Advantages and Experiences of the Use of Long Length PE Pipes for Marine Pipeline Construction & Installation Techniques for Flexible PE Pipes by Trygve Blomster Export Manager Pipelife Norge AS
Who is Pipelife

- One of the world’s leading producers of plastic pipes & fittings
- Wide range of products and materials for all major pipe & fitting markets
- Headquarters in Vienna, Austria
- A fully owned subsidiary of Wienerberger AG, Austria
Facts and Figures about Pipelife

- **Locations worldwide**
  - Region US
  - Region West & Nordic
  - Region Central Eastern Europe (CEE)

- **Sales Offices 2011:** 27 Countries
- **Production Sites 2011:** 27
- **Employees 2011 (average):** 2,651
Pipeliife in Norway

Head office:
Surnadal

Production sites:
Surnadal
Stathelle

Marketing departments:
Surnadal
Stathelle
Oslo
Trondheim

Order / sales office:
Surnadal
Continuously Extruded Long Length PE Pipes

From Pipelife Norge AS, Stathelle, Norway

Protected location in a narrow fjord

Continuous extrusion into the fjord

Transport by tugboat to the marine destination
Part of Scandinavian PE Pipe History

PE pipe production started in 1960

Due to lack of proper welding methods at that time, the pipes had to be made as long as possible.

From there the long length pipe concept has been developed
PE Pipe Range from OD 20 mm up to OD 2500 mm

Pipelife can offer:

- PE pressure pipes in the range from OD 20 mm to OD 2500 mm in SDR classes from 41 to 7.4 (SDR21 for the largest ones)
- Continuously extruded PE pipes in lengths up to 550 - 600 m
PE Pipe Range from OD 20 mm up to OD 2500 mm

The range of products include all accessories needed for a complete pipe system:

- PE segment welded bends
- PE welded T-branches
- PE reducers
- PE stub ends
- Steel loose backing rings
- Diffusers
- Manholes
Important Characteristics of PE Pipes

- Light in weight, density 0,95 - 0,96 kg / dm$^3$
- Buoyancy in sea water
- Flexible, accept bending radius down to 20 x OD
- Non-corrosive
- Non-toxic, potable water approved
- High abrasion resistance
- High chemical resistance
- High strength
- High resilience to shocks
- High fatigue strength
- Permanent low head loss
- Weldable, by butt fusion
- Almost unlimited lifetime underwater
Quality Control on PE Pipes

Pipelife Norge AS is certified according to ISO9001 and ISO14001. Main standards used: ISO 4427:E and EN12201

ISO 9001 Certificate  Typical Quality Control Plan
Quality Control on PE Pipes

Control of the raw material

Density
ISO1183

Melt Flow Rate (MFR)
ISO1183

Oxidation Induction Time (OIT)
EN728

The results of the tests are shown on the resin suppliers material certificates.
Quality Control on PE Pipes

Control on Ready Made Pipe

• Same raw material control is also made on the ready made pipe, i.e. (Density, MFR and OIT)

• The use of an inert gas, (nitrogen) in the pipe manufacturing ensures the quality of the material performance (anti oxidants) in the finished pipe is high and more stable.
Quality Control on PE Pipes

Control on Ready Made Pipe

Appearance and dimensions:

• Appearance  ISO4427:E / EN12201
• Diameter  ISO4427:E / EN12201
• Ovality  ISO4427:E / EN12201

Measuring of the pipe diameter

Gravimetric control
Quality Control on PE Pipes

Hydrostatic Test

Hydrostatic strength  ISO4427:E / EN12201

PE80:  +80°C / 4,5 MPa / 165 h and +80°C / 4,0 MPa / 1000 h

PE100: +80°C / 5,4 MPa / 165 h and +80°C / 5,0 MPa / 1000 h
Quality Control on PE Pipes

Tensile strength test on weld

ISO 13953 - 2001

**Conditioning:** test piece in air for a min. 6 h at 23°C ± 2°C, testing not be carried out less than 24h after the butt fusion of the joint.

**Procedure:** Record the maximum force applied and the type of failure as ductile or brittle, as characterized by the ductile and brittle failure modes. Only failures at the butt-fusion joint shall be taken into account.
Quality Control on PE Pipes

Certification Requirements on Welding Machines and Welders

Own experienced, certified welding specialists, (here welding a ø2100 mm pipe with 70 mm wall, a brine outfall for a desalination plant, 2012)
Tow Preparation

Traditional Tow Preparation with End Plugs and Towing Clamps

Welding of end plug on 1600 mm pipe, (Tay Region, Scotland, 1999)

Pipes ready with towing clamps, hawsers and front cones, (Fylde, the U.K. 1995)
Tow Preparation

Tow with Flange Connections Ready Assembled at the Factory

Welding of stubend on 2100 mm pipe,

Assembly of blind flange and protective tyre on 1600 mm pipe,
Tow Preparation

The design of the towing gears is controlled by internationally recognized certifying bodies.

Departure of 1400 mm pipe tow, 10 pipes á 480 m, (Cartagena, Spain, 2005)

Departure of 1200 mm pipe tow, (Cork, Ireland, 2001)
Towing in the Open Ocean

Pipelife Norge AS long length deliveries include:

towing transport and transport insurance

Towing of 1400 mm pipes,
(Reykjavik, Iceland, 2001)

Towing of 1000 mm pipes,
(Split, Croatia, 2001)
Inspection and Control at Arrival

The delivery is always jointly inspected by representatives from the Contractor, Project Consultant and Pipelife.

2000 mm pipes in storage, (Aveiro, Portugal, 2008)

Mooring and inspection of 1200 mm pipes, (Sibenik, Croatia, 2002)
Advantages with Supply of PE Pipes in Long Lengths

Which are the main advantages with the long length pipe concept?

• No or very little welding work
• Low transport costs
• Substantial time and cost savings for the contractor, as normally no land based work site and storage area is required
• Less risk for damages during handling, transport and storage
Installation of flexible PE Pipes in Long Lengths

Methodology

- Surface preparation with concrete weights
- Surface assembly of long sections
- Surface positioning along lay route
- Installation in a continuous operation
- Surface to seabed transfer utilizing the PE pipe’s flexible properties
- Submersion by water filling / air evacuation
- The operation can be reversed if required
- Fast, practical sinking speed 500-1000m/hour
- No sophisticated equipment required
Installation of flexible PE Pipes in Long Lengths

S-LAY INSTALLATION OF FLEXIBLE PIPELINES
Installation of flexible PE Pipes in Long Lengths

Important Parameters

• Water filling method; pressure-, gravitation
• Sinking speed / equilibrium pressure
• Inlet arrangement / flow capacity
• Relative pressure / hydrostatic buckling
• S-curve / critical bending radius
• Longitudinal pulling force
• Concrete weight slide / bolt torque
• Time- / stress factor during temporary stops
• Weather conditions / positioning control
• Contingency actions
Installation of flexible PE Pipes in Long Lengths

Longitudinal pulling force

• Assists positioning along lay route
• Compensates wind- and wave action
• Provides safety margin for S-curve bends
• Maintains control when offshore end dives, (S→J configuration), (water in / air out)
• Achieves safe landing of end arrangement on seabed
Concrete Ballast Weights

Various concrete weight designs, depending if the pipeline is installed on the seabed or in trench

Montpellier, France - ø1600 mm
Limassol, Cyprus - ø1600 mm
Stobrec, Split, Croatia - ø1000 mm
Loudden, Stockholm, Sweden - ø630 mm
Reykjavik, Iceland - ø1400 mm

Montpellier, France - ø1600 mm
Limassol, Cyprus - ø1600 mm
Stobrec, Split, Croatia - ø1000 mm
Concrete Ballast Weights

Concrete weight bolts, rubber compensators, EPDM rubber friction straps and sacrificial anodes

Antalya, Turkey - ø1600 mm
Reykjavik, Iceland - ø1400 mm
Concrete Ballast Weights

Assembly of the concrete weights on the PE pipe. Various methods.

Lough Mahon, Cork, Ireland - ø1200 mm
Reykjavik, Iceland - ø1400 mm
Södertälje, Sweden - ø1000 mm
Porto de Suape, Recife, Brazil - ø1600 mm
Submerging of flexible PE pipelines

Antalya, Turkey - ø1600 mm

Carrigrennan, Cork, Ireland - ø1600 mm

Terga, Algeria – ø2000 mm
Submerging of flexible PE pipelines

Xove, Spain - ø2000 mm

Montpellier, France - ø1600 mm

Sibenik, Croatia - ø1200 mm
Submerging of flexible PE pipelines

Offshore surface connections of pipe strings

Montpellier, France - ø1600 mm
Submerging of flexible PE pipelines

Pipeline end details

Compressed air hose connected to the pipe end
(Stobrec, Croatia - Ø1000 mm)

Towing end Ø1600 mm for ocean towing
of the ready weighted pipes
328 m long tapered diffuser 1600 / 500 mm with 120 diffuser ports in ø160 mm for Antalya sea outfall - main pipe ø1600 mm, (Turkey)

Totally 78 numbers of 160 mm diffuser risers on the ø1600 mm main pipeline - Montpellier, France

Ø500 mm diffuser risers to be assembled on the ø1400 mm main outfall - Accra, Ghana
Special accessories

- Ø1600 mm Embedded spool piece
- Flanged 57 degree Ø2000 mm bend for Insuamar - Spain
- 3D tailor made fitting Ø800 mm PN10
- Ø1400 mm intakes on Ø2000 mm main pipe - Insuamar - Spain
Reference projects

Fylde Sea Outfall, the U.K. - 1995
Pipe diameter 1400 mm (5200 m + 1100 m)

Assembly of concrete weights & submerging
Reference projects

Antalya Sea Outfall, Turkey - 1997
Pipe diameter 1600 mm (5400 m)

Submerging of the sea outfall  Diffuser section
Reference projects

Aveiro Sewerage Project, Portugal - 1998-99
Pipe diameter 1400mm (2780 m) and 1600 mm (1800 m)

Sea transport of pipes and Concrete weight assembly
Reference projects

Santander Sea Outfall, Spain - 1999
Pipe diameter 1400 mm (2690 m)

Pipe welding and concrete weight assembly
Reference projects

Larnaca Desalination Plant Project, Cyprus - 1999 / 2000
Pipe diameter 1200 mm (1050 m) and 1000 mm (1500 m)

Tow departure from Norway
Pipes stored in the port of Limassol
Reference projects

Levenmouth Sea Outfall, the U.K. - 2000
Pipe diameter 1600 mm (1036 m)

Production of diffuser sections            Tow preparation
Reference projects

Cooling Water Intake, Södertälje, Sweden - 2000
Pipe diameter 1000 mm (6134 m)

Pulling of 500 m pipe length over the lock  Concrete weight assembly
Reference projects

Reykjavik Sea Outfall, Iceland - 2001
Pipe diameter 1400 mm (5690 m), 1200 mm (155 mm) and 1000 mm (400 m)

Assembly of concrete weights, jointing of pipe sections and submerging
Reference projects

Bekkelaget Sea Outfall, Oslo, Norway - 2001
Pipe diameter 1200 mm, twin pipe 2 x 370 m + diffuser

Preparation of diffuser for laying suspended 2 m above the sea bottom submerging

Submerging of the first outfall pipe
Reference projects

Stobrec Sea Outfall, Split, Croatia - 2001
Pipe diameter 1000mm length 2932 m, including a 204 m long diffuser

Towing of the pipes

Pipe installation

Sinking of the deep section
Reference projects

Lough Mahon Crossings, Cork, Ireland - 2001
Pipe diameter 1200mm twin pipeline total length 7064 m
Reference projects

Carrigrennan Sea Outfall, Cork, Ireland - 2002
Pipe diameter 1600 mm Pipe length 800 m

Pipe installation
Reference projects

Termopernambuco Cooling Water Outfall, Recife, Brazil - 2002
Pipe diameter 1600 mm total length 1624 m

Department from Stathelle

The power plant

Weighted pipes in Suape port
Reference projects

Loudden Waste Water Pumping Main, Stockholm, Sweden – 2003
Pipe diameter 630 mm total length 6820 m

Concrete weight assembly
Towing of the pipes through the archipelago of Stockholm
Reference projects

Montpellier Sea Outfall, France – 2003
Pipe diameter 1600 mm total length 10.827 m

Assembly of the GRP coupling and pipe submersion

Welding of PE stubend
Reference projects

Sibenik Sea Outfall, Croatia – 2003 and 2004
Pipe diameter 1200 mm total length 5134 m

Installation of the first 1500 m section

Mooring of the pipes in Sibenik
Reference projects

Submarine Cooling Water Pipeline, Stockholm, Sweden – 2004
Pipe diameter 800 mm PN10 total length 2100 m

The PE pipes are lifted over the lock in Södertälje for further towing to site

Special bends, re-inforced with GRP around the butt welds in order to get PN10 rating
Reference projects

Water Pipeline for Paper Mill, Halden, Norway – 2004
Pipe diameter 1400 mm total length 1490 m

Welding of the OD 1400 x 66,7 mm SDR21 PE pipe at site.

Installation of the marine part of the pipeline in a river.
Reference projects

Schola Green Outfall Relining, Morecambe, the U.K. – 2004
Pipe diameter 1400 mm total length 967 m

Departure of the tow with the 967 m long PE pipe OD 1400 mm SDR26
Installation of the PE pipe into the old concrete lined steel pipe
Reference projects

Korle Lagoon Outfall, Accra, Ghana – 2004
Pipe diameter 1400 mm total length 1800 m

Tow departure from Stathelle with the 4 numbers of diameter 1400 mm pipe

Mooring of the pipes in Sekondi harbour, Ghana
Reference projects

Drinking Water Pipeline, Kalmar, Sweden – 2004
Pipe diameter 710 mm PN10  total length 7920 m

The OD 710 mm SDR17 PN10 PE pipe, 500 m long, is pulled into the laying position with a forest tractor

The pipe is in position. The trench shall be excavated to the right of the pipe
Reference projects

Brine outfall from a desalination plant, Cartagena, Spain – 2005
Pipe diameter 1400 mm  total length 4800 m

The pipeline is ready for submerging – buoyancy required

Departure of the tow with 10 x 480 m long PE pipes OD 1400 mm
Reference projects

Sea water intakes for a fish farm, Galicia, Spain – 2005
Pipe diameter 2000 mm total length 2230 m

Departure of the tow with 4 pipes,
2 x 630 m + 2 x 485 m long PE pipes
OD 2000 mm SDR30 and SDR26 PE80

Pipe submerging in Xove harbour
Reference projects

Sea outfalls for Zadar and Biograd, Croatia – 2006
Pipe diameter 1200 mm total length 2810 m
Pipe diameter 630 mm total length 3419 m

Pipes in storage
Submerging of the ø1200 mm PE pipes in Zadar
Reference projects

Sea water intakes for Abutaraba desalination, Libya – 2006
Pipe diameter 1400 mm total length 1288 m

Sinking of the OD 1400 mm SDR26 PE80 pipes in Abutaraba in August 2006
Reference projects

Sea water intakes and brine outfall for Hamma desalination, Algiers, Algeria – 2006
Pipe diameter 1600 mm  total length 1348 m

Installation of one Ø1600 SDR26 sea water intake
Reference projects

Tangier sewer outfall, Morocco – 2006/2007
Pipe diameter 1400 mm total length 2195 m

Arrival of the second delivery to Tangier MED harbour in March 2007
Ready weighted pipes in storage
Reference projects

Tetouan sewer outfall, Morocco – 2006/2007
Pipe diameter 1200 mm  total length 3100 m

Ballast weight assembly

Tetouan – Submerging of the ø1200 mm pipeline
Reference projects

Sea water intakes and brine outfall for Chennai desalination, India – 2007
Pipe diameter 1600 mm  total length 1700 m

Welding and ballasting of the pipeline in Chennai.
Reference projects

Cooling water outfall for a power plant, Ireland – 2007
Pipe diameter 2000 mm  total length 437 m

Welding of the PE stubend to the Ø2000 SDR33 pipe on site in Cork.

Ø1200 mm PE manhole assembled on the Ø2000 mm pipe on site.
Reference projects

Sea water intakes for the MIRA fish farm, Portugal – 2007/2008
Pipe diameter 2000 mm  total length 5308 m

Departure of the second tow with 6 numbers of ø2000 SDR26 pipes.

Pipe submerging outside Mira

Concrete ballast weighting in the port of Aveiro
Reference projects

Sea water intakes for the Barcelona desalination plant, Spain – 2007/2008
Pipe diameter ø1400 mm – 1330 m and ø1800 mm - 4320 m

Directional drilling operation under a river – 1400 mm SDR21 PE pipe
Departure of the second tow with 10 numbers of ø1800 SDR26/30 pipes.
Reference projects

Sewer outfall for the city of Rabat, Morocco – 2008
Pipe diameter 2000 mm  total length 1365 m

Submerging of the ø2000 SDR26 diffuser pipe in Rabat.

Concrete ballast assembly
Reference projects

Sewer outfall for the city of Tripoli, Lebanon – 2008
Pipe diameter 1600 mm  total length 1473 m

Assembly of ø710 mm diffuser risers in the port of Tripoli.

Concrete ballast assembly
Reference projects

Sewer outfall for the city of Lisbon, Portugal – 2009
Pipe diameter 1400 mm  total length 1364 m

Arrival of the ø1400 SDR26 PE pipe delivery to Lisbon.
Reference projects

Sea water intakes & outfall for the Fouka desalination plant, Algeria – 2009

Pipe diameter ø1600 mm – 1800 m and ø1200 mm - 380 m

Departure of the tow with the pipes for Fouka, (7 pipes), and for Lisbon, (3 pipes).

Assembly of concrete weights in the port of Algiers.
Reference projects

Cooling water intakes for the Terga power plant, Algeria – 2009

Pipe diameter $\phi 2000$ mm – 3790 m

Departure of the tow with the 11 $\phi 2000$ mm SDR26 pipes.

Ready weighted pipes in the Arzew port.
Reference projects

Sewer outfall for Gdynia, Poland – 2009
Pipe diameter 1300 mm  total length 2480 m + diffuser

Departure of the tow with the 4 numbers ø1300 mm SDR26 pipes and the diffuser.

Arrival of the pipe delivery to Gdansk.
Reference projects

Cartagena sewer outfall, Colombia – 2009
Pipe diameter 2000 mm  total length 4321 m

Departure of the tow from Stathelle on May 17, 2009

Arrival of the tow to Cartagena de Indias on July 16, 2009
Reference projects

Carboneras sea water intake for a desalination plant, Spain – 2009
Pipe diameter 2000 mm  total length 1007 m

Pipe arrival in the port of Carboneras, south of Spain
Manhole assembly
Reference projects

Sea water intake and brine outfall for a desalination plant – Limassol, Cyprus - 2010

Pipe diameter: 1400 and 1200 mm – total length 2250 m
Reference projects

Ta’Barkat sewer outfall – Malta - 2010
Pipe diameter: 1600 mm – total length 1000 m

Concrete weight assembly

Ready installed outfall pipeline, with diffuser risers equipped with Tideflex valves.
Reference projects

El Jadida sewer outfall, Morocco - 2010

Pipe diameter: 900 mm  total length 2160 m

Pipes ready for departure to El Jadida & Malta
Reference projects

Submarine casings pipelines for a wind mill park,
Norderney islands, Germany- 2010

Pipe diameter: 450 and 250 mm  total length 5690 m
Reference projects

Shoreham sewer outfall, Brighton, the U.K. - 2010

Pipe diameter 1400 mm – total length 1658 m + tapered diffuser

Departure of the tow together with ready made diffuser.

Pulling the pipes over the pier towards designated mooring place.
Reference projects

Pipes for deep sea supports for oil pipelines, Luanda, Angola - 2010

Pipe diameters: 900 and 1100 mm – total length 845 m

The pipes in the assembly hall in Antwerp
Reference projects

Tailings outfall pipes for a copper mine – Batu Hijau, Indonesia - 2010

Pipe diameter: 1000 mm – total length 3690 m

Stored pipes ready to be shipped

Loading of pipes on the cargo vessel chartered by the Buyer.
Reference projects

Odessa sewer outfall, Ukraine - 2011

Pipe diameter 2000 mm – total length 4307 m

Departure of the tow from Stathelle.

The tow is passing the Bosphorus in Istanbul on the way to Odessa.
Reference projects

Storm water outfalls, Doha, Qatar - 2011
Pipe diameter 1400 and 1800 mm – total length 2551 m

Pipe welding on site in Doha
Pipe submerging
Reference projects

Jeddah outfalls, Jeddah, Saudi Arabia – 2011 -12

Pipe diameter 2000 mm – total length 1102 m

The pipeline is floated out on the sea

Pipe welding on site in Jeddah
Thank You for Your Attention

Trygve Blomster