

Plastic Pipes for High-pressure Systems

Technology, Practical Applications, Cost Comparison

IGRC 2014 (International Gas Research Conference)
Copenhagen, 17-19 Sept. 2014

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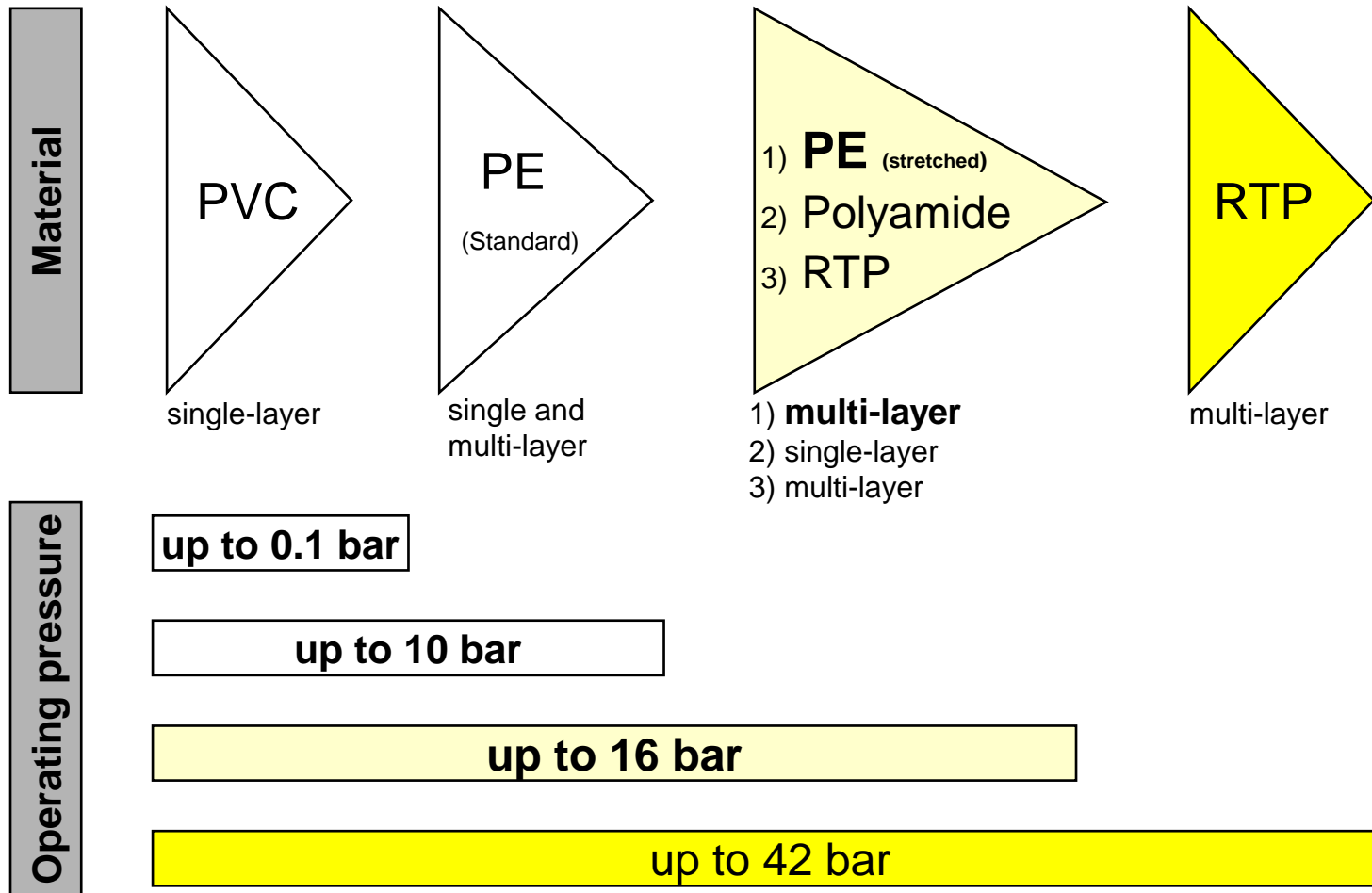
Dipl.-Ing. Werner Weißing, E.ON (E.ON Technologies GmbH)



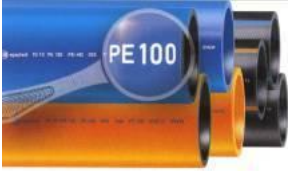





Overview

- **Introduction: General information on plastic pipes**
- **High-pressure plastic pipes: Pipe materials & designs**
- **Current situation in ‘DVGW standardisation’**
- **HP HexelOne[®] pipeline construction project E.ON (Bayernwerk)**
Design / execution / NDT methods (US phased array and bead bend back (BBB) tests)
- **Cost comparison: Steel vs. HexelOne[®] pipeline installation**
- **Conclusions**

Development of plastic gas pipelines



High-pressure plastic pipes (>10 bar): Product overview

	<p>Standard polyethylene (PE)</p> <p>Design: single-layer</p> <p>Material: PE63/PE80/PE100/PE100RC</p> <p>up to OD 400 / up to PN 10 bar</p> <p>Connector: HS / HM</p> <p>Gas permeability: * 4.46 m³/km a</p>		<p>Soluforce classic® - Pipelife (RTP)</p> <p>Design: multi-layer</p> <p>Material: PE100 - Aramid (high percentage) - PE100</p> <p>up to OD 150 / up to PN 42 bar</p> <p>Connector: HS / HM</p>
	<p>HexelOne® - egeplast (PE)</p> <p>Design: multi-layer</p> <p>Material: - PE100 RC (internal pipe) - PE100 stretched (interm. layer) - PE100 (outer layer)</p> <p>up to OD 160 / up to PN 16 / 20 bar</p> <p>Connector: HS / HM</p> <p>Gas permeability: * 6.80 m³/km a</p>		<p>Vestamid® LX9030 - evonik (PA)</p> <p>Design: single-layer</p> <p>Material: Polyamide (PA12)</p> <p>up to OD 160 / up to PN 18 bar</p> <p>Connector: HS / HM</p> <p>Gas permeability: * 0.32 m³/km a</p>
	<p>Soluforce light® - Pipelife (RTP)</p> <p>Design: multi-layer</p> <p>Material: PE100 - Aramid (low percentage) - PE100 (10% Pipelon® UB45 may be added)</p> <p>up to OD 150 / up to PN 25 bar</p> <p>Connector: HS / HM</p> <p>Gas permeability: * 6.88 m³/km a</p>		<p>Pipelon® 401 - DuPont (PA)</p> <p>Design: single-layer</p> <p>Material: Polyamide (PA6.12)</p> <p>up to OD 250 / up to PN 16 bar</p> <p>Connector: HS / HM</p> <p>Gas permeability: * 0.07 m³/km a</p>

* Methane at max. PN



Practical applications: HP gas pipeline system

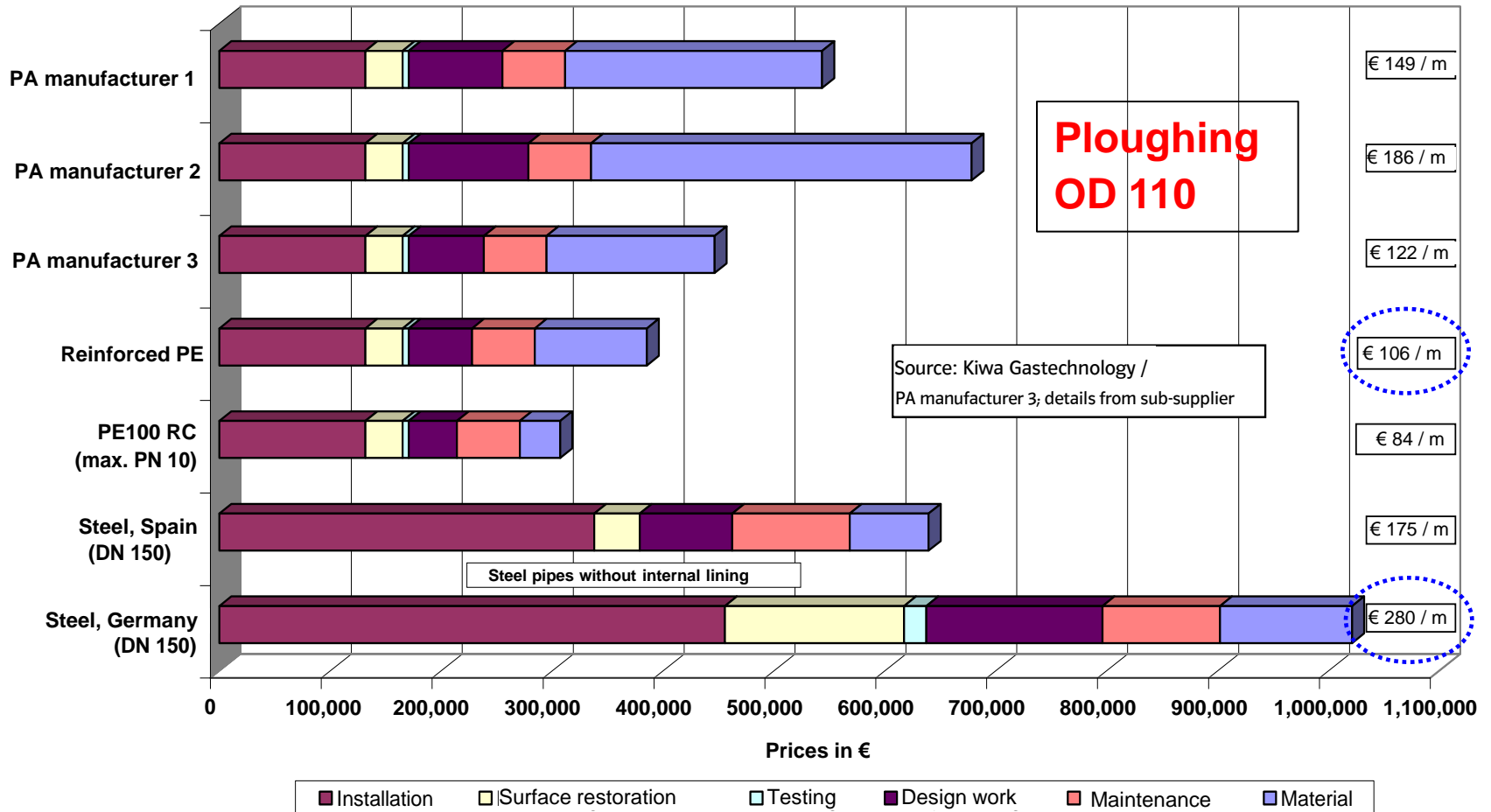
RTP Soluforce® Classic (Pipelife)

Plastic pipe	Construction project		Pipe details				Testing		
	Material designation	Client (utility)	Completion date	Pipe dimensions OD	SDR	Pipeline length (km)	Medium carried	Operating pressure (bar)	Test medium*
RTP Classic M570	VNG	April 2004	150	-	0.06	waste water	-	water	105
RTP Classic M570	Erdgas Südwest *	April 2004	150	-	4.2	natural gas	25	water	105
RTP Classic M480	E.ON	Oct. 2004	125	-	0.6	natural gas	25	water	123
RTP Classic M480	E.ON	Oct. 2005	125	-	0.44	natural gas	22-42	water	123
RTP Classic M480	Erdgas Südwest	Oct. 2006	125	-	1.9	natural gas	16	water	123
					7.2				

* 60 m of RTP Soluforce® Classic M480 pipe incl. connectors successfully tested over 12,000 operating hours at 46 bar at E.ON Ruhrgas in Dorsten

* after 8 years of operation: 1,000 h strength test of specimen taken from the field – no changes to material

Results of cost comparison Plastic vs. Steel pipelines (PN 16)



Practical applications: HP gas pipeline system HexelOne® (egeplast)

Plastic pipe Material designation	Construction project		Pipe details					Test	
	Client (utility)	Completion date	Pipe dimensions OD	SDR	Pipeline length km	Medium carried	Medium pressure (bar)	Test medium*	Test pressure (bar)
HexelOne®	SW Bad Langensalza (BV Zimmern)	2010/2011	110 x 10	11	7.0	biomethane	16	air	21
HexelOne®	SW Bad Langensalza (ALG Wiegleben)	2011/2012	110 x 10	11	9.1	biomethane	16	air	21
HexelOne®	SW Kassel (BV Neue Mühle)	2011	110 x 10	11	0.8	natural gas	-	-	-
HexelOne®	SW Münster (Dücker)	2011	160 x 14.6	11	0.2	natural gas	-	-	-
HexelOne®	Croatia	2011	125 x 11.4	11	0.7	natural gas	-	-	-
HexelOne®	E.ON Storage (Epe gas storage facility)	2011	110 x 10	11	2.8	natural gas	16	air	21
HexelOne®	E.ON Thüringer Energie	2011	110 x 10	11	4.5	biomethane	13.5	air	21
HexelOne®	E.ON Avacon	2012	110 x 10	11	0.1	natural gas vent line	-	-	-
HexelOne® SLM	SW Hagenow	2012	125 x 11.4	11	0.4	natural gas	-	-	-
HexelOne® SLM	E.ON (Bayernwerk)	2013	110 x 10	11	3.2	natural gas	14	air	18.5
			160 x 14.6	11	3.3				
HexelOne® SLM	Mitte (formerly E.ON)	2014	125 x 11.4	11	3.2	biomethane	16	-	-
Total					35				05.03.2014

* 60 m of HexelOne® system pipe incl. connectors successfully tested over 16,000 operating hours at 24 bar at E.ON Ruhrgas in Dorsten

Product range: HexelOne® / HexelOne® SLM / HexelOne® DCT / HexelOne® SLA / HexelOne® SLM / HexelOne® 3L



DVGW regulations: Certification of plastic pipeline systems

Technische Regel

Prüfgrundlage VP 642 | Juni 2004

Faserverstärkte PE-Rohre (RTP) und zugehörige Verbindungen für Gasleitungen mit Betriebsdrücken über 16 bar

Technische Regel

Prüfgrundlage VP 643 | Juni 2004

Flexible, gewebeverstärkte Kunststoff-Inliner und zugehörige Verbindungen für Gasleitungen mit Betriebsdrücken über 16 bar

DVGW GW 335-A5 (VP) / Dezember 2013



Kunststoff-Rohrleitungssysteme in der Gas- und Wasserverteilung; Anforderungen und Prüfungen - Teil A5: PE-Mehrschichtrohre mit Verstärkung (PE gestreckt) sowie zugehörige Verbinder und Verbindungen

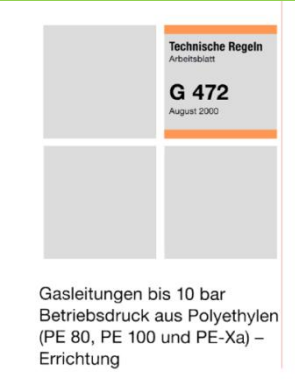
Vorläufige Technische Prüfgrundlage

DVGW GW 335-A6 (VP) | Februar 2014



Plastic pipeline systems for gas and water distribution; Requirements and tests – Part A6: Pipes made from PA-U 160 and PA-U 180 as well as associated connectors and connections

DVGW regulations: Construction and operation of plastic pipelines




Technische Regeln
Arbeitsblatt
G 472
August 2000


Draft of the new G 472 addresses the installation of high-pressure plastic pipelines on a supplementary sheet .

Gasleitungen bis 10 bar
Betriebsdruck aus Polyethylen
(PE 80, PE 100 und PE-Xa) –
Errichtung

Technische Regel – Arbeitsblatt
DVGW G 469 (A) | Juni 2010




Druckprüfverfahren Gastransport/Gasverteilung



Technische Regel
Arbeitsblatt
G 465/I
November 1997

Überprüfen von Gasrohrnetzen mit einem Betriebsdruck bis 4 bar

Technische Regel – Arbeitsblatt
DVGW G 466-1 (A) | November 2012



Gasleitungen aus Stahlrohren für einen Betriebsdruck größer als 5 bar – Instandhaltung

Pipeline route – E.ON, Bayernwerk (construction project 1)



Pipelaying methods used and construction times

- After contract award, the contractor proposed to install most of the pipeline using the ploughing method.
- Following soil tests, the client agreed to this method being used.
- Using this minimally invasive technology was the only way of meeting the requirements imposed by the authorities (nature reserve).
- Along the section where ploughing was not possible the pipeline was installed in an open trench (using a wheel trencher).
- Construction period along route: late July to early September 2013.

The work could only be completed within the allotted time frame by installing HexelOne[®] piping using the ploughing method.

Pipeline grid specification: E.ON (Bayernwerk) pipeline project

Operating pressure	bar	14
Pipe specification (egeplast)		HexelOne [®] SLM
Diameter	mm	OD 110 / OD 160
Length (different ODs)	metre	3,200 / 3,300
Length (total)	metre	6,500
Ploughing, length	%	80
Trench cutting, length	%	20
No. of connectors	piece	61
1 connector per pipe length	metre	107
Testing of fusion welds		19 welds tested using NDT
Area / landscape		nature reserve
Test pressure	bar	18.5
Test medium		air
Two pipeline tie-ins were installed.		

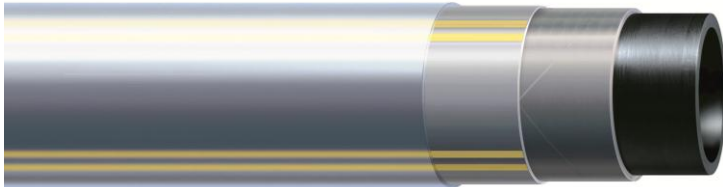


HexelOne® pipe: product examples

HexelOne® without protective coating



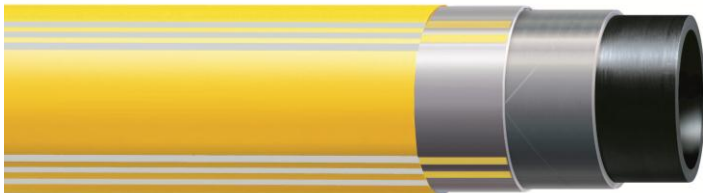
HexelOne® with transparent PP protective coating



material used at E.ON
(Bayernwerk)

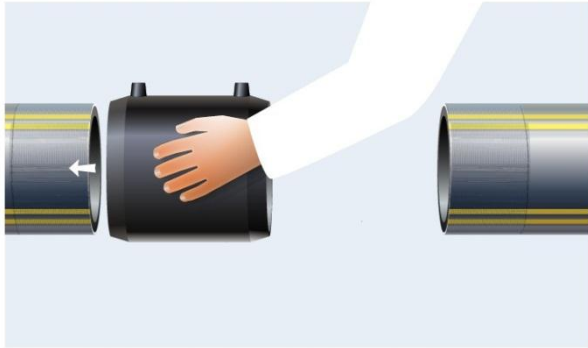
HexelOne® with yellow protective coating made of PE and additional silver strip

(This protective coating is the only coating design available since 2014; PP is no longer available)

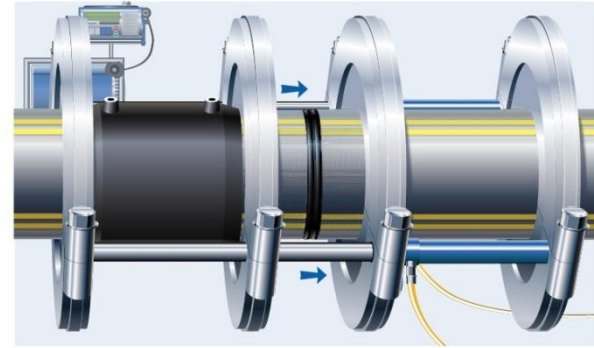


Source: egeplast

HexelOne® pipe: Fusion welding methods

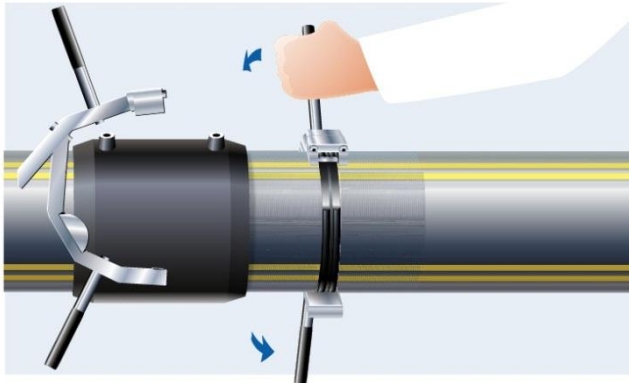


Slide on socket

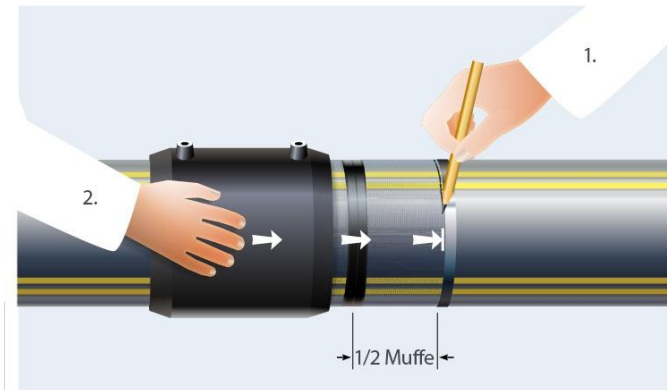


Butt fusion welding

Source: egeplast



Bead Bend Back (BBB) test
on peeled bead



Socket fusion welding:
US phased array test

Pictures from the field



**Press-fit
connection**



Pipe on reel

**Fusion
welding in
the field**



Pictures from the field



Removal of protective sleeve prior to welding

Welding with automatic welder



Pictures from the field



Installation of plastic pipe incl. warning tape by ploughing

Cutting of trench with simultaneous installation of pipe



Pictures from the field



Wheel trencher

**Pipe trench with HexelOne®
pipeline and warning tape**



Pictures from the field



**Installation in
category 7 soil**

**Storage area with
empty reels**



Pictures from the field



Completed joint



Installation by ploughing

Pipeline laid out prior to installation



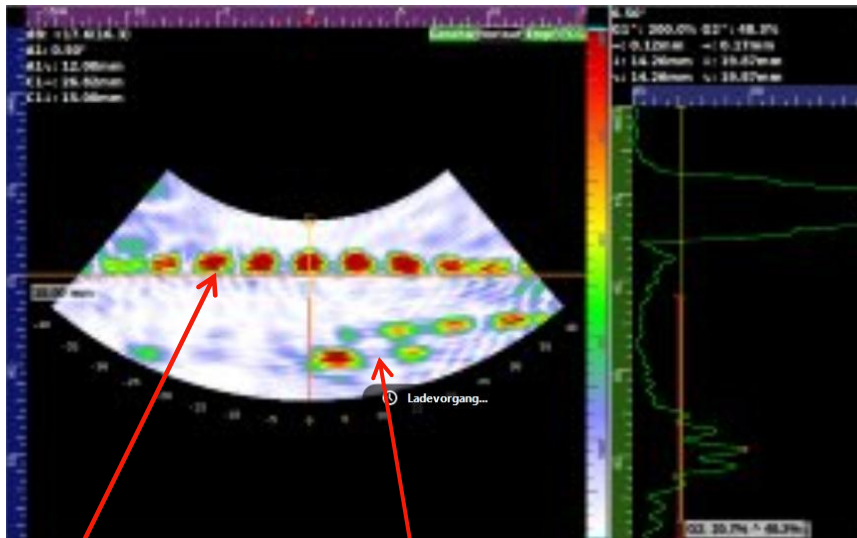
Pipeline ploughed into the ground



NDT methods

19 sockets tested using phased array method / all butt welds tested using BBB test

Phased array scan taken on site
(OD110, socket fusion welds)



Doubling of pipe back wall

Wires of socket fusion coil: All wires are in a straight line. The weld is OK.

Bead Bend Back test
(BBB test)



Bending test on peeled bead

Local nature conservation authority

Nature Protection Dept.

Landratsamt Nürnberger Land - 91205 Lauf a. d. Peg.

nürnberger land

Bohn Ingenieure GmbH
Richard-Wagner-Straße 36
95444 Bayreuth

Landratsamt Nürnberger Land
Untere Naturschutzbehörde

E-Schreiben
Empfänger: Bohn Ingenieure GmbH
E-Mail: h.heini@nuernberger-land.de
Datum: 17.12.2013

Auskunft erteilt	E-Mail-Adresse	Tel. 09123	Fax 09123	Zimmer	Lauf a. d. Pegnitz
Herr Heini	h.heini@nuernberger-land.de	950-6243	950-7243	Nr. 414	17.12.2013
Unser Zeichen (bitte bei Antwort angeben)		Ihre Zeichen		Ihre Nachricht vom	
21.3		Kr/ho - 130527		09.12.2013	

**Erdgasleitung Hirschbach – Hartenstein, d 160/110, DP 16 der Bayernwerk AG;
Abschlussbericht der Fachbauleitung für Naturschutz**

Sehr geehrte Damen und Herren,

von dem Abschlussbericht der Dr. Heimbucher GmbH wurde Kenntnis genommen. Anlass zu Beanstandungen sind nicht gegeben.
Für die gute und konstruktive Zusammenarbeit dürfen wir uns ausdrücklich bedanken.

Mit freundlichen Grüßen

Heini

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Dienstag 7:30 – 16:00 Uhr
Mittwoch 7:30 – 12:30 Uhr
Donnerstag 7:30 – 18:00 Uhr
Freitag 7:30 – 12:30 Uhr

Bankverbindung
Sparkasse Nürnberg
Nr. 240 105 526 (BLZ 740 501 011)
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BIC SSKNDE77XXX

StadtBus Lauf
Haltestelle Altdorfer Straße
Haltestelle Landratsamt
S-Bahn
Linie S 1
Bahnhof Lauf West
Bahnhof Lauf (l. Pegnitz)

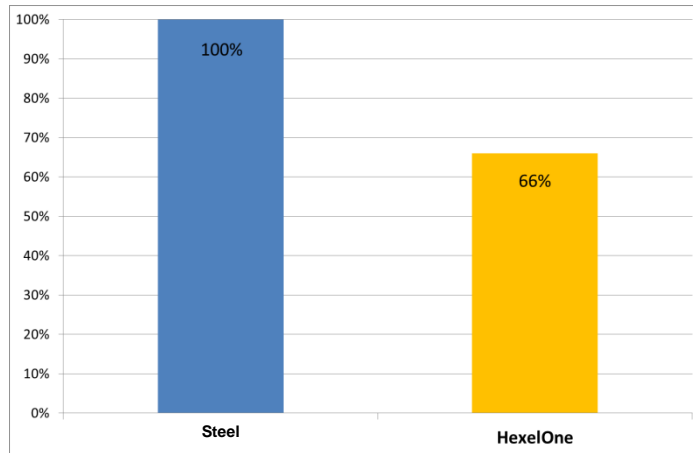
Final report:

(issued by local nature conservation authority)

- No objections
- Thanks expressed for good and constructive cooperation

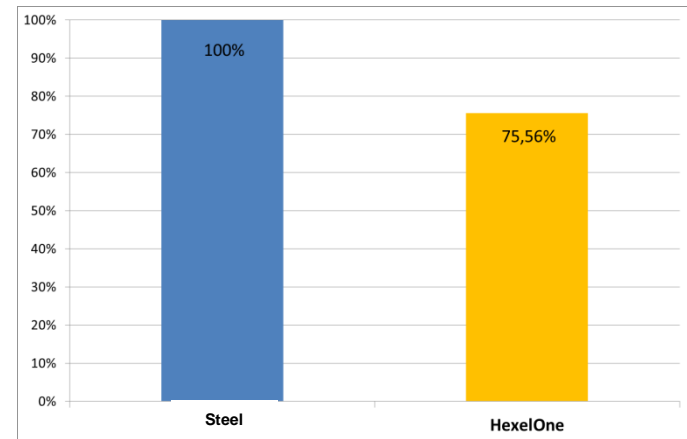
Cost comparison for three construction projects HexelOne® vs. steel pipes

construction project 1



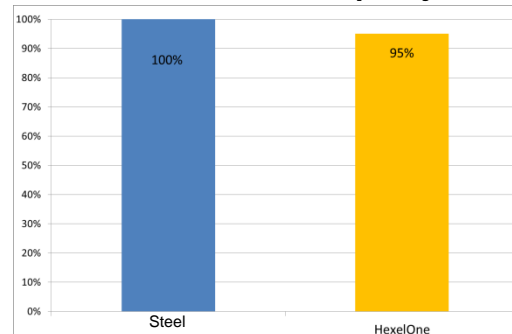
Project was carried out using HexelOne

construction project 2



Decision taken to use HexelOne after planning process

construction project 3

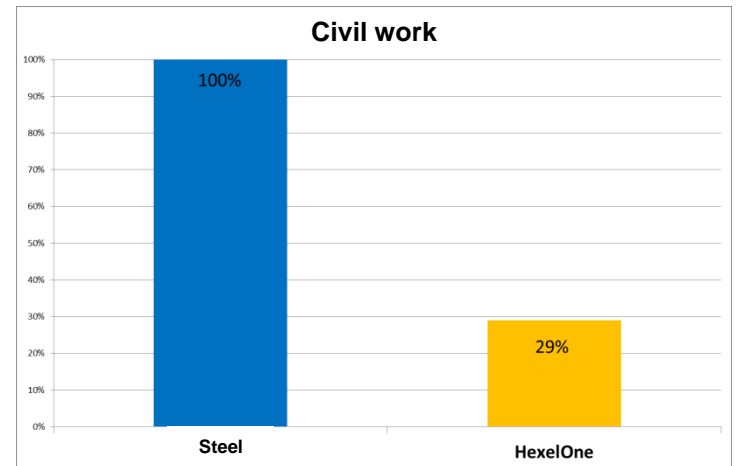
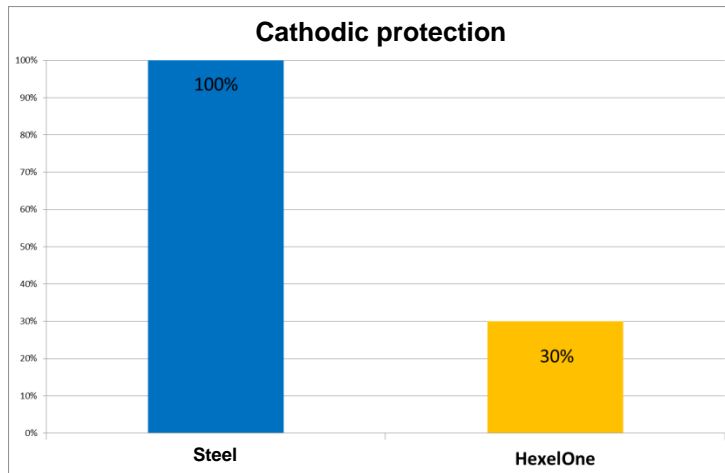
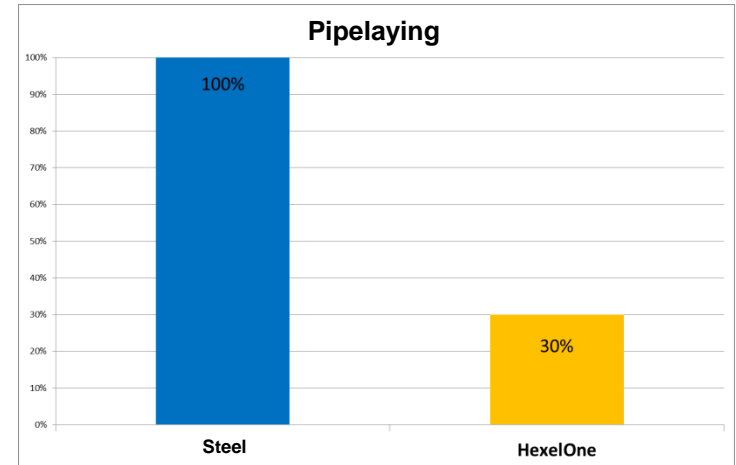
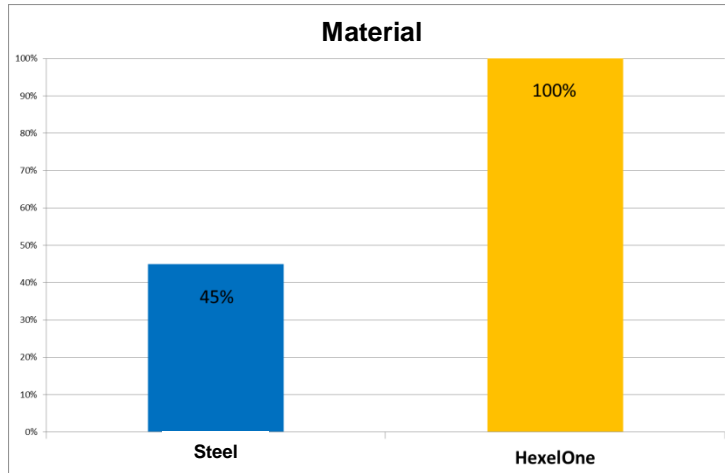


Project was carried out using steel pipes



Cost comparisons for each of the disciplines

Material, CP, pipelaying and civil work in construction project 1



Advantages and disadvantages

Steel vs. plastic pipes (≤ 16 bar)

Feld experience gained during E.ON (Bayernwerk) project

Parameters examined		Steel pipe (Standard)	Plastic pipe (HexelOne)
Material	Operating pressure	+++	○ (max. 16 bar)
	Diameter	+++	○ (< OD 160 mm)
Construction work	Installation in nature reserve	--	+++
	Width of working strip	○	++
	Open trench	○	+
	Installation by ploughing / trench cutting	○	+++
	Pipe laid in sand bed	○	++
	Mechanical protection	○	+
Components / pipeline	Flexibility of pipe string	○	+++
	Bends / spools (costs)	++	○
	Block valves	+	○
Pressure testing	Testing in acc. with G 469	○	○
	Active & passive corrosion protection	○	++

+++ = very positive

-- = very negative

○ = neutral



Conclusion: HexelOne® installation at E.ON (Bayernwerk)

- Installation of HexelOne pipe bundles delivered to site **on reels** is much faster.
- A higher **ploughing percentage** (dependent on soil conditions) meant less civil work, which led to considerable cost savings and reduced the working width required along the route.
- Since the **HexelOne® pipe came with a protective coating** there was no need for a sand bed, i.e. no trucks delivering sand or removing soil from site (reduced impact on environment; better eco-balance).
- **Compensation for damage to agricultural land caused by construction project can be reduced significantly**, leading to greater acceptance of construction projects by landowners and tenants of the agricultural land (important argument in negotiations with landowners).
- On the other hand, if the line suffers any **damage**, it has to be shut down for the repair work. Processes and components allowing repairs to be made without interrupting the gas flow still need to be developed.

Any questions?

Thank You!