Technip technologies and products

Flexible pipe
Technip Profile

Listed on the Euronext Paris and New York Stock Exchange

Revenues: almost 7 billion euros in 2006

22,000 people worldwide

One of the five world leaders in oil and gas, and petrochemical engineering technologies and construction services

4 business segments

**SURF**
(Subsea, Umbilicals, Risers & Flowlines)
- Design, manufacturing and supply of deepwater products (flexible and rigid pipelines, umbilicals, riser systems)
- Subsea construction and pipeline installation services

**Offshore Facilities**
- Engineering and fabrication of fixed platforms for shallow waters and floating platforms for deep waters

**Onshore-Downstream**
- Gas treatment and liquefaction, Gas-To-Liquids (GTL)
- Oil refining (refining, hydrogen, and sulfur units)
- Onshore pipelines
- Petrochemicals (ethylene, aromatics, olefins, polymers)

**Industries**
- Fertilizers, chemicals and pyrotechnics
- Life sciences
- Metals and mining
- Biofuels
- Building and infrastructure
Flexible pipe

Technip offers a broad range of services in engineering, manufacturing, installation and retrieval of flexible pipe systems with the most advanced integrated solutions for deepwater and ultra deepwater field developments.

Technip is the most experienced provider of integrated solutions for subsea field developments, based on a broad range of field-proven products and services. Early in the 70’s, Technip pioneered flexible pipe technology and used it to provide its clients with ever-higher levels of reliability and quality, even in the world’s harshest and deepest offshore environments.

For over 30 years our high pressure flexible products have provided offshore operators with reliable and efficient subsea solutions worldwide. To date, more than 9,000km of Technip high-pressure flexible pipe have been installed throughout the world.

Our products are versatile, corrosion-resistant and compliant, and they are easy and quick to install, retrieve and reuse for marginal or evolutive field architectures, thus environmentally friendly.

They have carved out their place not only for floating facilities but even in the shallow and medium water markets that were once the exclusive domain of rigid steel flowlines. With internal diameters ranging from 2" to 19", flexible pipes are the product of choice for infiel lines.

At the same time, the flexible pipe’s versatility and ability to evolve with the industry will continue to ensure its place within the deepwater and ultra deepwater markets that characterize new offshore field developments.

Sample of an IPB* (Integrated Production Bundle)

* Proprietary technology.
What is flexible pipe?

A fit-for-purpose structure

A flexible pipe is made up of several different layers. The main components are leakproof thermoplastic barriers and corrosion-resistant steel wires. The helically wound steel wires give the structure its high-pressure resistance and excellent bending characteristics, thus providing flexibility and superior dynamic behaviour. This modular construction, where the layers are independent but designed to interact with one another, means that each layer can be made fit-for-purpose and independently adjusted to best meet a specific field development requirement.

Main characteristics

**FLEXIBILITY**

Flexibility is the distinctive property of flexible pipe. A typical 8” internal diameter (ID) flexible pipe can safely be bent to a radius of 2m or less. This is the reason why flexible dynamic risers have been the enabling technology for floating production systems. This flexibility is also important for flowlines laid on uneven seabed conditions. Flexibility makes it possible to spool the pipe on a reel or in a carousel for efficient and quick transportation and installation.

**INSTALLABILITY**

Because the flexible pipe comes in a continuous length, laying speed commonly averages 500m per hour. Separate sections are connected on deck during installation, eliminating the need for any intermediate riser base structure or subsea connections. This elimination of interfaces reduces risk in operation.

**MODULARITY**

The independent layers of a flexible structure enable it to be tailored to the precise needs of a specific development. Simple flexible pipes for medium pressure water transport comprise only four layers. The most complex flexible pipes may have up to 19 layers.

Beyond the basic fluid barriers and stress-resistant tendons, additional layers can be included to prevent wear between steel layers (in dynamic applications) or to provide improved thermal insulation ("standard" flexible pipe already has a much better insulation coefficient than that of steel pipe).

Besides including new plastic or steel layers within the product, it is also possible to assemble plastic hoses, electrical cables or optical fibers around a flexible pipe to produce an Integrated Service Umbilical (ISU®), or include active heating for flow assurance in deepwater to produce an Integrated Production Bundle® (IPB).

In 2001/2002, Technip participated in the DEMO 2000 JIP, demonstrating its ability to supply heat traced flexible, including gas lift tubes and temperature monitoring optical fibers within the same line. Heat tracing and monitoring allow temperatures to be perfectly tuned within the core production flexible in order to meet flowing or cool down requirements. This type of flexible pipe provides an “all-in-one” solution for deepwater applications.
Flexible pipe: a cost-effective solution

The combination of flexibility, installability, modularity, corrosion resistance and re-usability, pressure resistance and versatility explains why flexible pipe is an overall cost-effective solution.

Corrosion resistance

Since the steel tendons are not in direct contact with the conveyed fluid, they do not require the same corrosion resistance as steel pipe. This means that our design experience and knowledge of gas diffusion through thermoplastic materials enable us to use carbon steel where the equivalent rigid pipe application would require much more expensive corrosion-resistant alloys.

Pressure resistance

Flexible pipes resist all fluid pressures currently encountered in the most severe subsea applications. Again, the modularity of the flexible pipe manufacturing process enables us to adjust thickness, shape and number of steel wire layers to meet the specific requirements of our clients.

Versatility and re-usability

Modularity enables flexible technology to cover very different applications:
- flexible products already installed in water depth down to 1,890m
- Kill & Choke line for drilling (up to 15,000 psi)
- drain pipe & foam lines for onshore refinery applications
- RTP (Reinforced Thermoplastic Pipe) for land applications.

Even more important, it means that the flexible pipe structure is constantly evolving to meet stringent field specifications:
- higher pressures (up to 7,200 psi for a 9” ID, up to 10,000 psi for a 7.5” ID) on dynamic riser applications
- higher temperatures (up to 130°C)
- enhanced insulation through thick foam fillers laid on SZ machine
- active heating
- designs available for ultra deepwater (down to 2,500m).

Moreover, flexible pipe is the only product, environmentally friendly, which can be recovered and reinstalled several times to be used successively for several marginal or evolutive field architectures as regularly done for years by Petrobras in Brazilian waters.
Providing the best suited solutions for our clients’ field developments

The worldwide reference

In the early 70’s, Technip pioneered flexible pipe design, manufacture and installation, and has now accumulated more than 35 years of field-related in-depth experience. Our aim and strategy is to base our leadership on technological differentiation and, in that respect, the flexible pipe product is our historical reference. We are committed to researching new solutions to better serve our clients’ needs. We introduced Coflon®, Crossflex®, Gammaflex®, various types of Cofoam® insulation materials, both Zeta and Teta vault profiles, the Vertical Laying System®, Steep Wave® and Plant Wave® riser configurations, midwater arch configurations and buoyancy modules, Integrated Service Umbilicals® and multibore risers. Technip has also developed most of the analytical and numerical tools used to design, test and monitor flexible flowline and riser systems.

Today, this drives us to find the most reliable and client-focused solutions for the deep and ultra deepwater challenges that lie ahead.

The widest range of services

Technip is the only offshore contractor that seamlessly integrates design, engineering, manufacturing and installation services to its clients’ benefit. It is the staff of our local business units who regularly interfaces with our clients worldwide. Technip’s Product Engineering Division (PED) co-ordinates flexible pipe-related engineering within our regional business units.

FLEXIBLE PIPE PLANTS

Among other facilities that manufacture umbilicals, Technip currently operates two flexible pipe plants:
- Flexi France (Le Trait, France)
- Flexibras (Vitória, Brazil).

With investments made in 2006, production capacity now reaches 450km at Flexibras (mix of products for Brazilian market) and 250km at Flexi France (more complex and larger diameter product mix for international market).

PIPELAY

We own and operate a large fleet of dynamically positioned vessels, four of which are dedicated to flexible pipelay. The Deep Blue, the flagship of the Technip fleet, is the only vessel of her class to lay both flexible and rigid pipes (reel-lay and J-lay) up to 3,000m water depth. In addition, Technip is also the leading supplier of reeled rigid pipe solutions worldwide. All these assets and capabilities are integrated by our unique Project Management organisation. It enables us to compare and optimize the solutions we offer to our clients and provide the optimum flowline and riser systems, rigid or flexible for any offshore development (see map on page 8).
In addition to manufacturing and supply activities, Technip offers solutions tailored to clients' needs. With our long offshore field experience and our intimate knowledge of the technical challenges faced by flexible pipes, we can and do deliver the highest quality flexible products available anywhere in the world.

All Technip activities are placed within an integrated Quality System which ensures that our organisation, manufacturing process, product solutions and services are reliable and efficient. The Group is certified ISO 9001 and its flexible pipe plants have received the API 17J certification for the design and manufacture of unbonded flexible pipe. The Group is applying permanent improvement processes throughout its organisation.

Field experience and milestones

1973  First flexible pipe installed in Congo for Elf Emeraude
1974  First flexible flowline in the North Sea on Mobil Beryl
1976  First dynamic flexible riser in Brazil on Petrobras Garoupa
1978  First flexible riser with heat tracing in Indonesia on Conoco Udang
1982  First flexible riser with thermal insulation
1986  First dynamic flexible riser system installed in the North Sea on Balmoral Sun Oil
1987  First flexible pipe with a Coflon® pressure sheath in the North Sea and Spain
1988  Largest diameter of flexible riser (9½" ID) on Statoil Statfjord C
1989  First installation using the VLS (Vertical Laying System) on Saga Snorre
1992  First flowline (6½" ID, 3.5 km) manufactured in carousel
1994  First ISU® (Integrated Service Umbilical) on Norsk Hydro Troll
1997  New depth records for flowline (7,093m) and riser (3,930m) in Brazil on Petrobras Marlim Sul
1998  First flexible riser with a Teta pressure armour on Norsk Hydro Visund and Enterprise Oil Pierce
2000  New depth record for flowline (8,833m) on Petrobras Roncador
2002  Installation of the deepest flowline (8,890m) on Petrobras Roncador
2003  First project using 46mm thick insulation fillers - Agip Abo (550m) in West Africa
2004  First qualification for 2,100mwd (DIP test offshore Brazil, 7½" and 9½" ID flowlines)
2005  Installation of the deepest riser (7.5" ID - 10,000 psi for water injection) in 8,900m for BP Thunder Horse in the Gulf of Mexico
2006  Extension of BV certification to 15,000 psi

Since 1972, the yearly OTC award for companies has been honouring the one company (amongst operators and contractors), that has significantly contributed to the offshore oil and gas industry. In that respect, we obtained the 1995 OTC award for the design, manufacture and installation of flexible steel pipe used in floating production systems, deepwater developments and high pressure pipes for drilling and well servicing.

Excellence

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REFERENCES
A worldwide presence and experience

To-date, more than 9,000km of Technip flexible pipe have been manufactured and installed worldwide.
A client-focused organisation

Performance
- Largest internal diameter: 19" ID export riser for the Statfjord C offloading system
- Highest value of diameter times pressure: 7.5" ID with 10,000 psi - Thunder Horse, Gulf of Mexico
- Longest continuous line: 17,000m for 2" ID
- Deepest dynamic riser: 1,890 m, Thunder Horse, Gulf of Mexico
- Deepest production flowline: 1,890m, Roncador, Brazil
- Innovative proprietary technology: flexible Integrated Production Bundle (IPB), 1,400m Dalia, Angola

A client-oriented company dedicated to cost-effectiveness and technology

Research & Development

Technip spends yearly about EUR 15 million on flexible pipe in its research centers. The Product Engineering Division has full responsibility for Technip’s flexible pipe R&D program, and is equipped with a full range of test facilities, including a state-of-the-art laboratory for advanced material testing and analysis, making it possible to simulate realistic service conditions on actual pipe samples.

The R&D activity is oriented towards extending the current product range by introducing new products and materials. Cost reduction and manufacturing quality is a permanent and parallel objective of these efforts. When a given development has come to fruition, its qualification testing is frequently carried out under the auspices of a JIP (Joint Industry Program). This enables key operators to participate in the transition between the development phase of an application and the “real” marketable and industrial phase.

Complex development projects are carried out within dedicated task forces. This was the case for Technip’s integrated Ultra Deep Water development program. This task force developed a new generation of flexible pipes primarily for deep and ultra deepwater.
Engineering

The Group engineering organisation responds to and meets two main challenges: being close to our clients in order to answer their needs while at the same time ensuring a sustained level of engineering excellence is available in all parts of the Group. This is achieved through a combination of:

- local engineering departments in each business unit, able to perform most engineering tasks related to a project, within the project teams
- a centre of excellence located in Le Trait (France), sharing the same site as the main flexible pipe manufacturing facility.

This Product Engineering Division (PED) ensures support to the business units, consolidates the experience acquired throughout the Group and develops new products and materials via a robust and innovative R&D program. Information exchange between the business units is routed via PED which consolidates the knowledge and ensures a reliable and efficient engineering service across the Group.

Pipe Integrity Management

The lifetime of offshore field developments can be as long as 20 to 30 years. Operators must have continuous focus on their assets throughout the field’s life. Hence, monitoring of the operational data is key in assessing integrity and ensuring safe and optimal operation of the pipeline system. In cooperation with Force Technology, Technip has set up a Pipe Integrity Management (PIM) system where relevant operational “data monitoring” and inspection results are gathered into a database, treated and analysed. A Risk Based Inspection program is also established and various support services can be included. A PIM system has recently been implemented for a major field development project in the North Sea, Norwegian sector.

Manufacturing

Manufacturing is organised under a global factory policy whereby the two flexible pipe factories of Le Trait (France) and Vitória (Brazil) are managed in an approved and similar manner, by applying common quality and safety Group standards.

As the manufacturing centre of excellence, Flexi France, the Le Trait plant, has the facilities and capability to produce the widest range of flexible pipes. It is where all our innovative pipe designs are first manufactured and tested. Flexibras, our flexible pipe manufacturing plant located in Vitória (Brazil), has primarily been established to supply the local market but can also supply flexible pipe internationally.

Installation

Because of our integrated approach to flexible pipe technology, we have always considered installation as a part of our core business activity and we have always ensured that our vessels and equipment are designed to install the flexible products we have developed and manufactured. The Sunrise 2000, the Constructor, the Deep Pioneer and our ultra deepwater vessel, the Deep Blue, are specialist installation vessels, which in terms of deck layout and installation equipment, benefit from the Group’s intimate knowledge of the flexible pipe product and which have therefore become key to our ongoing success. The Deep Blue’s PLS (Pipe Lay System) can also install rigid pipe, either by reel lay or J-lay.

As far as equipment is concerned, we have developed and patented the VLS (Vertical Laying System). The system allows for the efficient installation of flexible flowlines and risers in deepwater and harsh environments. The utilisation of the VLS makes it safer to lay flexible lines especially when equipped with intermediate connections, buoyancy modules or other ancillaries.

Technip’s installation innovations have now extended to fabrication of a new PPS (Portable Pipelay System) design which has been used on several vessels, thereby adding another vessel to our installation fleet for flexible pipe.

Vertical Laying System (VLS)*

* Patented technology
Towards ultra deepwater

Ultra deepwater flexible pipe: Current and future capabilities

Ultra deepwater extends from 1,000 to 3,000 m and beyond. Our 1997 world depth record in Brazil was achieved using traditional Technip structures and standard materials.

Technip further extended the operational experience with the installation in 2002 of 6” insulated production flowlines in 1,890 m of water and with Deep Immersion Performance full scale tests (DIP) performed offshore Brazil in 2004 (7” and 9” ID tested in 2,100 m of water depth).

Full use is being made of the modularity of flexible pipes and the Group’s capacity to efficiently and effectively evolve them. In the case of the ultra deepwater developments, it is the steel layers that are most affected and each improvement answers a specific client-led challenge:

- Internal carcass for collapse resistance
- Pressure vault for collapse and weight reduction
- Tensile armours for weight reduction

Another significant area is active heating and this is being addressed by adapting the field-proven ISU® concept to the circulation of hot water around the central core of the pipe. Other more peripheral lines can be used for gas lift. Thus, the ISU® lines with multi-functions are gathered in a single line and become the Integrated Production Bundle® (IPB) to guarantee flow assurance even for the deepest fields.

In deep and shallow waters, the Technip flexible pipe technology will continue to be a core component supporting the evolution of the subsea oil industry and we will therefore be in a position to offer our clients high quality and cost-effective solutions tailored to their very needs.

*Proprietary technology.
With a workforce of 22,000 people, Technip ranks among the top five corporations in the field of oil, gas and petrochemical engineering, construction and services. Headquartered in Paris, the Group is listed in New York and Paris. The Group’s main operations and engineering centers and business units are located in France, Italy, Germany, the UK, Norway, Finland, the Netherlands, the USA, Brazil, Abu-Dhabi, China, India, Malaysia and Australia. In support of its activities, the Group manufactures flexible pipes and umbilicals, and builds offshore platforms in its manufacturing plants and fabrication yards in France, Brazil, the UK, the USA, Finland and Angola, and has a fleet of specialized vessels for pipeline installation and subsea construction.