Design, Construction and Operation of Gas Pipelines

Essen, 10. April 2014
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Gas transmission pipelines (onshore) in Germany

Pressure: > 16 bar (currently up to 100 bar)

Diameters: DN 100 (4”) to DN 1400 (56”)

Temperature: -10°C to +60°C

Length: few kilometers up to several hundred kilometers
Procedure / Timeschedule of pipeline projects

1) Introduction

Project duration:
Project start - Commissioning: about 3,5 Years
Project start - End: about 4,5 Years (incl. Restoration)

**Right of way / Acquisition of rights**
- UVU I und II
- Natura 2000 (FFH)
- LBP

**PFV**
- Plan approval §5 Anzeige
- Acquisition of land
- Wayleave

**ROV**
- Notification of regional planning

Project start
- Feasibility study: 3 Mon.
- Project-Identification: 3–6 Mon.
- Basic Design: 6 Mon.
- Detailed Engineering: 3–6 Mon.
- Construction: 12 Mon.
- Remaining work: 3 Mon.
- 8 Weeks before constr.

End of project
- 9 Mon.
- 12 Mon.

Commissioning IBN
- Prel. certificate §6.1
- Final certificate §6.2

Plan approval
- §5 Anzeige

2) Basics / Regulations

Legal Basis

- **Law**
  - EnWG (Energy Law)

- **Regulation**
  - GasHDrLtg-VO (High Pressure Gaspipeline Regulation)

- **Technical Rules**
  - DVGW codes of practice, DIN-EN, ISO Standards

- **Intra Corporate Instructions**
  - OGE Instructions, Guide Lines,
§ 49, Requirements for energy facilities

(1) Technical security of energy facilities has to be ensured, compliance with generally accepted standards of technology

(2) Compliance with generally accepted standards of technology shall be presumed when at the plants for the generation, transmission and distribution of:
   1. Electricity: the technical rules of the Association of Electrical Engineers,
   2. Gas: the technical rules of the German Association for Gas and Water (DVGW) are observed.
High pressure gas pipeline regulation - GasHDrltg-VO

§ 3 General requirements

§ 5 Notification and objection of pipeline projects
  § 5 (1): Notification to authority at least 8 weeks before start of construction

§ 6 Commissioning, prohibition
  § 6 (1): Preliminary certificate (after construction, before commissioning)
  § 6 (2): Final certificate (After completion of all tests)

§ 8 Monitoring
DVGW Code of Practice G 463

Construction of gas pipelines made of steel pipes for operation at pressures in excess of 16 bar

- Planning
- Design
- Construction
- Construction monitoring
- Commissioning
Gas Pipelines

Material for gas pipelines:

- up to 10 bar operating pressure: often plastics (DVGW G 472) and steel
- > 10 bar operating pressure: steel (DVGW G 462 and G 463)
  - Coating: 3 layer PE, PP, Epoxy
  - Internal lining: Epoxy (thickness 0.4-0.5 mm)

Different steel gas tubes:

- Seamless pipes
- Longitudinally welded pipes or
- Spiral welded pipes

Selection of tubes according to various criteria:

- Internal pressure
- Material
- Wall thickness
- Weldability
- Corrosion protection (active-CP / passive-pipe coating)
- Price
Pipe fittings – Curved parts

Horizontal / vertical changes of direction by installing curved parts

Long laying radius:
- Deflection of the welded pipe string with permitted elastic deformation

Smaller laying radius:
- Field bend; bends are made of coated steel pipes at construction site with a bending machine (1 - 1.5° per step, e.g. bend DN 500 -> R about 25 m)
- Factory bend, cut bend, production at the factory, heating through induction annealing subsequent bending. (e.g. factory bend R = 10 x D, R = 5 x D)
Pipe fittings – Other

- Tee, branches off the main line
- Reducer, installation in case of necessary changes in diameter
- End Caps
- Flanges with screws / nuts and seals
- Insulated joints / insulating flanges
- Vent
- Slug catcher
- Pig trap
- etc.
Valves

- Distinction by type
  (ball valve, slide valve, gate valve)

- Distinction by function
  (tightly – bit worn)

- Large gas pipelines
  ⇒ mostly ball valves
  (advantage: low construction height & lower weight)
Valve station – Structure

DVGW Code of Practice G 463:
Distance service valve every 10 to 18 km

3) Design

Venting system in order to be able to work without gas on single line sections
Corrosion control of underground piping

Buried steel pipes are protected by a combination of electrochemical protection (cathodic protection) and isolating plastic coating (passive corrosion protection).
Crossings with traffic routes and barriers

In pipeline projects, many traffic routes have to be crossed (streets, railways, rivers, canals, nature reserves and landscape protection areas)

Possible crossing techniques

- Open building method
- Closed building / trenchless pipe laying:
  - Impact ramming and thrust boring
  - Horizontal directional drilling (HDD)
  - Microtunneling
  - New methods, for example Direct Pipe
Crossings with traffic routes and barriers

Open building method/ river crossing

- Total / partial blocking temporarily necessary
- Railways: installation of so-called temporary bridges for each track, afterwards the trench will be built under it.
- Crossing of larger rivers / canals by pulling in a culvert
- Small streams / ditches can be crossed open
Crossings with traffic routes and barriers

Trenchless pipe laying

Product pipe jacking
- Trenchless laying is done in nominal size of the planned gas pipeline
- Advantages of a product pipe crossing:
  - Warranty of safe CP
  - Simple technical structure
  - More cost-effective implementation

Casing pipe jacking
- Pipe jacking with a casing pipe
- Pulling of the product pipe with skids (insulating spacer)

Note:
Pipe jacking with casing should be avoided if possible (problems with CP)
Crossings with traffic routes and barriers

Horizontal directional drilling (HDD)

Crossings possible up to ca 2600 m and DN 1400
Civil work and pipe construction

Basis for construction execution

- Plan approval and “free wayleave“
- Construction plans and calculation sheets
- Placed orders

Pipe laying

- Pipeline Method by long pipelines projects:
  - As long as possible pipeline next to trench
  - Use of pipe-laying machines (side booms)
  - Installation services up to about 1,000 m / day

- Single pipe installation: short pipes, built-up areas and working strip narrowing
  - Lowering of individual pipes in trenches with lifting equipment
  - Pipes are welded together in head access holes
Civil work and pipe laying

1. Preparation of the route
2. Pipe hauling
3. Pipe bending
4. Stringing and welding
5. Testing of welds and coatings

Sequence of operations by construction

6. Trenching
7. Lowering in
8. Construction survey
9. Backfilling
10. Pressure test
11. Route recovery
Quality Assurance

Example: Quality monitoring from the raw material to pipeline operation

Steel production

Material testing / tensile test (K*s)

Weld testing and hydrotesting at workshop (each pipe)

Material certificate for each component

Tests: welder and welds

Tests: installation company and pipe installation

Stress testing of completed pipelines

Preliminary and final test certificate by TÜV inspection authority

Safety of the pipeline

Material

- Ensuring production requirements (pre-production meeting)
- Control of the raw material
- Production surveillance (Expediting)
- Acceptance by independent experts
- Complete documentation (APZ-acceptance test certificate)

Planning and construction

- Review of planning documents (§ 5 reports)
- Certified construction companies (DVGW GW 301)
- Extensive testing (weld inspection, pressure test)
- Reduction of laying / welding stresses before use (stress-pressure test)
- Supervision of work by client
- Acceptance by independent experts (§ 6 certificate)
Quality monitoring

Walking survey  Mobile survey  Aerial survey  Investigation of reports

Cathodic protection monitoring  Intelligent pigging  Repairs
Safety of the pipeline

Operation

- Corrosion protection
- Protection against external influences
- Pipeline Integrity Management System (PIMS)

Monitoring

- Control of the coating (intensive measuring)
- CP control
- Intelligent pigging

Patrolling, Inspection

- Protection from approaching construction measures
- Assign the route (protective strip)
- Leak detection by Helicopter (Charm)
Natural Gas Pipeline Project Loop Sannerz-Rimpar
Thank you for your attention!

Your Questions......
Hyperlinks Slide 32
Working strip (Example DN 1000)

- Top soil storage: ca. 8 m
- Working track: ca. 14 m
- Width of pipe trench: ca. 4 m
- Excavation storage B- and C-Horizont: ca. 8 m

Width of working strip: ca. 34 m
Preparation of the route (1)

Removal of top soil

Preparation of working strip
4) Construction

Pipe hauling (2)

Pipe storage space

Pipe hauling to the route
Pipe bending (3)

Bending machine
Stringing and welding (4)
Testing of welds and coatings (5)
4) Construction

Trenching (6)
Lowering in (7)
4) Construction

Backfilling (9)
Pressure test (10)

Proof- & tightness test
(hydrostatic / high-level test: “Stress-test”)
Route recovery (11)

Application of topsoil

Recultivated route

Recultivated route after reseeding
Recultivation of the route and landscape

During construction.......... and one year later !!