

WHY PIPE MATTERS
IN TODAY'S
ENERGY INDUSTRY



STEEL CASING, TUBING
AND THREADED
CONNECTIONS ARE
EMPLOYED IN OIL
AND GAS EXTRACTION



LINE PIPE SERVES
TO TRANSPORT
HYDROCARBONS
FROM THE WELL
TO THE REFINERY



LINE AND PRESSURE
PIPES ARE USED IN OIL
AND GAS REFINERIES
AND PETROCHEMICAL
PLANTS

THE GAME HAS CHANGED

STEEL PIPE IS AN INTEGRAL PART OF EACH STAGE IN THE OIL AND GAS INDUSTRY, from the drilling and completion of exploration and production wells to the transportation to refineries as well as in distribution networks carrying hydrocarbon fluids and natural gas.

THE CONDITIONS in which oil and gas companies operate today have become increasingly complex in the quest to find and exploit new reserves, placing extraordinary demands on pipe manufacturers and service providers.

QUALITY AND RELIABILITY are critical factors for an industry where investments involve major economic, human and environmental risks.

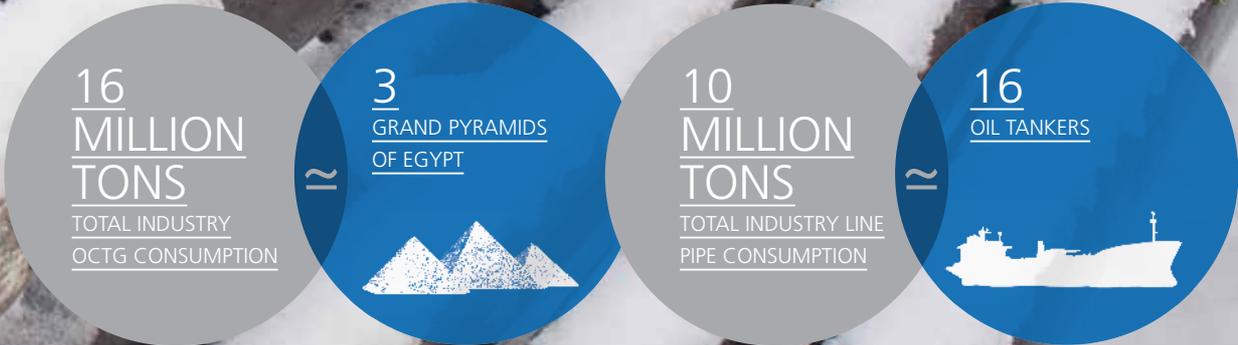
In addition, remote locations and difficult operating environments require THE TIMELY SUPPLY of many different tubular products and include the application of detailed planning processes in order to comply with demanding project schedules.

PIPE:

THROUGHOUT THE ENERGY PRODUCTION CYCLE



EXTREME ENVIRONMENTS DRIVE PRODUCT REQUIREMENTS. Steel tubular products are used in well drilling and completion activities and are manufactured in a range of fully tested materials and sizes to meet specific needs and applications in highly challenging environments, which are often places of immense ecological sensitivity.



OIL COUNTRY TUBULAR GOODS

Casing, tubing and drill pipe are collectively known as Oil Country Tubular Goods (OCTG). Steel casing is used to shore up the walls of oil and gas wells during and after drilling. Steel tubing conducts production fluids, including crude oil and natural gas in different forms, to the surface after drilling has been completed. Pipes are connected using threaded joints and couplings, together known as connections.

LINE PIPE. TRANSPORTATION AND DISTRIBUTION CHALLENGES

Line pipe is the generic name for the steel tubular products used in hydrocarbons transportation throughout the energy cycle. In energy distribution networks, pipe must transport oil and gas safely across rivers and mountains, through towns and villages, as communities and the environment rely on its long-term integrity to ensure their well-being.

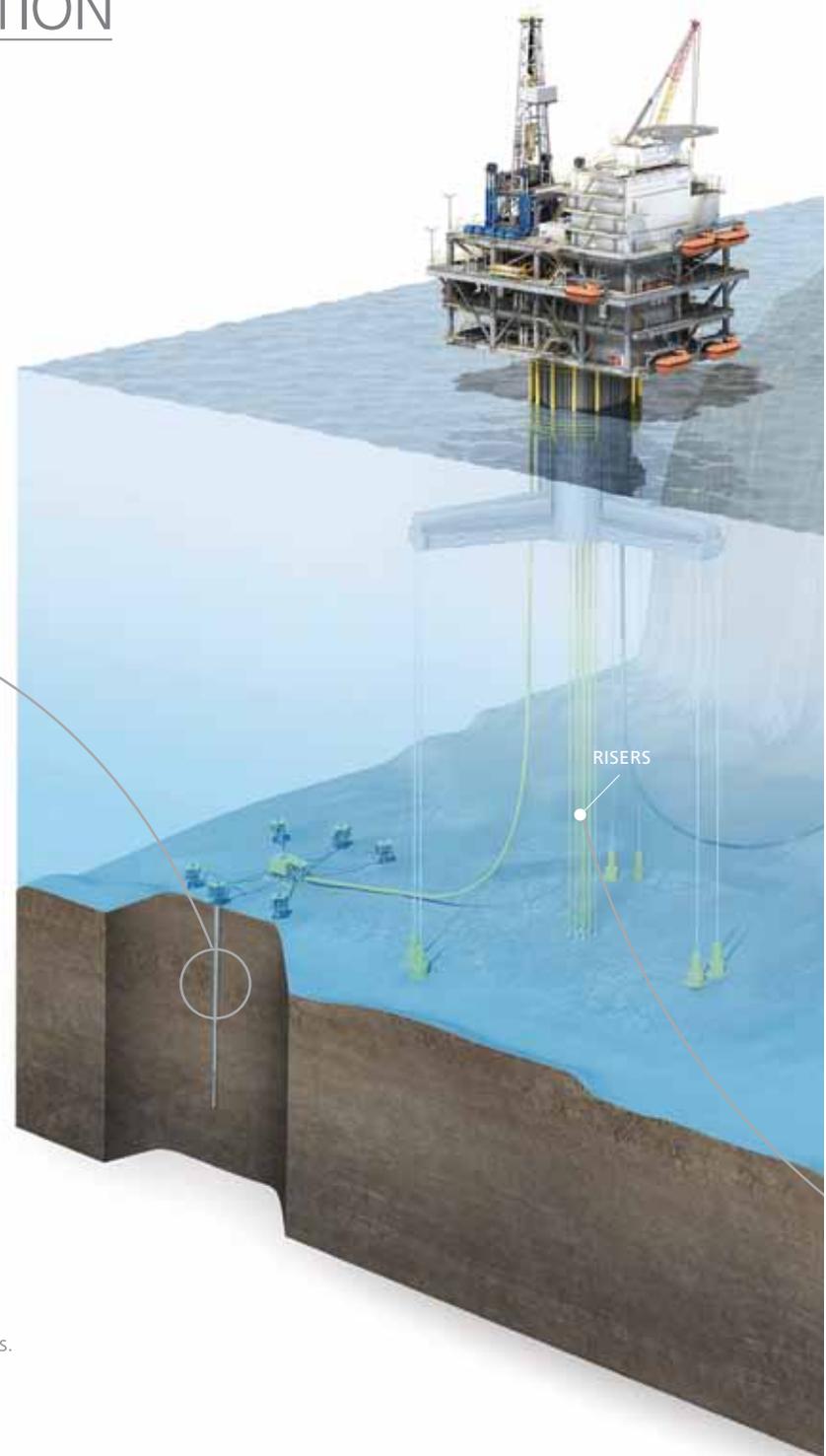
HEALTH, SAFETY AND THE ENVIRONMENT

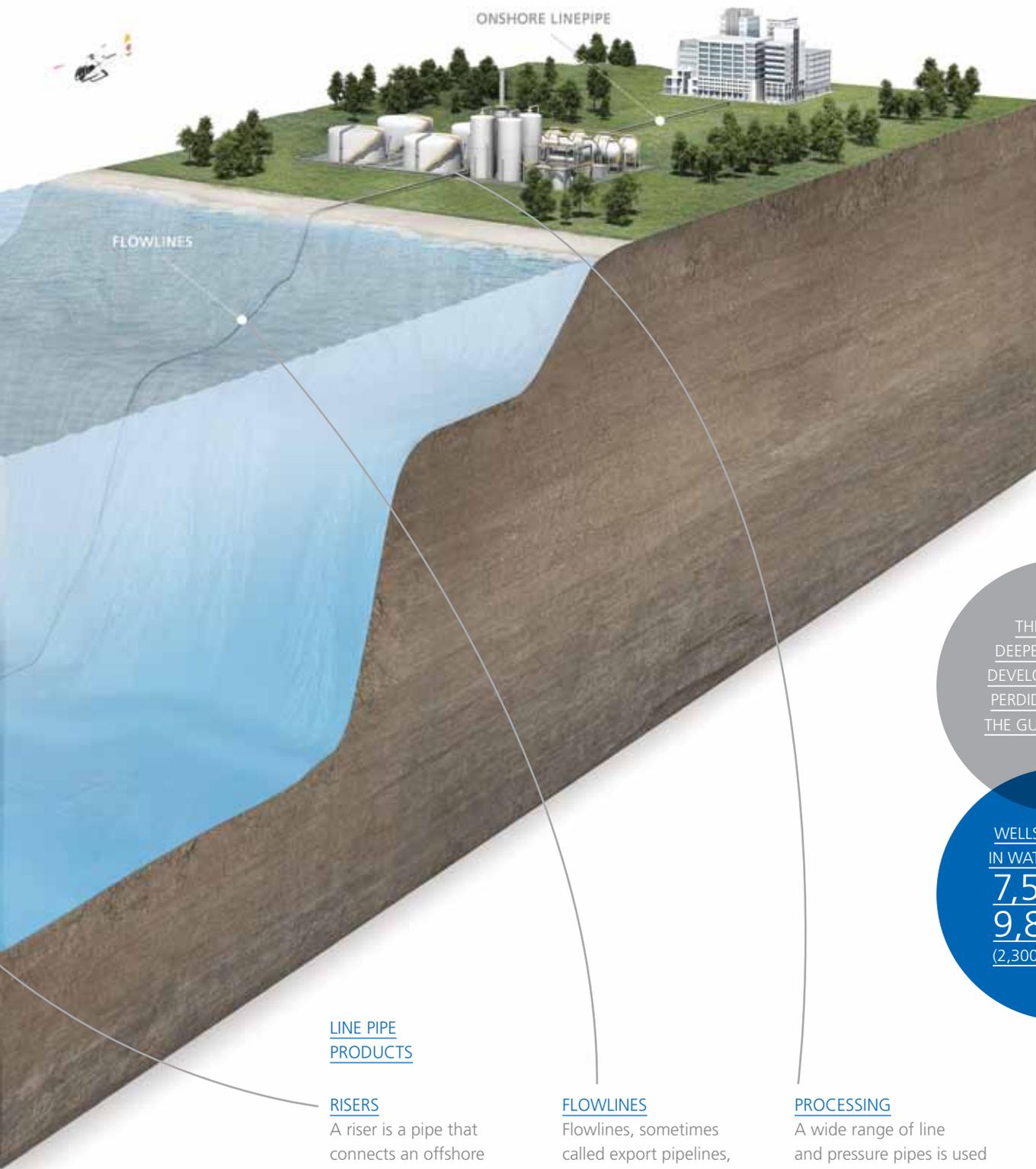
The health and safety of workers and local communities is critical, and thus the quality and reliability of pipe products is of paramount importance. The more sensitive the environment and the more complex the drilling conditions in terms of pressure, temperature and corrosion, the more critical the performance of the pipe.

FROM DRILLING AND EXTRACTION TO PROCESSING AND CONSUMPTION

THE DESIGN OF A CASING STRING

depends on various factors, including well depth, geological conditions, expected flow rates and whether the well is located onshore or offshore.





ONSHORE LINEPIPE

FLOWLINES

LINE PIPE PRODUCTS

RISERS

A riser is a pipe that connects an offshore Floating Production Structure or a Drilling Rig to a sub-sea system either for drilling, completion and workover purposes or production injection and export.

FLOWLINES

Flowlines, sometimes called export pipelines, transport processed or non-processed oil or gas fluids to the shore.

PROCESSING

A wide range of line and pressure pipes is used downstream at refineries, petrochemical and gas-processing plants.

THE WORLD'S DEEPEST OFFSHORE DEVELOPMENT IS THE PERDIDO PROJECT IN THE GULF OF MEXICO.

WELLS ARE DRILLED IN WATER DEPTHS OF
7,546 TO 9,843 FT.
(2,300 TO 3,000 M.)

THE EVOLUTION OF THE OIL AND GAS INDUSTRY: THE DAYS OF SPINDLETOP ARE LONG GONE



1859
The first commercial oil well in North America also signaled the start of modern drilling methods using pipe. Developed in Pennsylvania by Colonel Drake, a drill bit was hung from a cable attached to a walking beam powered by a steam engine. This raised and dropped the bit to penetrate the rocks. An iron pipe was then sunk into the borehole to avoid water and gravel collapsing inwards while crude oil rose up the pipe.



1901
The legendary Texan Spindletop well, drilled to **1,100 FEET**, which produced over **80,000 BPD** (BARRELS PER DAY) in its heyday, it proved the value of hydraulic rotary drilling equipment in unconsolidated formations by using mud circulation for the first time.



1908
The Anglo-Persian Oil Company was created after a large oil field find in Persia, now western Iran. A pipeline whose sections were carried by mule was laid across 210 km of mountainous terrain to transport the thick crude oil to a refinery complex in the Persian Gulf.



1910
After Henry Williams' successful use of piers to support drilling rigs in the shallow waters off the Californian coast of Summerland, **GULF REFINING CO. EMBARKED ON AMERICA'S FIRST TRUE OFFSHORE** drilling in Caddo Lake, Louisiana. That same year, the first long-distance pipeline was completed, transporting crude oil from Caddo Parish to the refineries at Baton Rouge.



1967

When the **FIRST NORTH SEA WELL WAS DRILLED** hardly anyone believed oil would be found. Six months later, crews found the Forties field, able to produce 400,000 barrels of crude oil a day. Oil prices at the time were booming, making exploration and production costs viable. For pipe manufacturers, the move offshore represented the advent of premium connections since these difficult conditions required enhanced connection sealability and compression performance.

1944

OPERATION PLUTO

(Pipe Lines Under The Ocean) was a World War II operation developed by UK scientists, oil companies and the armed forces to build oil pipelines under the English Channel between England and France. The scheme aimed to provide allied forces on the continent with fuel to relieve dependence on slow, vulnerable oil tankers. The first pipeline, laid in August 1944, ran from the Isle of Wight to Cherbourg.

Europe's first major transnational pipelines were built to bring natural gas from the vast Groningen field in the Netherlands (discovered in 1959) and from a number of smaller gas fields in western Ukraine (which were known since before the war) to major consumption centers in Western and Eastern Europe, respectively. By the early '70s, the Soviet Union was exporting gas through the Trans-Siberian pipeline through Czechoslovakia to the West. The Trans-Alaska Pipeline System was built between 1974 and 1977 on extremely tough terrain.

1980

Stable offshore production output in the 1980s led to **BIG CHANGES IN THE GULF OF MEXICO**, as seismic limitations drove exploration for larger fields to deeper waters where huge reserves lay thousands of feet under the sea floor. Drilling and survey technology became more sophisticated, while platform design shifted from fixed to semi-submersible to accommodate the greater depths and rougher weather out to sea. Deepwater field flow rates often exceeded 10,000 bpd. Exploration in the Gulf of Mexico caused pipe manufacturers to develop proprietary steel grades and new premium connection technologies—including integral flush and semi-flush connections—to adapt to the design requirements and take on high pressures and temperatures.

2009

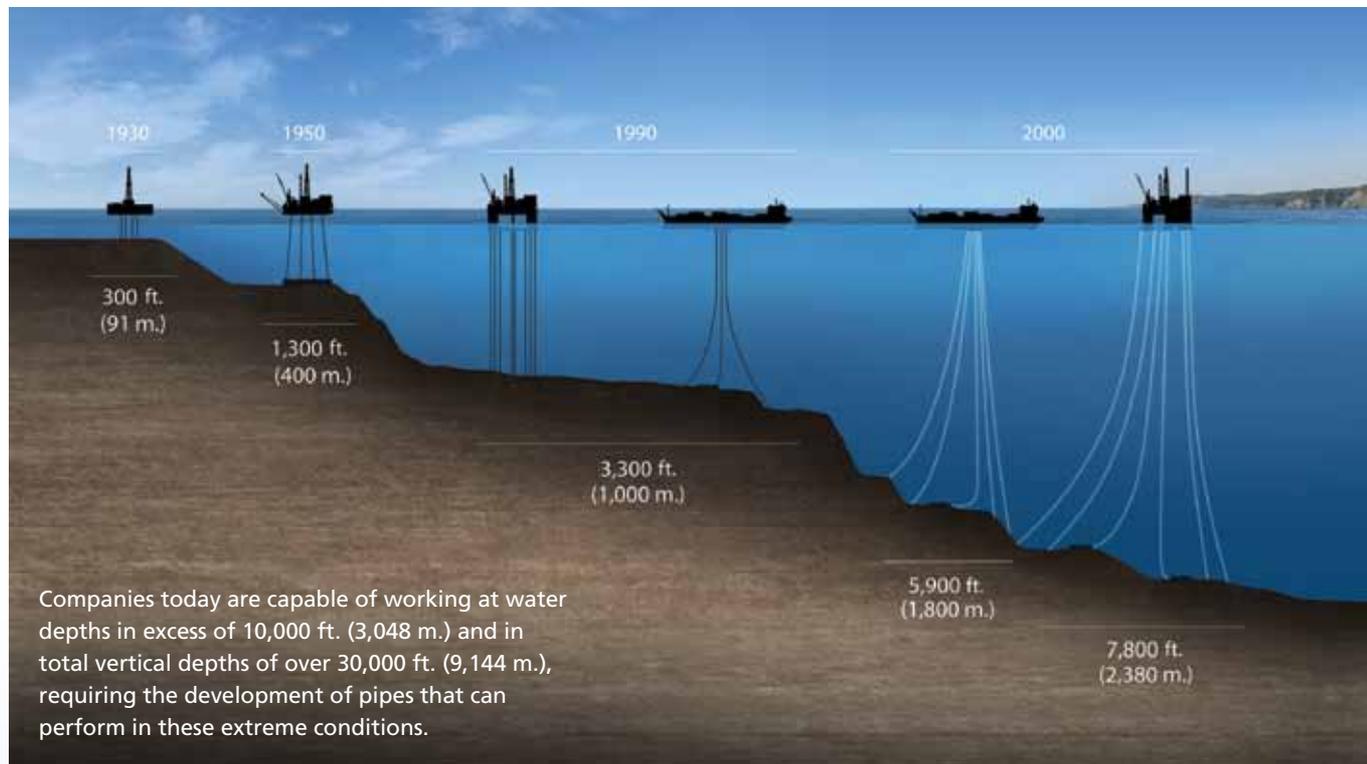
The SHALE BOOM

changes the North American energy landscape. Large oil and gas deposits trapped in rock formations are now accessible due to hydraulic fracturing and horizontal drilling technologies. Pipe used in these operations must withstand high tension and compression, with horizontal extensions as long as the Empire State Building in New York. Domestic oil production in the United States begins to increase after 25 years of decline and shale gas accounts for 15% of US gas production.

GROWTH IN OFFSHORE AND DEEPER WELLS HERALDS NEW CHALLENGES

Most of the largest onshore fields were discovered by the late 1960s. Since then, offshore development in the North Sea and the Gulf of Mexico has encouraged exploration in deeper waters. Today, offshore spending accounts for around 30% of total exploration and production spending, as the oil and gas industry moves to meet rising energy demand and high rates of depletion from producing fields.

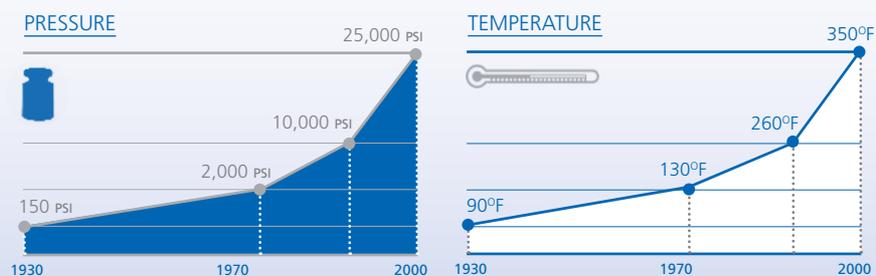
WATER DEPTH



FAR BENEATH THE EARTH'S CRUST

Ultra-deepwater wells plunge a mile or even two beneath the waves down into the ocean bed through several more miles of hard rock, dense salt and thick sand to the oil and gas reservoirs below. Yet last year they accounted for more than half the world's new discoveries.

The Gulf of Mexico is the leading location for ultra-deepwater development, a challenge that presents a host of complications, while potentially lucrative prospects beckon in still greater depths such as the Lower Tertiary where exploration is only just beginning.



PRE-SALT CHALLENGES
In the Santos basin offshore
Brazil, challenges include
drilling through

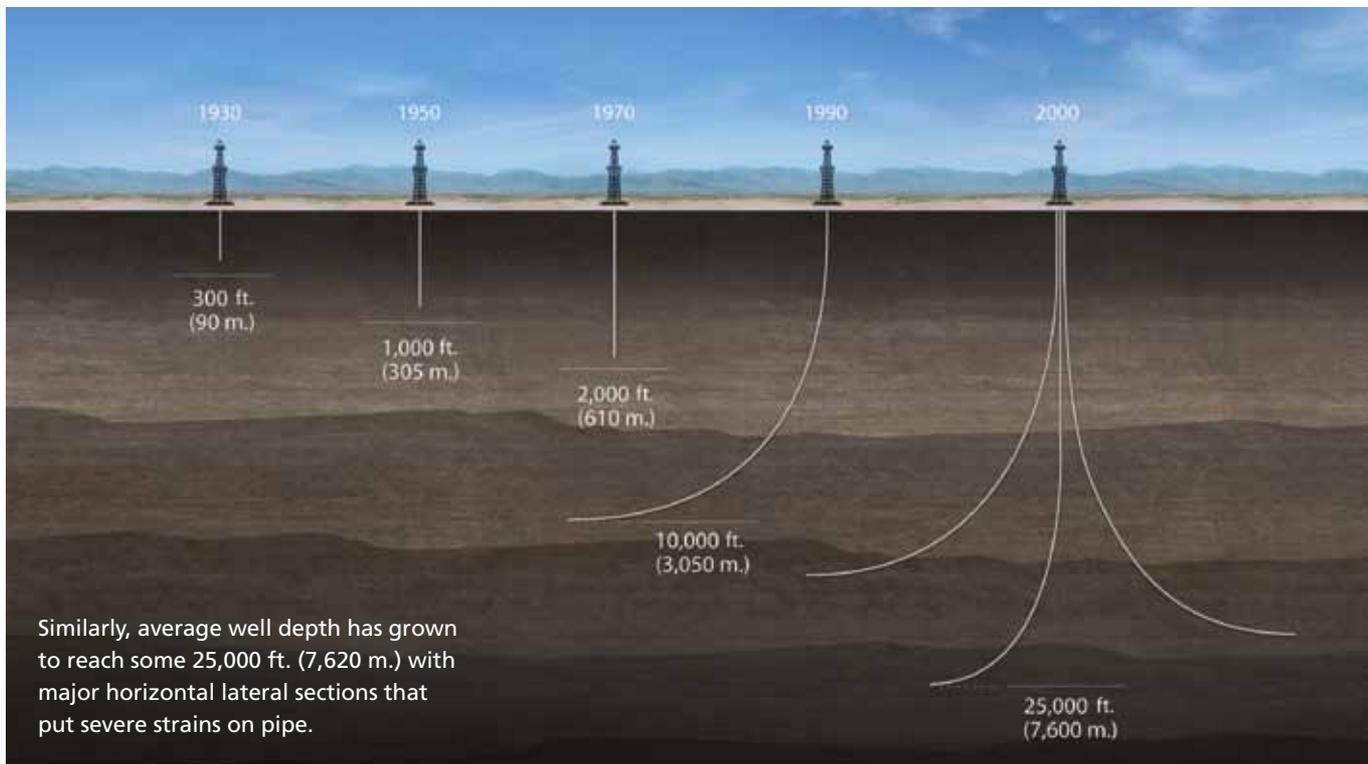
1.25 MILES

(2 KM)
of salt into uncharted
carbonate reserves with
corrosive compounds
in the mix.



THE PRESSURE AT THIS
DEPTH IS SIMILAR TO
A PERSON BALANCING
15 JUMBO JETS.

WELL DEPTH



ONE OF THE DEEPEST WELLS

The Tiber Prospect well lies 35,055 ft. (10,685 m.) beneath the Gulf of Mexico, under 4,000 ft. (1,200 m.) of water, where vast deposits of crude oil have recently been discovered.

35,055 FT
(10,685 M)

TEMPERATURE =
250° F



HIGH PRESSURES AND TEMPERATURES

The percentage of high pressure and high temperature (HP/HT) wells has dramatically increased, creating the need for special pipes and premium connections to resist high internal pressure and customized alloys to withstand the enhanced effects of corrosion.

EXTREME CONDITIONS: RAISING THE BAR FOR TUBULAR PRODUCTS

The specific difficulties encountered in oil and gas operations have become a major issue for the industries supplying operators and spurred competitive development in new materials and applications.

SHALES

HAYNESVILLE SHALE, USA

LOCATION

10,500 to 13,000 ft. (3,200 to 4,000 m.)
below ground

FORMATION TEMPERATURE

260 to 380°F (126 to 194°C)

SPECIAL FEATURES

The high-pressure / high-temperature environment demands specially-manufactured pipes and connections to ensure safe and efficient completion.

This formation is unusually deep and thick (approximately 60 meters or 200 feet) and thus pressures and temperatures are high, with both vertical and horizontal wellbore temperatures ranging from 260 to 380°F (126 to 194°C). The connections must be strong enough to bear the hydraulic fracturing.

DEEPWATER

GULF OF MEXICO, USA

LOCATION

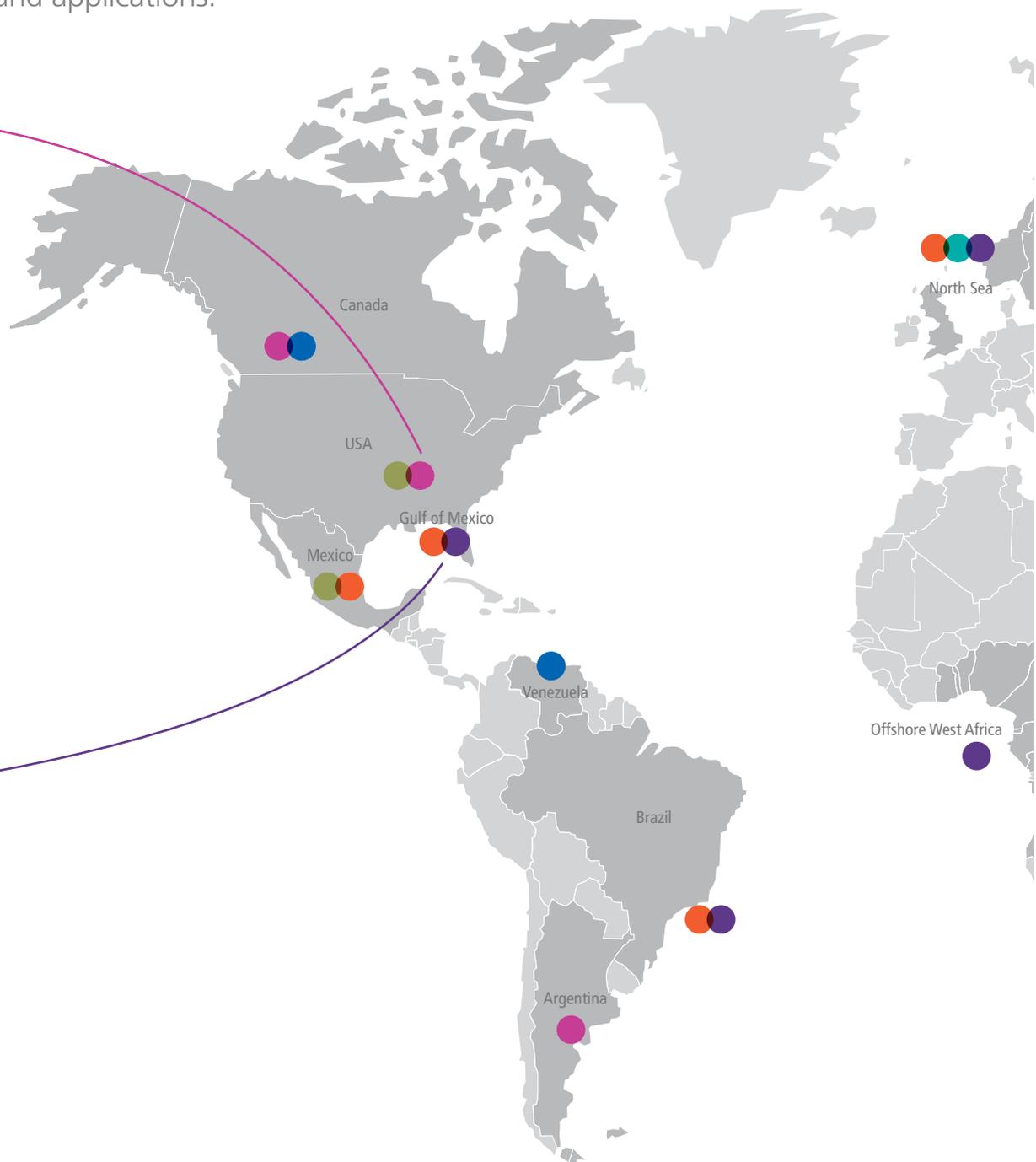
In 3,000 ft. (914 m.) of water

PRODUCTION

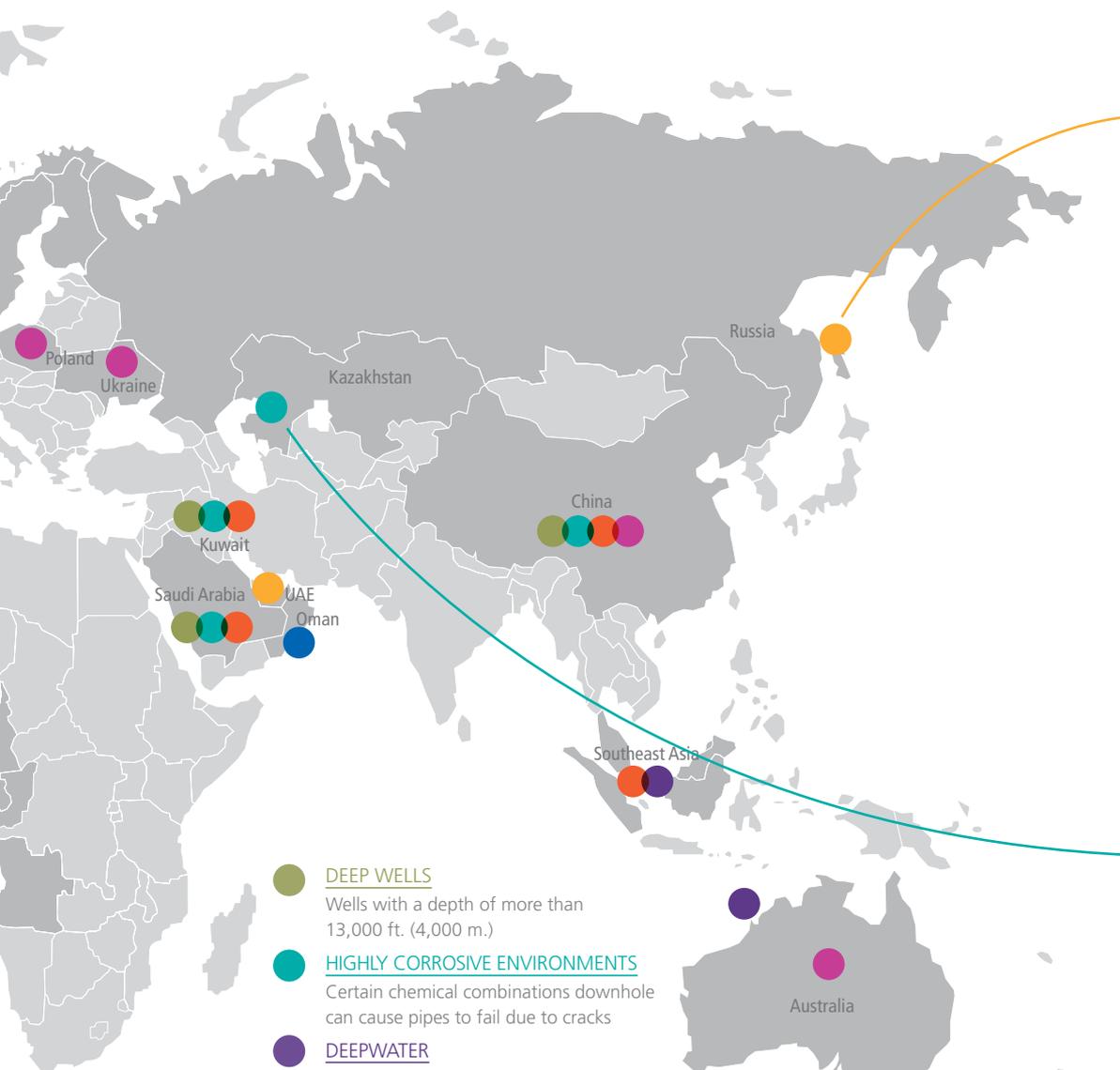
770 million barrels of oil equivalent (boe)
(1989-2011)

SPECIAL FEATURES

The challenges include strong currents and depositional formations which require lighter drilling fluids at the same time as rising downhole pressures can potentially destabilize the wellbore. The Mars oil and gas field is one of the oldest deepwater developments in the Gulf of Mexico, lying in some 3,000 ft. (914 m.) of water.



EACH PARTICULAR WELL HAS INDIVIDUAL CHARACTERISTICS THAT DETERMINE ITS COMPLEXITY. Operators plan the pipe program and identify the main challenges that need to be addressed, such as high temperatures, pressures or corrosive environments that call for specialized products.



- **DEEP WELLS**
Wells with a depth of more than 13,000 ft. (4,000 m.)
- **HIGHLY CORROSIVE ENVIRONMENTS**
Certain chemical combinations downhole can cause pipes to fail due to cracks
- **DEEPWATER**
Exploration and production operations in water depths of more than 1,000 ft. (305 m.)
- **HP/HT**
Wells with high temperatures (over 300°F/150°C) and pressures (10,000 psi)
- **SHALES**
A dense, non-porous gas and oil-bearing rock
- **EXTRA HEAVY OIL**
Pipes must withstand temperatures of up to 350° during steam injection to extract oil of less than 10° API gravity.
- **EXTENDED REACH WELLS**
The long horizontal extension requires high torque and bending capabilities.

EXTENDED REACH WELLS
SAKHALIN ISLAND, RUSSIA

LOCATION

The North Pacific, off the eastern coast of Sakhalin in the Sea of Okhotsk

AMBIENT TEMPERATURE

-4°F (-20°C)

SPECIAL FEATURES

Pipes are expected to provide absolute reliability throughout the entire lifecycle of the well, which may last up to 50 years.

The Odoptu OP-11 is the longest extended-reach well to-date and was bored 37,648 ft. (11,470 m.) under the sea floor to reach the hydrocarbon reserves. This kind of well requires pipes to be rotated into place horizontally following an initial vertical section.

HIGHLY CORROSIVE ENVIRONMENTS
KASHAGAN, KAZAKHSTAN

LOCATION

The Kashagan Field

AMBIENT TEMPERATURE

-31 to 104°F (-35 to 40°C)

SPECIAL FEATURES

These service conditions require the use of special Corrosion Resistant Alloys able to withstand Hydrogen Sulfide (H₂S) and premium connections capable of enduring extreme temperatures and loads for a prolonged period of time.

The Kashagan Field is estimated to have recoverable reserves of some 13 billion barrels of crude oil. Harsh conditions and extreme temperatures make it one of the most challenging worldwide.

PREMIUM CONNECTION PERFORMANCE IN TODAY'S CHALLENGING PROJECTS

ACCORDING TO INDUSTRY ANALYSIS, more than 90% of pipe failures occur in the connection, which takes up a mere 3% of the pipe length and represents 10-50% of the total tubular costs. Any possible connection failure would be a significant problem in a context of escalating well investment costs.

PERMIAN BASIN, TEXAS



In the past, many wells were simply built, a vertical construction downwards with only a few casing strings.

Surface Casing

Standard Connection

Production Casing

Tubing

6,000 ft.
(1,830 m.)

In simpler wells, pipe costs represent approximately 20% of the entire investment.

OFFSHORE ABU DHABI



Fast and reliable pipe installation is imperative in horizontal wells, as the risk of an open hole collapsing is higher than in vertical wells.

Surface Casing

Intermediate Casing

Premium Connection

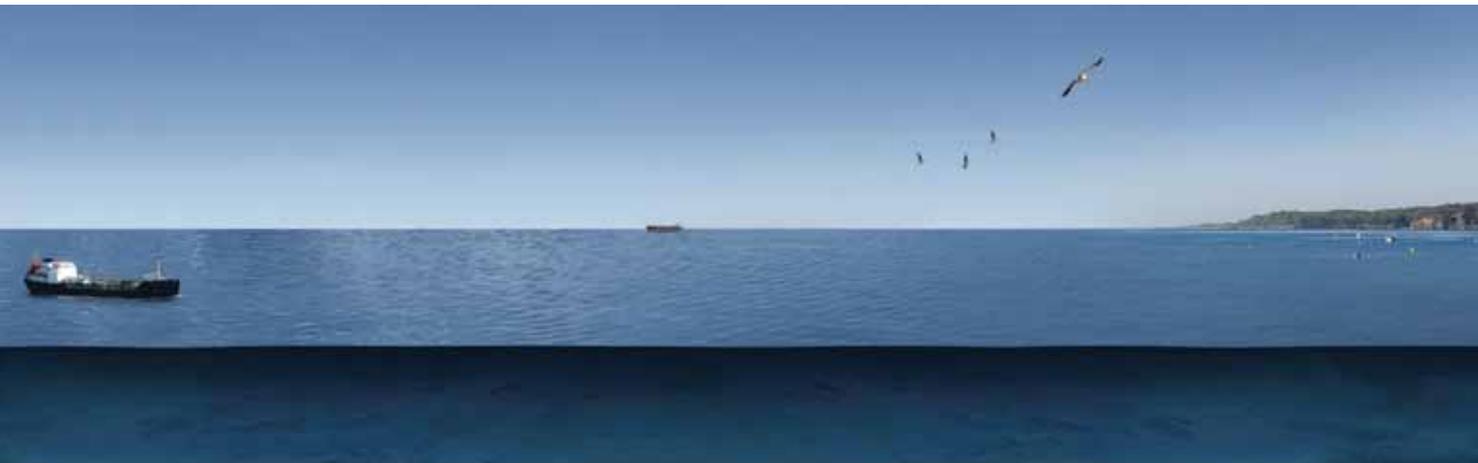
Production Casing

In more complex projects, pipe represents 4-5% of the well cost.

Choosing the right connection is critical: 90% of pipe failures occur in the connection.

Pipe manufacturers and suppliers invest major sums in R&D to create proprietary connection technology with optimum structural and sealing performance for steel casing and tubing in high-temperature and high-pressure environments. The aim is to achieve 100% reliability and performance

through the design of special threads applied to the end of the pipe. Manufacturers of premium connections and pipe –once separate businesses– are now leveraging their understanding of casing and tubing performance and how steel reacts in varied environments to create perfect-fit seals.



Premium connections vs standard connections

As well design becomes more challenging, operators turn to premium connections to help ensure reliability.

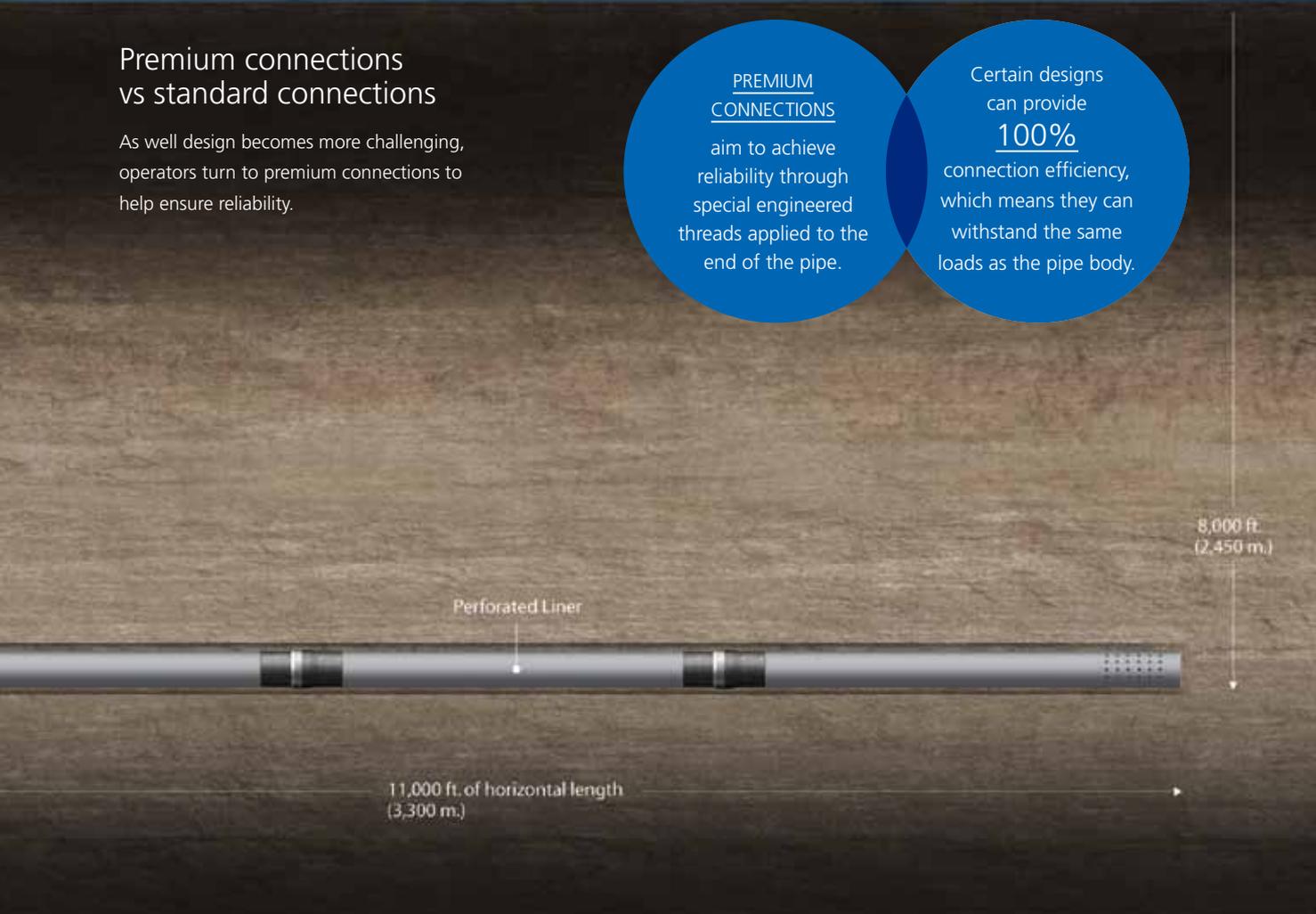
PREMIUM CONNECTIONS

aim to achieve reliability through special engineered threads applied to the end of the pipe.

Certain designs can provide

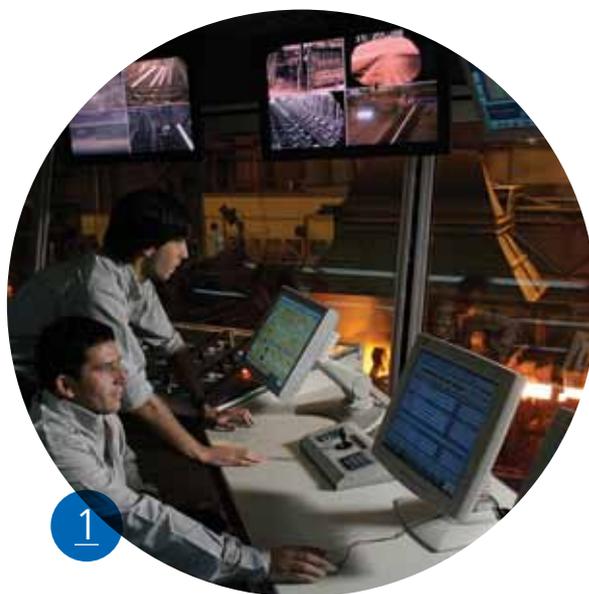
100%

connection efficiency, which means they can withstand the same loads as the pipe body.



SERVING THE INDUSTRY: TIMELY, PRECISE SUPPLY

IN OIL AND GAS EXPLORATION AND PRODUCTION, where major sums are at stake and the risk potential for the environment is huge, quality acquires critical relevance for every part of the process, through product design, manufacturing, delivery and onsite assistance.



1

PRODUCT CUSTOMIZATION

Many pipe manufacturers work in close PARTNERSHIP WITH OIL AND GAS COMPANIES to jointly analyze, measure and control all variables capable of impacting on project performance and risk: manufacturers offer material selection and string design services to help companies limit risk exposure by providing advice about the performance of casing, tubing and premium connections for each operating environment.



2

QUALITY MANAGEMENT SYSTEMS

PIPE MANUFACTURERS SET SPECIFIC CONTROLS AT KEY POINTS IN THE MANUFACTURING PROCESS

These controls, as well as end-product testing, are enshrined in quality management systems that are documented to align information with process controls. They also ensure a common set of standards is met. All controls are pre-determined by the pipe's downhole functions according to the dimensional and mechanical specifications set by the customer in the context of the well service conditions.



3

TIMING AND ON-SITE SERVICE

Supply chain teams are assigned by some manufacturers to follow the evolution of each project, and implement any changes in production requirements, or propose logistics solutions to access challenging locations.

In addition, many pipe manufacturers deploy field service specialists to optimize product installation safety and efficiency on site. These added value services aim to reduce well installation costs and improve returns on capital investment.



4

PARTNERSHIP

The pipe manufacturing industry for the oil and gas sector has evolved into a complex business providing tailored solutions on time to some of the most remote locations in the world, enhanced by the ability to develop a rich and many-layered partnership with operators with whom they share the same concerns, responsibilities and values.

SUSTAINABILITY

THE PERFORMANCE AND RELIABILITY of steel pipe is a critical factor in minimizing the risks of accidents and environmental damage in the oil and gas industry.

Today oil and gas operators need to pay close attention to the careful selection of steel pipes in accordance with the operating conditions that can be expected over the life cycle of a well or a pipeline. Quality is paramount and certain pipe manufacturers have developed integrated quality management systems to ensure the reliable supply of high-quality products.

Leading steel pipe manufacturers employ health, safety and environment management systems to minimize the risks of accidents and the environmental impact of their operations. These include programs to reduce the use of energy and water and minimize emissions. Steel is a recyclable material and to a large extent by-products and wastes generated in steel pipe manufacturing processes are recycled. Manufacturers also provide logistic and supply chain management services designed to minimize excess supply and inventories and to reduce project management time and risks.

To reduce the use of contaminating compounds used for pipe storage and running at oil and gas rigs, special coatings are being developed and applied to pipe connections during the manufacturing process. Dope-free coatings help to considerably decrease health and safety risks at the rig and minimize contamination in the field and the reservoir.

ABOUT TENARIS

Tenaris is a leading manufacturer and supplier of steel pipe products and services for the energy industry worldwide. Operating an integrated global network of manufacturing, research, testing, finishing and service facilities present in most oil and gas markets worldwide and producing a wide range of over 100,000 high quality pipe products, Tenaris plays a key role in the world's oil and gas industry.



MANUFACTURING
CONTROLS HELP
GUARANTEE
CUSTOMIZED, QUALITY
PIPE PRODUCTS.



SPECIAL COATINGS
HAVE BEEN
DEVELOPED TO
AVOID THE NEED
FOR PIPE DOPE.



EXPERIENCED
PROFESSIONALS
MINIMIZE RISK
ONSITE.



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