Flexible pipe

How Technip offers a broad range of flexible pipe systems with the most advanced integrated solutions for deepwater and ultra deepwater field developments.
Technip is a world leader in project management, engineering and construction for the oil and gas industry.

With a global footprint, our talents constantly offer the most innovative technologies and best solutions to our clients to optimize their investments and meet the world’s energy challenges.

Our mission is to deliver safe, sustainable and quality projects across the world.

We operate in three main businesses:

**Subsea**

In subsea hydrocarbon field development, Technip’s activities include the design, manufacture and installation of rigid and flexible subsea pipelines and umbilicals.

Thanks to our portfolio of technologies, industrial and operational assets on all continents and a state-of-the-art fleet, we offer a unique vertically integrated model in the industry.

**Offshore**

In the Offshore business, our activities include engineering, procurement, construction (EPC) and installation of fixed and floating platforms.

We use a complete range of technological solutions to answer the challenges faced by our clients. We are leveraging our expertise in full-range of offshore facilities, as well as our strong know-how with added-value process skills and proprietary platform design.

**Onshore**

In the Onshore business, we deliver to our clients all the experience we have acquired for almost 60 years, combined with a large technology solutions portfolio. We are working on onshore facilities that the energy sector needs, in particular for oil and gas industry players. Technip is one of the global leaders for the refining business and petrochemical units. We also reinforced our position on project management consultancy (PMC) activities, by leveraging our expertise in the management of complex projects.
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. *In the early 1970’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 now 40 years, our high pressure flexible products have provided offshore operators with reliable and efficient subsea solutions worldwide. To-date, more than 10,000km of Technip high-pressure flexible pipe has been installed throughout the world.

Our products are versatile, corrosion-resistant and compliant, and they are easy and quick to install, retrieve and re-use 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 20”, flexible pipes are the product of choice for infield 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.

*IPB* [Integrated Production Bundle]
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 a 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 \( 500 \text{ m per hour} \). 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.

In November 1971, the first Technip flexible pipe was installed in Congo. It took 1.5 hours to lay the 650m flowline, including connections.

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 wires, 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 thermoplastic 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 (Integrated Production Bundle). 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. It has been used several times in West of Africa deepwater fields and will soon be installed offshore Brazil.

Corrosion resistance

Since the steel wires 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.

* Proprietary technology
Flexible pipe: a cost-effective solution

High 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. Modularity enables flexible technology to cover very different applications:
- production flexible products already installed in waters down to 2,140m
- kill & choke line for drilling (up to 20,000 psi)
- drain pipes and foam lines for onshore refinery applications

Even more important, it means that the flexible pipe structure is constantly evolving to meet stringent field specifications:
- higher pressures (up to 10,000 psi for a 7.5” ID, up to 7,350 psi for a 9” ID and up to 6,700 psi for a 10” ID) on dynamic riser applications
- higher temperatures (up to 170°C)
- enhanced insulation through thick foam fillers laid on SZ machine
- enhanced flow assurance: active heating, gas lift and temperature monitoring
- ultra deepwater and up to 3,000 mwd

Versatility and re-usability
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 fields as regularly done for years in Brazilian waters.

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

In the early 1970’s, Technip pioneered flexible pipe design, manufacture and installation, and has now accumulated 40 years of field-related in-depth experience worldwide (see map on page 8).

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®, Gamma-Flex®, various types of Cofoam® insulation materials, both Zeta, Teta and Psi vault profiles, the Vertical Laying System*, Steep Wave and Pliant Wave riser configurations, midwater arch configurations and buoyancy modules, Integrated Service Umbilicals (ISU®) and multibore risers.

Technip has also pioneered the development of most of the analytical and numerical tools used to design flexible flowlines 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. The staff of our regional business units regularly interfaces with our clients worldwide. Technip’s Product Engineering Division (PED) coordinates the flexible pipe-related engineering within our regional business units.

FLEXIBLE PIPE PLANTS

Technip currently operates three flexible pipe plants:
- Flexi France (Le Trait, France)
- Flexibras (Vitória, Brazil)
- Asiaflex Products (Tanjung Langsat, Malaysia) was inaugurated late 2010 to service the Asia Pacific and Middle East subsea markets.

A fourth plant is under construction in Açú, Brazil. It will be dedicated to high-tech flexible pipes. Based on a normalized 8” ID pipe, the current capacity of Technip plants reached a total of 1,060 km of product in 2010.

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) down 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.

Providing the best suited solutions for our clients’ field developments

Coflon®, Crossflex® and Gamma-Flex® are registered trademarks of Technip
* Patented technology
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**

- **1971** - 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** - Largest diameter of flexible riser (19” ID) on Statoil Statfjord C
- **1988** - New depth record for flexible riser (567m) in the Gulf of Mexico on Conoco Jolliet
- **1989** - First flexible pipe with a Crossflex® pressure sheath
- **1992** - First installation using the VLS (Vertical Laying System)* on Saga Snorre
- **1994** - First flowline (16” ID, 3.5 km) manufactured in carousel
- **1997** - New world depth records for flowline (1,709m) and riser (1,990m) 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 (1,877m) on Petrobras Roncador
- **2001** - Implementation of the first Product Integrity Management System (PIM) on the Åsgard field, Norway
- **2002** - Installation of the deepest flowline (1,886m) on Petrobras Roncador
- **2003** - First Oil Offloading Lines (OOL) 2 x 2,240m long installed on Shell Bonga
- **2004** - First qualification for 2,100mwd (DIP test offshore Brazil, 7” and 9” ID flowlines)
- **2005** - Installation of the deepest riser (7.5” ID - 10,000 psi for water injection) in 1,690m for BP Thunder Horse in the Gulf of Mexico
- **2006** - Extension of BV certification to 15,000 psi
- **2007** - Supply and installation of the world’s first smooth bore 14” ID dynamic riser for gas export on Statoil Åsgard, Norway
- **2007** - Installation of the deepest single section riser for an 8” HP/HT sour service production application in 1,500mwd for Chevron Agbami in Nigeria
- **2010** - Supply and installation of 6” and 10” flowlines in 2,100mwd, offshore West Africa
- **2010** - Supply and installation of 2 x 10” IPB™ risers in 800 mwd for Total Pazflor, offshore Angola
- **2010** - Deep Immersion Test and qualification for 3,000 mwd
- **2011** - Supply and installation of 6” and 9/16” risers in 2,140mwd on Petrobras Lula pre-salt field
- **2012** - Qualification of 9” carbon fiber armour for pre-salt ultra deepwater applications

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.
To-date, more than 10,000km of Technip flexible pipe have been manufactured and installed worldwide.
A client-focused organisation

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

Research & Development

Technip spends yearly about EUR 25 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.

Performance

- Largest internal diameter: 19” ID export riser on Statfjord C (Norway) and Bonga Offloading lines (Nigeria)
- Deepest risers in Brazil: 6” and 9” ID - 2,140 m, Lula
- Deepest and highest value of diameter times pressure: 7.5” ID 10,000 psi, water injection risers and flowlines, Thunder Horse (Gulf of Mexico) in 1,890 mwd
- Innovative proprietary technology: flexible Integrated Production Bundle (IPB)*, 1,400 m Dalia, Angola and 800 mwd Pazflor, Angola and soon offshore Brazil
- World’s first 14” ID smooth bore gas export dynamic riser, Åsgard, Norway. Successfully tested to a max. flow of 48 MSm³/d
- Highest pressure ever reached (4”; 20,000 psi) in service for the offshore well stimulation industry
- Deep Immersion Performance test in the Gulf of Mexico: 9” at 3,000 mwd
- Development of carbon fiber armour wires (corrosion free, ultra deepwater and oil offloading applications)
- Anti-H₂S sheath for an H₂S free flexible pipe annulus
- High temperature (170°C) with thermal screen

* Proprietary technology
Research and Development

Engineering

The Group engineering organisation, led by Technip Innovation & Technology Center, located in Paris area, 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.
- sharing of the same design rules by all engineering and manufacturing centers.

The 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. A dedicated flexible R&D center (RDD) has also been established in Rio de Janeiro to support the Brazilian market. RDD works in close collaboration with PED.

Integrity Management

Within the Technip Asset Integrity Management (AIM) department, innovative integrity management technologies and services have been developed. Our philosophy relies on four cornerstones:

- Risk management, critical failure modes identification and associated surveillance program: annulus conditions, corrosion, fatigue, etc.
- Monitoring products using, amongst others, acoustic emission detection, optical fibre, microelectronic or ultrasonic technologies (integrated systems, or external systems that may be retrofitted).
- Data management & Interpretation (based on our flexible pipe expertise).
- Offshore services (inspection including annulus testing, maintenance, and repairs).

AIM settled several collaborations with experts and leading partners to create synergies with Technip expertise (engineering, manufacturing and installation of flexible pipe) and deliver fit for purpose Integrity Management (IM) solutions. Should you need integrated monitoring solutions to mitigate risks of industry new challenges or support for your existing assets, AIM could provide you with a dedicated solution.

Manufacturing

Manufacturing is organized under a global factory policy whereby the three flexible pipe factories of Le Trait (France), Vitória (Brazil) and Tanjung Langsat (Malaysia) are managed in an approved and similar manner, by applying common quality and safety Group standards. Our Malaysian plant also operates following our worldwide QHSE standards. As the manufacturing centre of excellence, Flexi France (Le Trait, France) 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.

Flexibrás (Vitória, Brazil), has primarily been established to supply the local market but can also supply flexible pipe internationally. Asiaflex Products (near Johor Bahru, Malaysia) started up at the end of 2010. It serves the Asian and Middle East markets.

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. As far as equipment is concerned, we have developed and patented several laying systems (VLS*- Vertical Laying System, PPS*- Portable Pipelay System and flexible pipe laying towers).

These laying systems allow for the efficient installation of flexible flowlines and risers in deepwater and harsh environments. Their utilisation makes it safer to lay flexible lines especially when equipped with intermediate connections, buoyancy modules or other ancillaries, for a 550-tonne capacity.

* Patented technology
Ultra deepwater extends from 1,000 to 3,000m and beyond. Deep Immersion Performance full scale tests (DIP) were performed in the Gulf of Mexico in 2010 (7” and 9” ID tested in 3,000m of water depth).

Technip extended its operational experience with the installation:
- in 2010: 6” and 10” for sour service in 2,100m water depth
- in 2011: 6” insulated production risers (high temperature: 130°C) and 9.13” export risers for sour service in 2,140m water depth on Petrobras Lula field

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