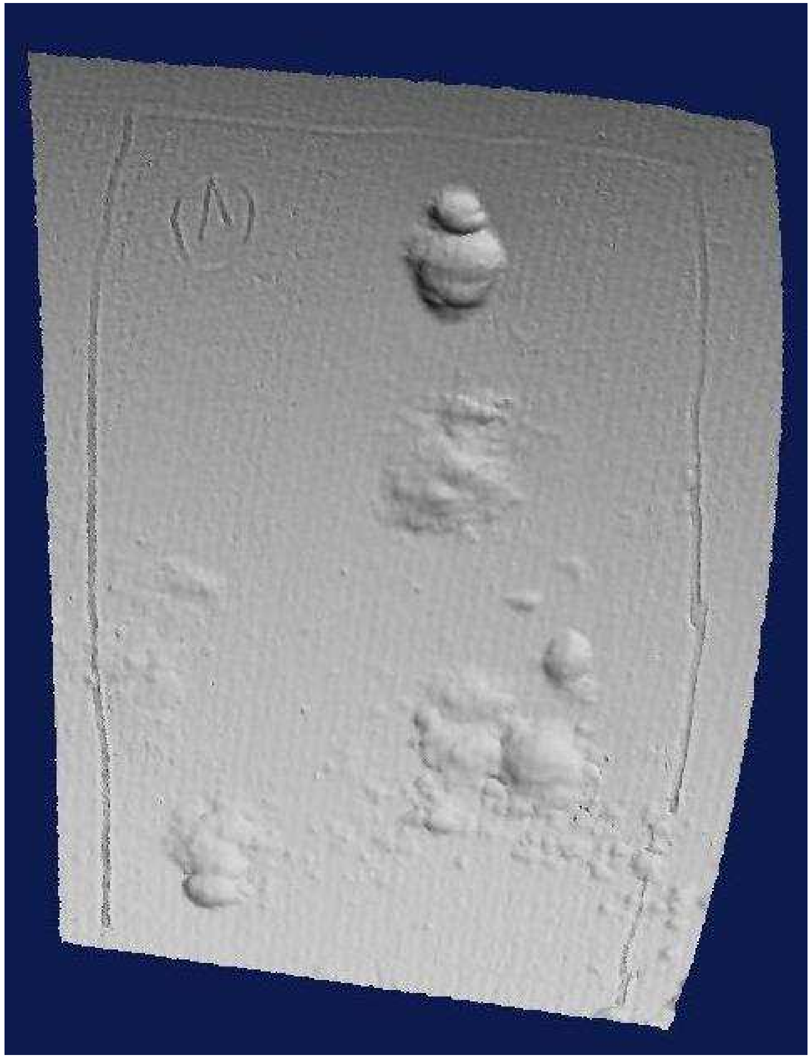
- Determine remaining operation life for wall thickness deterioration
- Optimize repair time / method (avoiding supply interruption, e.g. by field coating, clock spring, collars, etc.)
- Plan repeat inspection pigs

Applications:

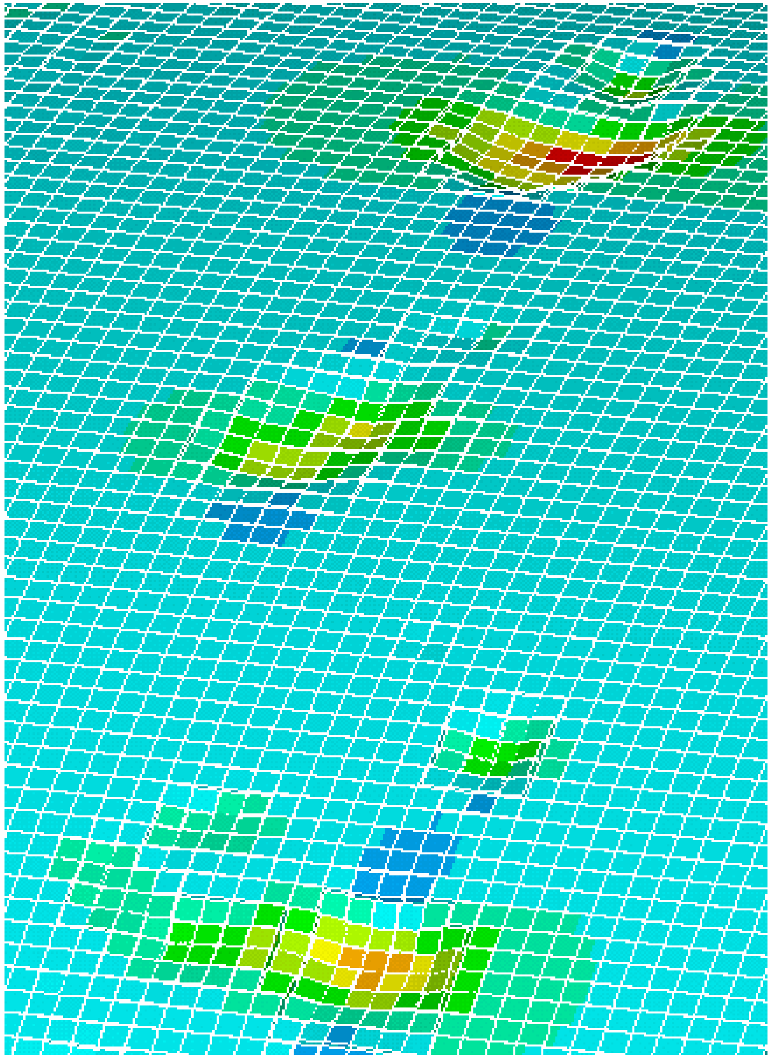
- Wall thickness deterioration requiring no immediate repair and for which the effectiveness of cathodic protection has not been proven

- FE Modelling of corrosion areas -

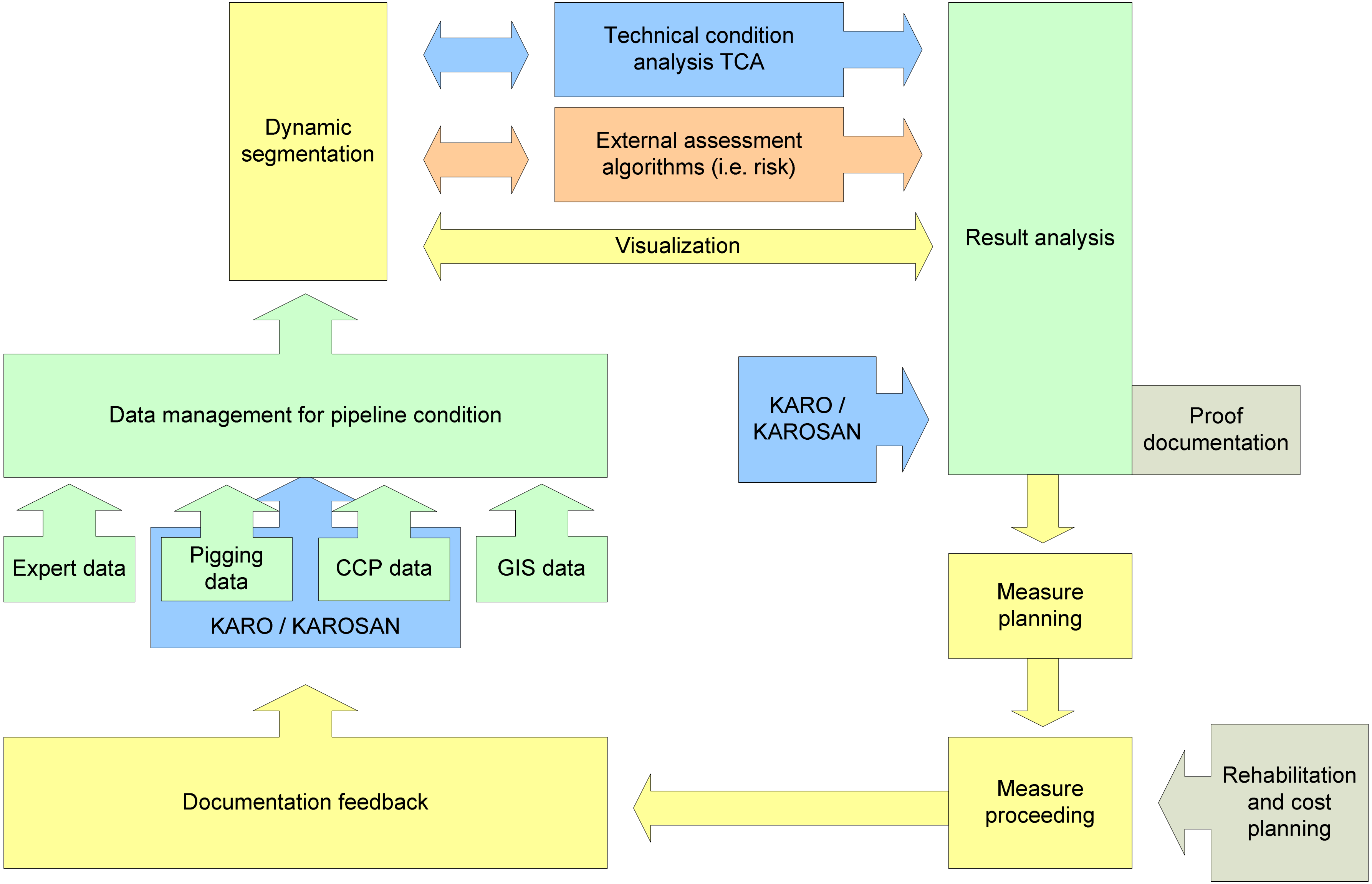
Surface scan



FE result



7. Process steps of PIMS



8. Conclusions

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- Using the TCA method since 1998 within the scope of PIMS
- up to now approx. 3,000 km of high-pressure pipelines assessed in detail and rehabilitation measures classified into priority stages 1 - 3 (defined levels)
- Results of rehabilitation processing in reference to realistic conditions optimally suitable for verifying
- Advantages: - Planning reliability / safety
  - cost lowering / optimization
  - proof of reliability and technical integrity