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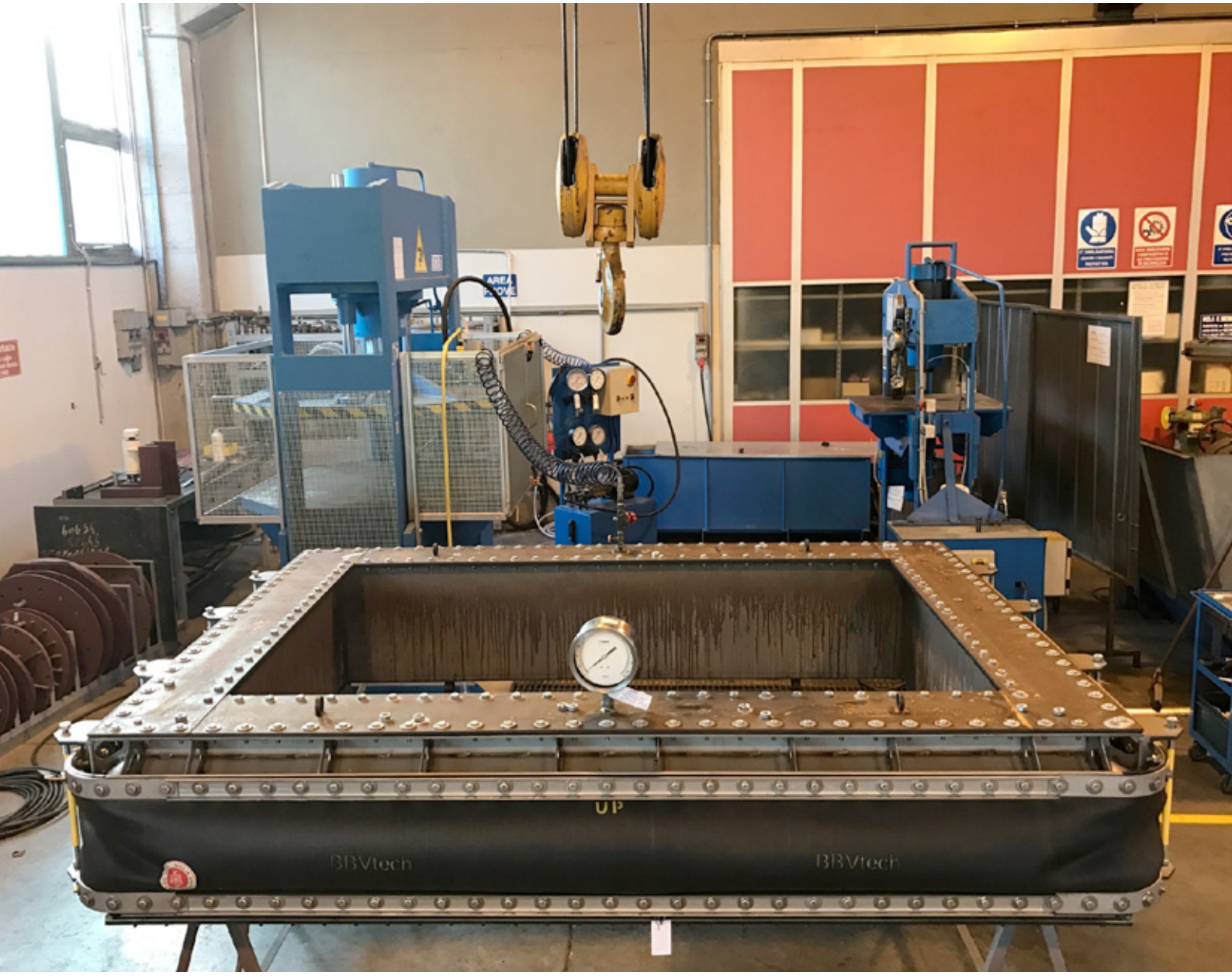

A New Generation of High-Performance and Eco-Friendly Textile Expansion Joints

Excellent results from a well-designed innovation program

Stefano Boni, Director of the R&D Production Department
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In 2006, *BBV Tech S.r.l.* (*Alflex*), a manufacturing company that is part of the *BBV Inoflex Group*, was called upon to manage and develop the *Production Department for Layered Textile and Rubber Products* and launched a specific research and development project to create a new generation of high-performance textile expansion joints. At the same time, studies have been carried out on several levels: analysis and design criteria, materials, and production processes.

The Innovation Program followed the development of naval shipbuilding projects by the Italian Navy that include the *FREMM frigates*, the new *PPPs - Multipurpose deep-sea patrol boats* and the *LHD - Landing Helicopter Dock*, under construction. The objective of the study was a set of textile expansion joints to be used in the output lines from gas turbine modules (by *General Electric* and *Rolls Royce*), to be placed in internal seals like engine shaft protection, and to connect the piping of gas exhaust, primary air and ventilation.

In 2006, BBV Tech S.r.l. (Alflex), launched a specific research and development project to create a new generation of high-performance textile expansion joints

In launching the Project, a strategic decision was made to question every technological and knowledge element already acquired through known technologies. At the same time, also favored by a similar intent of the clients, each new course of study was undertaken with the imperative of not setting limits on *dual-use technology* research, especially in order to seek new technological solutions useful to reconcile:

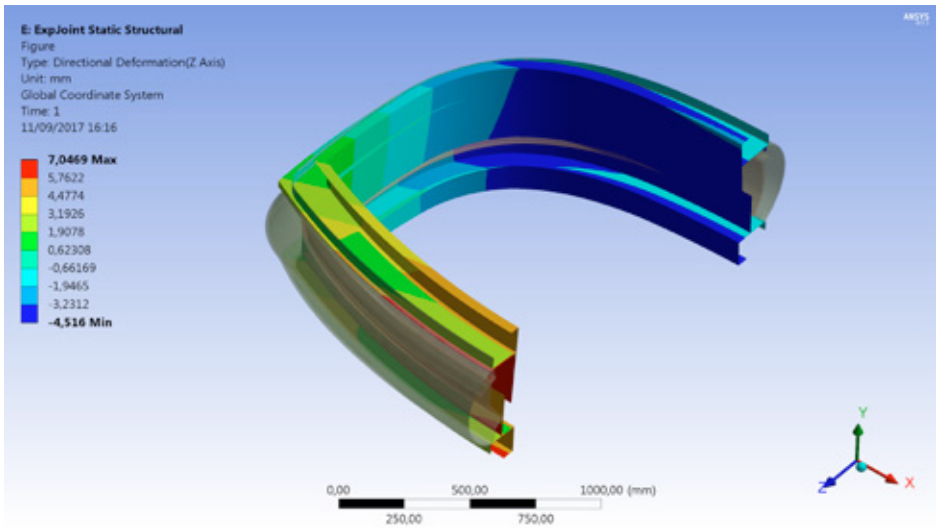
- the need to create systems capable of delivering ever-higher performance and
- the determination to contribute to a decisive reduction of pollutants (both acoustic and from the release of harmful chemical compounds into the environment).

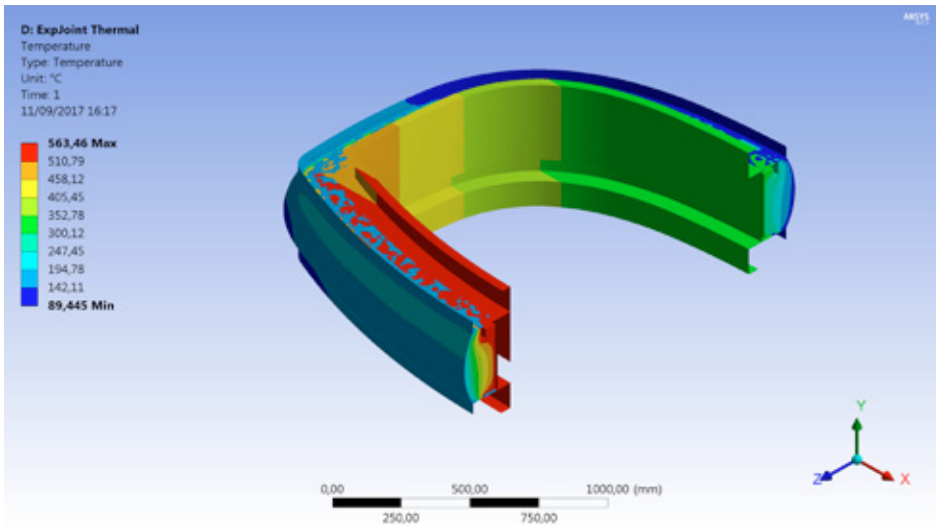
It was crucial to start with a thorough analysis of data concerning the design, construction and operational life of expansion joints coming off production lines and, over a forty year period, installed in thousands of industrial plants located all over the world. These were, in numerous cases, subjected to extremely complex working conditions due to both the environmental situation (sometimes extreme) and on the operating characteristics of the plants.

The innovation acquired has made it possible to achieve 100% of the desired performances, guaranteeing ship operational and stealth capabilities unthinkable with "mature" technologies

During the development of the project, *performance targets* were continuously raised according to ever-increasing levels of required operational capacity by the new ships.

The absolute rate of innovation acquired has made it





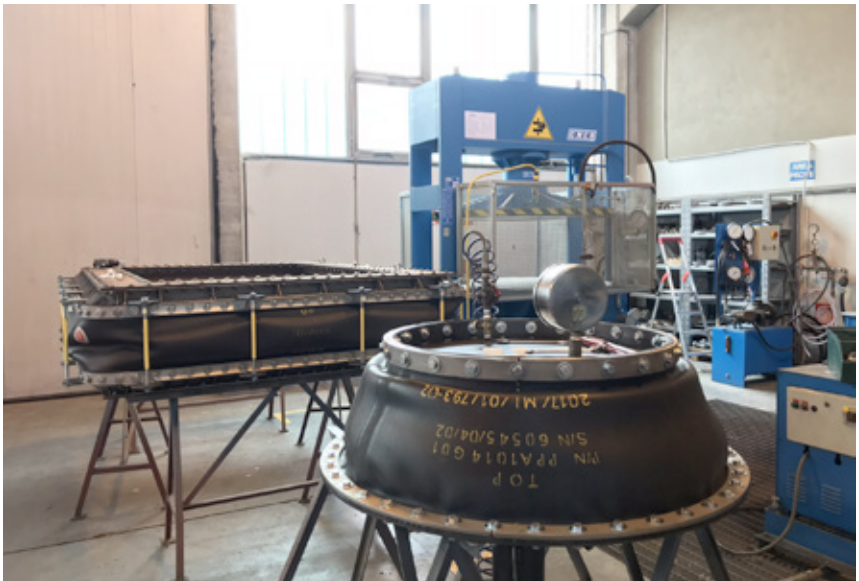
The following tables show some data on the operation of the expansion joints under normal conditions.

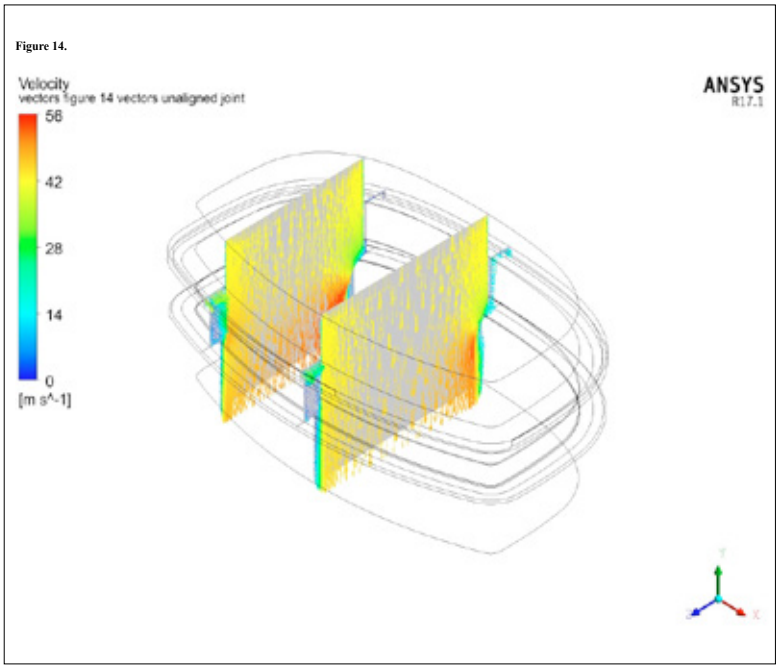
PROJECT:	**FREMM - European Multi Mission Frigate** **PPPs - Multipurpose deep-sea patrol boats**
Type of turbine:	LM2500+G4 Propulsion system
Power:	32 MW
Expansion joints provide an airtight, noise and temperature-attenuating seal between the enclosure and the ship's ducts and between the enclosure and the reduction gear box.	
PRIMARY INLET:	Rectangular expansion joint that forms the airflow path between the ship's intake duct and the enclosure primary air inlet penetration.
Performances requirements:	
Fluid:	AIR
Pressure:	-2.5 kPag normal condition 20.7 kPag short term condition
Temperature:	Min. -20 °C Max +49 °C
Axial Movements:	Normal ±13 mm / Short Term ±25 mm / Shock ±51mm
Lateral Movements (1):	Normal ±5 mm / Short Term ±13 mm / Shock ±25mm
Lateral Movements (2):	Normal ±8 mm / Short Term ±25 mm / Shock ±45mm
SECONDARY INLET:	Circular expansion joint that forms the airflow path between the secondary cooling enclosure for air inlet penetration and the ship's cooling air duct.
Performances requirements:	
Fluid:	AIR
Pressure:	3.5 kPag normal condition 20.7 kPag short term condition
Temperature:	Min. -20 °C Max +121 °C
Axial Movements:	Normal ±13 mm / Short Term ±25 mm / Shock ±51mm
Lateral Movements (1):	Normal ±5 mm / Short Term ±13 mm / Shock ±25mm
Lateral Movements (2):	Normal ±8 mm / Short Term ±25 mm / Shock ±45mm
PRIMARY EXHAUST GAS:	Rectangular expansion joint that forms the air path for the discharge of the secondary cooling air from the enclosure into the ship's exhaust uptake duct.
Performances requirements:	
Fluid:	EXHAUST GAS
Pressure:	3.5 kPag normal condition 20.7 kPag short term condition
Temperature:	Min. 0 °C Max +427 °C
Axial Movements:	Normal ±13 mm / Short Term ±25 mm / Shock ±64mm
Lateral Movements (1):	Normal ±5 mm / Short Term ±13 mm / Shock ±35mm
Lateral Movements (2):	Normal ±8 mm / Short Term ±25 mm / Shock ±51mm
SHAFT SHROUD:	Circular expansion joint that encloses the power coupling shaft between the gas turbine module and reduction gearbox.
Performances requirements:	
Fluid:	AIR
Pressure:	-1.7/3.5 kPag normal condition 20.7 kPag short term condition
Temperature:	Min. -20 °C Max +121 °C
Axial Movements:	Normal ±5 mm / Short Term ±13 mm / Shock ±25mm
Lateral Movements (1):	Normal ±5 mm / Short Term ±19 mm / Shock ±25mm
Lateral Movements (2):	Normal ±20 mm / Short Term ±25 mm / Shock ±50mm
DESIGN AND TEST PERFORMED:	
- TEST FOR SURFACE FLAMMABILITY – IMO Res. A. 653 (16) FTP Code MSC 61 (67) - PRESSURE TEST – AVIO SPC07-00195 - LEAKAGE TEST – AVIO SPC07-00195 - VIBRATION TEST – IEC 60068-2-47 – ISO2041 - ACOUSTIC TEST - AVIO SPC07-00195 – ISO 1683:1983	

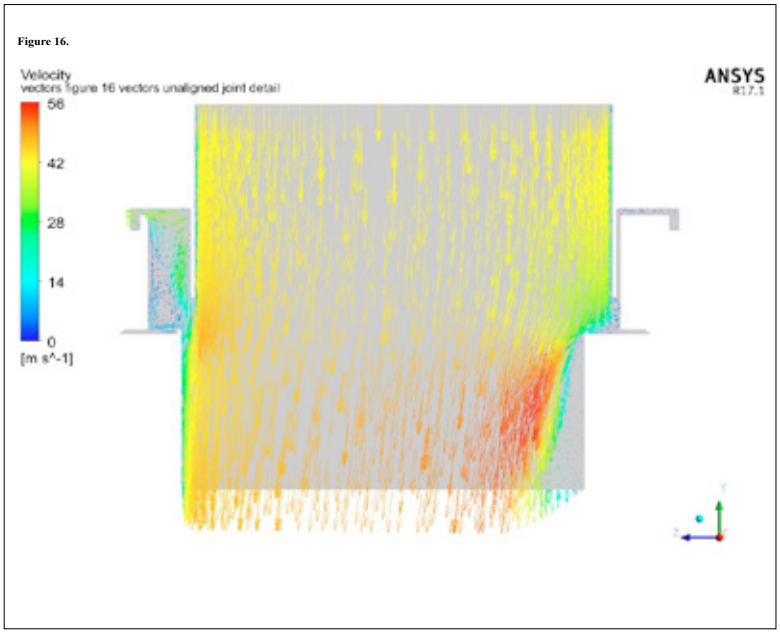
PROJECT:	- LHD Landing Helicopter Dock
Type of turbine:	MT30 Rolls-Royce
Power:	40 MW
Expansion joints provide airtight, noise and temperature attenuating seal between the compact package and the ship's ducts.	
INTAKE:	Rectangular expansion joint that is the MT30 Compact Package intake Bellow interface with the ship air intake ducting.
Performances requirements:	
Fluid:	AIR
Pressure:	5 kPa max
Flow:	116 Kg/s (19.3 m/s)
Temperature:	Min. -20 °C Max +49 °C
Axial Movements:	-68 mm / +56 mm
Lateral Movements (1&2):	±56 mm
VENTILATION:	Rectangular expansion joint that is the MT30 Compact Package Ventilation Bellow interface with the ship ventilation ducting.
Performances requirements:	
Fluid:	AIR
Pressure:	-1 kPa max
Flow:	20 Kg/s (10 m/s)
Temperature:	Min. -20 °C Max +49 °C
Axial Movements:	-75 mm / +62 mm
Lateral Movements (1&2):	±55 mm
PRIMARY EXHAUST:	Special shape expansion joint that is the MT30 Compact Package Exhaust Bellow interface with the ship exhaust ducting.
Performances requirements:	
Fluid:	EXHAUST GAS
Pressure:	5 kPa max
Flow:	119.2 Kg/s (40 m/s)
Temperature:	up to 581 °C
Axial Movements:	-75 mm / +60 mm
Lateral Movements (1&2):	±50 mm

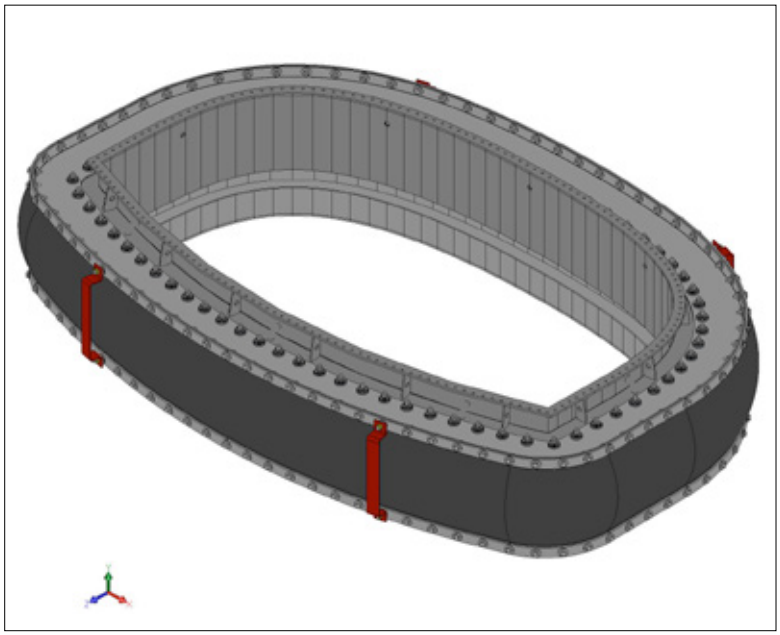
DESIGN AND TEST PERFORMED:

- THERMAL AND MECHANICAL ANALISYS.
- FLUID-DYNAMIC ANALISYS.
- EXPANSION JOINT MODAL SIMULATION.
- SMOKE AND TOXICITY TEST – FTP CODE 307 (88) Ed. 2010 Annex 1 Part 2
- TEST FOR SURFACE FLAMMABILITY – FTP CODE 307 (88) Ed. 2010 Annex 1 Part 5
- PRESSURE TEST – INTERNAL PROCEDURE PR-60742/17-03
- LEAKAGE TEST – INTERNAL PROCEDURE PR-60742/17-03
- DISPLACEMENTS TEST – INTERNAL STD.
- STIFFNESS TEST – INTERNAL STD.









possible to achieve 100% of the desired performances in the project, guaranteeing ship operational and *stealth* capabilities unthinkable with "mature" technologies.

With 20 ships fully in service, the first for over 10 years, and without any operating incident having occurred, it has been confirmed that the new generation of textile expansion joints have a 100% degree of reliability compared to the originally-requested warranty terms.

The project is undergoing further development and promises to provide further important application innovations.

As it often happens, military research opens up wide spaces of "portability" in merchant shipbuilding as well as in the civil and commercial industries.
In fact, the technological innovations acquired fully (and naturally) respond to current global policies that strongly push us toward developing the use of Liquefied Natural Gas (LNG) in order to significantly reduce pollution caused by combustion of raw fuels that are much less refined and more polluting.
Indeed, LNG is the most environmentally friendly fossil fuel in the world. For the shipbuilding industry, the use of LNG represents the adoption of the most innovative propulsion technology.

The new generation of textile expansion joints have a 100% degree of reliability compared to the originally-requested warranty terms

Technological change, strongly oriented towards the protection of the environment, among other things, will make it possible to travel by ship without being accompanied by the unpleasant smell of exhaust gases.
In addition, textile expansion joints, as an alternative to metal ones, guarantee a better level of silence and, depending on the application, can lighten lines where they are installed. This last factor is of great importance, given that the size of new ships is constantly increasing.

Stefano Boni

Stefano Boni, Director of the R&D Production Department of Gruppo BBV.
He joined Alflex S.r.l. in the early 1980's and was an active part of the team that brought the technology of planning and production of fabric expansion joints from the U.S.A. to Italy. Later, he became Head of the Technical Office at Alflex – Expansion Joints S.r.l. and worked on all the "in house" research and development projects as well as those jointly conducted with American industrial partners. With the acquisition of Alflex-CDD by BBV Tech S.r.l. and the birth of Gruppo BBV, he acquired his present function.

Luigi Valfrè

Luigi Valfrè collaborates with Gruppo BBV in the revision and industrialization of internal processes inherent in technical functions, production lines and research and development.
He graduated in engineering at the University of Genova.
He has over 25 years of experience in the design and installation of industrial and power plants with ABB, where he had a variety of responsibilities, among which were Director of the Business Unit and Country Manager in Algeria. He is the coauthor of various technical articles published in CIGRE and CIRED.