



Research & Development

FOUR CENTERS, AN ALIGNED AGENDA

Advanced metallurgy_ Advanced computer modelling
of processes and products_ Fracture mechanics and structural
integrity_ Full-scale testing of tubular products and premium
connections_ Advanced corrosion testing_ Nanotechnology_
Non-destructive testing and optical measurement_
Welding metallurgy and technology.



R&D CENTER
Veracruz, Mexico



R&D CENTER
Campana, Argentina



R&D CENTER
Kawasaki, Japan



R&D CENTER
Dalmine, Italy

At Tenaris, we aim to raise the quality and range of our products, by accompanying our customers and analyzing new trends in the sectors where they operate.

For major global companies that have moved beyond traditional operations to explore new fields in complex environments, Tenaris offers a complete partnership, rich in options and solutions.

The R&D network is a fundamental component in Tenaris's approach to serving the customer. Great knowledge of metallurgy and material behavior combines with our experience in the field.

Our R&D team is responsible for the development of innovative premium connections. We have developed a wide range of proprietary steel grades to withstand high pressure and temperatures as well as sour conditions. We have contributed to the development of specialized products for deep and ultra-deep water projects around the world.

Worldwide, more than 200 scientists and engineers, more than half of whom hold PhDs or Master's degrees work in our centers. Their dedication to continuous improvement and product innovation has already served complex E&P projects and high performance mechanical and structural applications.

Our global network of R&D centers collaborates with top universities and research institutions worldwide that conduct basic and applied research. This combination of internal and external expertise gives us the means to develop value-added products and improved production processes that directly contribute to our customers' operations and fuel our growth.

The Tenaris R&D Network



The Tenaris R&D Center is located at our seamless tubes mill. Strategically based on the Gulf of Mexico, we focus mainly on the creation of new products for line pipe and OCTG applications, innovations in welding technology, and the qualification of premium connections.

The Center was inaugurated in 2006. The full-scale testing laboratory possesses some of the most sophisticated equipment worldwide for testing tubes and threads.

Our researchers have contributed to the development of specialized products specifically for deep and ultra-deep water projects both in the Gulf of Mexico and around the world.

ORGANIZATION

The R&D Center conducts research and testing in five different areas: Metallurgy and Materials, Welding Technology, Process Development, Fracture Mechanics and Full-scale Testing Laboratory.

Metallurgy and Materials

Conducts research on and development of new products for the oil & gas industry, focusing mainly on specialty line pipe and OCTG products for high pressure, high temperature wells, sour service and deep and ultra-deep water applications around the world.

Welding Technology

Performs welding technology research and welding procedure specifications (WPS) for the most challenging line pipe projects around the world, where high-performance products like flowlines, steel catenary risers, top tension risers, installed by S-lay, J-Lay or reeling are involved. The division also supports the double joint operations performed in Tenaris's mills and evaluates new materials and products' welding characteristics.

Process Development & Mechanical Solutions

Applies advanced engineering techniques for the redesign, optimization and control of many of Tenaris's production processes. The division supports different areas and disciplines during the development of new products through structural and fluid mechanics analyses.



We serve customers operating in deep waters around the world, such as the Gulf of Mexico and West Africa.

R&D CENTER

Veracruz

A technician performs resonant fatigue testing on a girth weld of SCR Tenaris pipe.

Fracture Mechanics

Studies the structural integrity of tubular products, with welded or threaded connections for specific use in oil & gas production. This area also develops and applies the most advanced methods of material properties analysis for new products and predicts their behavior when used in specific oil fields.

Full-scale Testing Laboratory

The Center also has a full-scale testing laboratory that carries out testing for the qualification of premium threads in real dimensions, simulating extreme load conditions Tenaris products are exposed to in the field. This laboratory also conducts fatigue analyses of plain end, girth joints or threaded pipes on full-scale specimens. The full-scale testing laboratory is recognized as having the most sophisticated testing equipment worldwide in its field.

ACHIEVEMENTS

Through Joint Industrial Programs, Tenaris innovates products to meet the needs of strategic and demanding E&P projects. For example, Tenaris researchers in Mexico have worked with customers BP, Shell, Marathon, Petrobras, Total, Technip and EWI Microalloying on the development of weldable seamless tubes in X100 steel grade.

We also work with world-renowned researchers, universities, and research centers. We believe that sharing knowledge is the starting point for future technological discoveries.

As an example of customer focus and value, for Total's Pazflor and Dalia projects, both offshore developments in Angola, the R&D Center's welding laboratory and double joint plant developed high performance line pipe that saved the customer time and money by cutting back on welding times on the reeling vessels operations. Tenaris is one of three providers worldwide that is able to offer this special service.

We focus mainly on the creation of new products for line pipe, risers and OCTG applications, innovations in welding technology, and the qualification of premium connections.



Project spotlight Upset Work Over Risers

During the last five years, the Center has worked on the development of Upset Work Over Risers in two sour service steel grades: 90ksi SS and 100ksi SS. This product is a non-permanently installed riser subjected to many make-up and breakout operations in its service life and therefore demands high requirements to guarantee assembly performance.

This work has been conducted in close cooperation with customer FMC Technologies, a leading global provider of technology solutions for the energy industry. As a result of this joint development, Tenaris has manufactured and sold more than 1,000 Upset pipes in different OD/WT dimensions, grade 90 & 100ksi SS to FMC, continuing with the development of the next generation of products and potential R&D projects that will bring mutual benefit to both companies.



The Tenaris R&D Center in Campana is one of the oldest and most prestigious industrial research laboratories in Argentina.

Located at Tenaris's seamless tubes mill in Argentina, the R&D Center provides scientific and technological research support in diverse areas and disciplines such as metallurgy, steelmaking, chemistry, applied physics, structural integrity, mechanical design, materials and coatings. Numerical physical modeling is an essential part of our R&D projects, resulting in a correct mix of finite element analysis and full-scale testing. The R&D team consists of over 110 people, including senior researchers and technicians.

In order to expand the horizons of their work, the R&D center collaborates with a number of local and international universities in the development of new solutions and technologies required for operating in the world's most demanding environments.

Our research lines cover both products and processes. We work extensively on creating and improving our premium connections, OCTG and line pipe products. In terms of processes, researchers focus on innovating steel making, rolling, heat treatment, non-destructive testing and tracking of tubular products.

ORGANIZATION

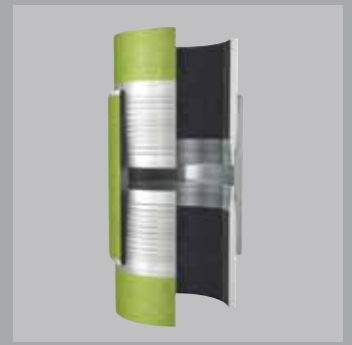
In order to meet its strategic research objectives, the Tenaris R&D Center is divided into the following activity areas:

Steelmaking

Enhances the fundamental process in the tubular products business. Through an examination of primary operations, continuous casting and ladle metallurgy, the area helps to guarantee the quality of our base materials and looks to improve the line's efficiency and produce greater steel cleanliness.

Metallurgy

Develops sour service and CO₂-corrosion-resistant products through basic research on corrosion mechanisms and alloy design as well as manufacturing process design, focused on the optimization of the heat treatment process and the control of microstructural transformations.



The Wedge™ technology group, based in Houston, contributes to premium connection research in Argentina and Mexico.

R&D CENTER

Campana

The team in Campana has developed our TenarisHydril technology.

Surfaces and Coatings

The department is composed of chemists and materials engineers whose research lines are related to the development and optimization of different types of surface treatments or coatings based on metallic or polymeric materials. Led by nanotechnology and conversion coatings experts, the team expands the possibilities to develop innovative solutions for tubular products with new and enhanced properties through significant process improvements in tools and manufacturing devices.

Applied Mechanics

Develops knowledge that can contribute to practical applications in the areas of mechanical properties, structural reliability, fracture mechanics, fatigue design, tribological systems of rolling and metalworking and pipe characterization. The department develops sucker-rods related products, as proprietary connections, and technology for the design and evaluation of TenarisHydril connections for casing while drilling or risers applications.

In addition, the area provides specialized modelling support to rolling projects and for the development and application of new numerical tools in the area of Applied Mechanics.

Applied Physics & NDT

Performs basic and applied research on the non-invasive detection of flaws or defects that could prevent a manufactured part from fulfilling its intended purpose. Magnetic, ultrasonic, optical and radiometric techniques are used in the inspection of seamless pipes. New and innovative solutions for measuring and gauging through optical systems are other common lines of activity.

Furnaces & Heat transfer

Works to achieve a heating quality necessary to produce steel parts with the required tolerances. The area strives to obtain the maximum productivity compatible with quality requirements while diminishing energy consumption and material waste.

Refractory Materials

Investigates wear evaluation, failure mechanics and high-temperature interaction of fracture materials for steelmaking with the aim of minimizing the degree of in-service refractory damage and optimizing product design.

String Design & Well technologies

Provides support to the assistance team and to customers with the revision or design of well strings, interacting with customers when necessary and providing support with the performance and selection of materials and connections.

This area also supports the development and testing of our premium connections. Extensive use of finite element analysis (FEA) helps to produce strength visualization and indicates the distribution of stresses and strains on Tenaris products by creating a detailed mapping of our sealing performance under the most varied and extreme operating and geometrical conditions.

The string design and well technologies team has the capacity to verify products' performance according to each customer's specifications or to qualify connections for a new environment where different operational loading conditions will be observed.



The team works on the optimization of coatings for tubular products.



The Tenaris R&D Center is one of the oldest and most prestigious industrial research laboratories in Argentina.

Full-scale performance testing complements FEA to fully verify some critical performance features such as galling resistance and sealability performance. This test validates the reliability of our products' structural design and performance, based upon testing that simulates the specific conditions in the oil field where it will be run.

Testing Laboratory

The finite element analysis and full-scale testing on our connections are only two of the many tests carried out in the Center's laboratory. We also perform full-scale tests on steel tubular products, examining collapse and bursts. Our Tenaris sucker rods are submitted to our numerous fatigue and ultimate torsion load tests. Fatigue response for casing and connection devoted to casing while drilling operations are also tested in focused high-speed resonant fatigue rigs. The laboratory also specializes in standard mechanical analyses: tension tests at room and elevated temperatures as well as tribological tests.

ACHIEVEMENTS

Our team has played a significant role in some key product development projects. We have created sour service materials such as TN 95SS, TN 110SS and others, leading the sour materials market.

Regarding our premium connections, the Center is responsible for the development of the TenarisHydril Blue™ Series, through the active participation in a culturally diverse product development team and the expertise acquired through many years using sophisticated FEA modeling and experimental testing.

Researchers have also created new proprietary premium connection sucker rods that provide outstanding performance in comparison with traditional API solutions.

Our investigation is done using state-of-the-art methodologies and tools including extensive use of modeling such as finite element analysis (FEA) and full-scale product testings.



Project spotlight Dopeless® technology

In 2001, a major North Sea operator approached Tenaris with a challenge. The E&P company needed to respond to a zero-discharge regulation for offshore wells aimed at protecting the natural environment. In response, Tenaris offered an alternative dope-free connection in an early stage of development, to eradicate the need for environmentally aggressive compounds with high contents of heavy metals. In 2003, the Dopeless® solution was commercially launched.

The Dopeless® coating eliminates storage compound and running dope, reducing operational times and costs as well as minimizing risks.

After seven years on the market, the innovative Dopeless® technology has become an essential resource in the oil and gas industry. The dry coating's enhanced performance has proven an effective solution in different environments. It has been tested in demanding conditions such as extreme cold weather, high temperature and sandy areas, in onshore and offshore wells.



The Tenaris R&D Center specializes in high-chromium steel tubular products for diverse applications. On location at the NKK Tubes mill, we carry out full-scale testing of premium connections, design and develop corrosion-resistant alloys, sour service materials and drill pipe.

With the incorporation in 2000 of NKK Tubes into Tenaris, the company had the support of the NKK Corporation R&D Center. In 2003 when the NKK Corporation merged with the Kawasaki Corporation into JFE, some of the most competent researchers from the NKK Corporation R&D Center transferred to NKK Tubes.

In addition to coordinating activities with the network of Tenaris R&D Centers in Argentina, Italy and Mexico, the NKK Tubes Center has a contract for joint research work with the Centro Sviluppo Materiali in Italy and a contract with the JFE Techno Research Company to carry out different kinds of R&D projects.

ORGANIZATION

From Japan, we conduct research in four main areas: Material Research, Corrosion, Rolling and Full-Scale Testing of Premium Connections.

We carry out investigation in fields like steelmaking, rolling, chemical analysis, heat treatment, material testing, physical analysis and microscopy.

Metallurgy and Material Research

Develops basic and applied knowledge in the field of metallurgy, and new steel grades including corrosion-resistant alloys, such as 13%Cr, to withstand the most demanding operational environments.

Corrosion Analysis

Analyzes the metallurgical performance of steel under severe service, seeking the optimization of existing products, and development of new ones. This division's research serves the OCTG, line pipe and power generation businesses.



We carry out material testing and examine steel grades and premium connections

R&D CENTER

Kawasaki

Rolling Process

Performs examinations of the rolling process, key in the manufacturing of seamless pipes. This area uses the Finite Element Method technique to optimize rolling processes, visualizing both the strengths of our tubular products and opportunities for tool design improvement.

Premium Connections Laboratory

Full-scale performance testing is a critical step to fully verify features such as galling resistance and sealability performance of our premium connections. These experiments include make-and-break testing, and extensive functional tests to verify sealability response.

ACHIEVEMENTS

The team at NKK Tubes R&D works in partnership with many Japanese universities on joint research projects. Over the past five years, we have carried out investigations of high-alloy OCTG, working with Hokkaido and Waseda universities. We have also addressed the issue of high-alloy line pipe with Kyushu University and Okayama University of Science and teamed up with University of Tokyo and Nagoya Institute of Technology to study the rolling process.

Tenaris R&D network is a magnet for scientists and technicians, eager to carry out research in advanced fields of metallurgy with the use of cutting-edge equipment.

We analyze steel performance under extreme service conditions and focus on high-chrome pipe for the OCTG, line pipe and power generation businesses.



Technology Spotlight TEMPALOY AA-1

The R&D center has developed the TEMPALOY AA-1 steel for the thermal power plant industry. The new material helps generate power more efficiently in thermal power plants, reducing CO₂ emissions. TEMPALOY AA-1 is a practical, austenitic stainless steel that is currently used in high-temperature and high-pressure areas in superheater and reheater sections of coal thermal power plants. These plants typically operate at steam temperatures above 600°C / 1112°F.

In the future, Tenaris intends to supply this product to be used at plants operating at steam temperatures exceeding 650°C / 1202°F and pressures of 25MPa. The higher steam temperature generates power more efficiently. In general, boilers must be stable for operating over 20 years or even longer and they must be cost effective as well. TEMPALOY AA-1 (18Cr-10Ni-3Cu-Ti-Nb) high-strength steel can satisfy all of these requirements.



The Tenaris R&D Center opened in November 2008 on the premises of our seamless tubes mill in Dalmine with an area of 2.800 square meters.

The Center specializes in hot rolling processes and in product development for mechanical and thermal applications. Since 2006, when the investment in the Center was approved, a heterogeneous group of Tenaris experts has been created and integrated taking into consideration skills from abroad. Developing specific parts of assigned projects, the Tenaris R&D Center in Italy completes the range of knowledge accumulated throughout the company's research network. Along with several national and international universities, the Center works closely with the Centro Sviluppo Materiali in Rome which has branch premises inside the company's mill in Dalmine.

The Center has been designed and equipped for up to 40 researchers, adding almost 70 people among technicians and operators working on testing for products and research projects.

ORGANIZATION

In order to meet its strategic research objectives, the Tenaris R&D Center is divided into the following departments:

Rolling Technology

Addresses and coordinates the R&D activities in the different Tenaris R&D Centers for issues related to production processes, quality and engineering.

Modeling & Control Process Systems

Develops models for hot rolling processes. In particular, this area is devoted to process control and simulation of innovative solutions to support design changes of the equipment and tools, to improve processes and support the development of new ones.

Metallurgy and Tribology

Equipped for the development of basic and applied knowledge in the fields of metallurgy, metallurgical analysis of new and already existing production processes and analysis of the metallurgical performance of steel products. The Department also has equipment to study the tribological behavior of materials aimed to improve the lifespan of the rolling tool and product quality.



In Italy, researchers focus on creating products for mechanical and thermal applications.

R&D CENTER

Dalmine

We work on improving
the most critical stage in
seamless tubes production

Structural Integrity

Uses state-of-the-art equipment for the development of basic and applied knowledge in the field of fracture mechanics and structural integrity. Practical applications are in the development and testing of the structural reliability of materials and products.

The Center has one of the largest creep laboratories in Europe: 282 creep tests can be performed simultaneously with the possibility of electronic strain measurement. The creep laboratory is used for the inspection and certification of Tenaris products and for the development of new creep resistant materials.

ACHIEVEMENTS

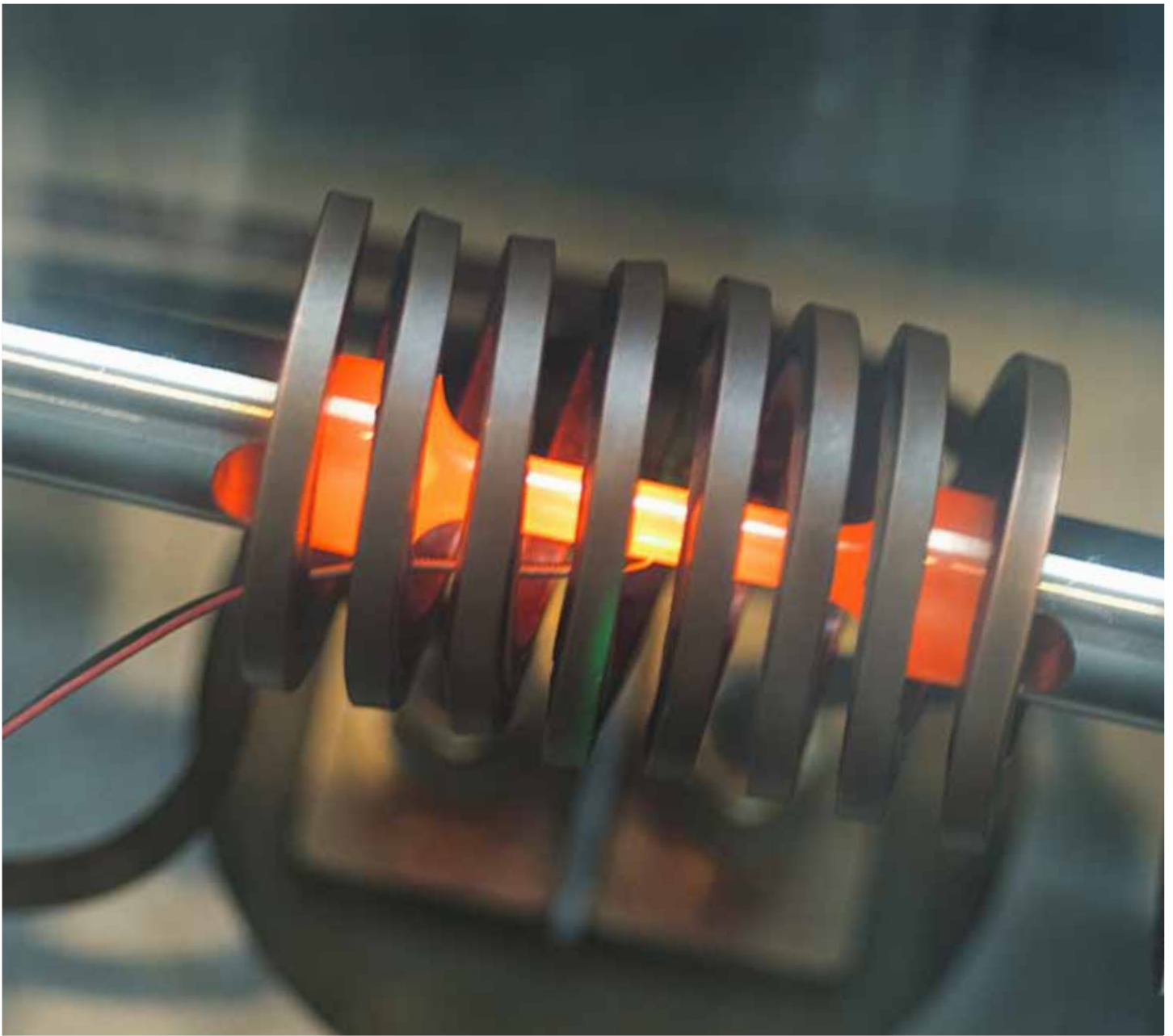
In the mechanical and automotive sector, we have worked extensively on the development of components for airbags. The product quality achieved has positioned Tenaris as the supplier of the most important customers in the airbag sector such as ARC and Autoliv.

We have also developed high machinability materials and new steel grades for cold-drawn tubes used in hydraulic cylinders with the highest safety requirements.

In the line pipe segment, we have contributed to the development of high-grade, heavy wall bends with excellent toughness for severe applications, which customers like Technip and Petrobras have used in projects such as Chinook and Cascade in the Gulf of Mexico.

Our team played an important role in the development of the 80 ksi sour service grade for top tensioned risers. Tenaris worked in close collaboration with subsea contractors and end users to offer this innovative product. Less than two years passed from laboratory investigation to production.

We develop models for hot rolling devoted to process control and simulations of innovative solutions for Tenaris mills. We carry out applied research on tubes for hydraulic cylinders, power generation, heavy wall line pipe and bends.



Technology Spotlight Hydraulic cylinders

Used typically in earth moving machines, cranes, presses and industrial machinery, the hydraulic cylinder is an actuator converting hydraulic energy into mechanical energy. Strength is commonly considered the essential requirement in order to resist stress, while toughness is usually not included as a design requirement in the specifications. Cold-drawn tubes combining tight dimensional tolerances, high strength and good toughness, reducing the significant difference between the longitudinal and transverse direction have been developed.

Structural integrity models have been implemented in a web application for the assessment of hydraulic cylinders' fatigue properties. These models create a prediction of the component's fatigue behavior, obtaining results in terms of number of cycles to failure and/or the maximum admissible defect for a given design life.

