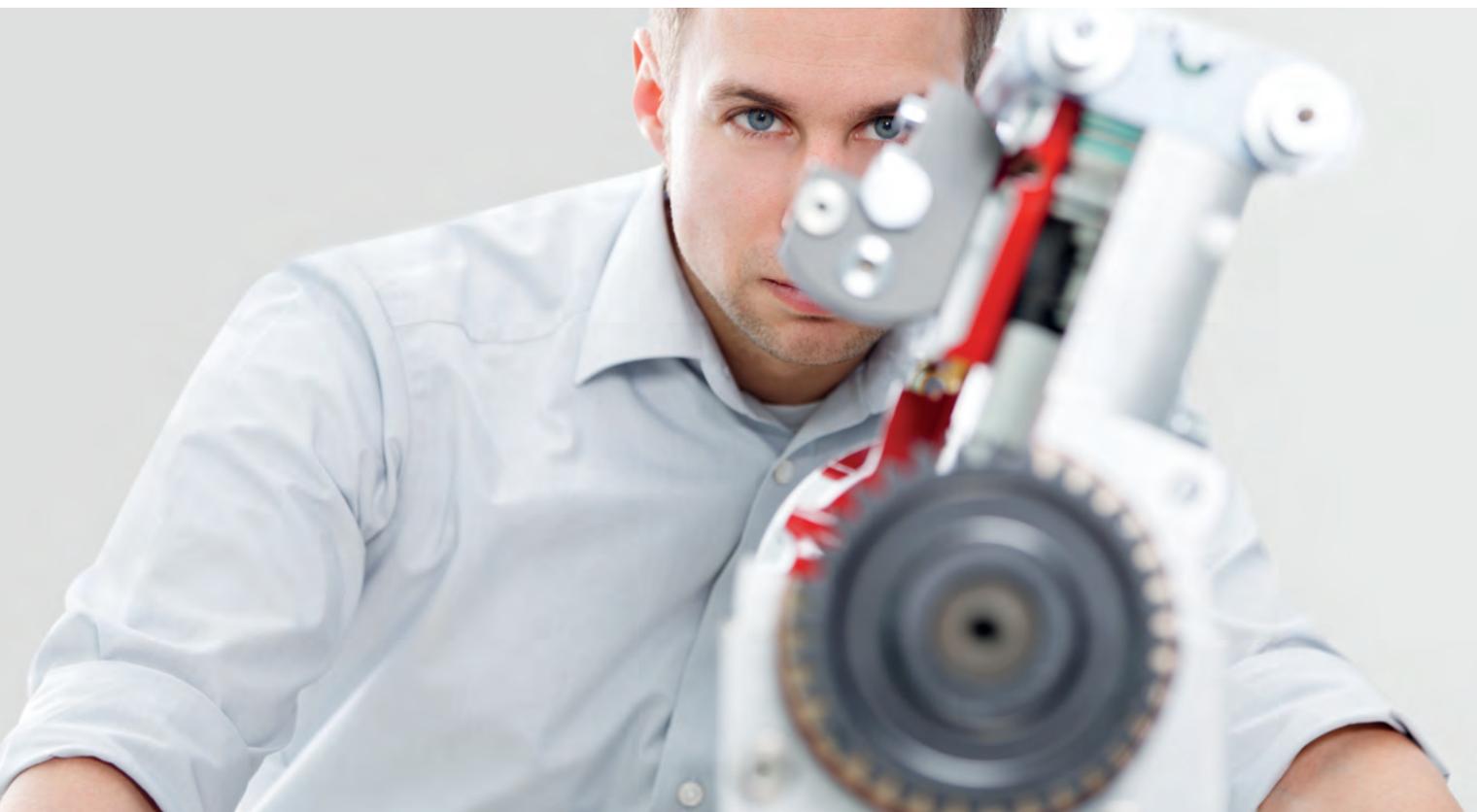


## Focusing on the Best Solution: Core Competencies at L'Orange.



\_\_\_\_\_ process management

\_\_\_\_\_ product development

\_\_\_\_\_ production and assembly

\_\_\_\_\_ quality assurance



## Rely on Our Strengths.

The core competencies of any company are key to its success. A strong commitment to steadily developing our strengths is a fundamental part of our corporate culture. Based on these competencies, we develop and produce pioneering injection system solutions for large engines. We've been delivering tangible customer-benefit for more than 80 years. With numerous technological and manufacturing innovations to our credit, we make an outstandingly strong partner. We actively support customers around the globe from the conceptualization phase to series production throughout the product life-cycle with our four fields of competency:

- \_ Process management
- \_ Product development
- \_ Production and assembly
- \_ Quality assurance

World-leading engine manufacturers place their trust in us. And you can rely on our services as well. We're more than happy to partner you along the way because, to us, a project is more than just the sum of the individual services we offer.

When you've been serving the shipping industry for a good 80 years  
**you know all the requirements for reliable performance**

# 01

## process management

Our aim is to offer faithful cooperation and perfect service to ensure that first-class products achieve their full potential. Key factors to our success are:

- Innovative edge
- Customizing
- Product and development optimization
- Life-cycle management
- Development and system partnerships
- Internationality

# 02

## product development

Experience, know-how and innovative capability are the cornerstones for the successful development of our products. These skills are key to developing leading-edge concepts and products.

- Generating and handling high pressures
- Platform and family concept
- Product qualification processes
- Prototype production and testing
- Measuring technology and simulation
- Failure analysis and materials expertise
- Fundamental research and development
- Profitability analysis



### our core competencies for your success

# 04

## quality assurance

Demanding great precision, fuel injection is one of the more complex processes involved in drive technology. We assure the highest quality standards in all phases of development and manufacturing to ensure that this process is repeated time and again with the same pinpoint accuracy in every combustion cycle. Our comprehensive management system is backed up by state-of-the-art measuring and testing techniques:

- Integrated management system
- Supplier management
- Purity and media analyses
- Product acceptance, distributor qualification
- Complaint management
- Measuring technology

# 03

## production and assembly

80 years of experience encompassing a widely-diversified range of manufacturing processes is your guarantee of optimum production results. Our experts are on hand to support your manufacturing process by assisting in the following areas:

- Production technology
- Product planning and manufacturing processes
- LEAN strategy
- Materials know-how
- Assembly processes
- Process engineering



## process management

### New ideas developed by teamworking **experts from all fields**

From the initial concept right through to production support, the product life-cycle can only be managed successfully when an experienced team of qualified experts work hand in hand. Cooperating closely with you to create complete system solutions in line with market requirements.



## Innovative edge

Our core line of business is based on the growing worldwide demand for enhanced performance in large engines. We continuously strive to push back the frontiers of technical feasibility in the field of fuel injection. Change and adaptation are routine in the dynamic market for large engines. This leads to new insights which enable us to develop the technology of the future for the market of tomorrow.

## Customizing

Extensive knowledge of target groups and markets is prerequisite to economic success. Our outstanding track record in niche markets with low-volume series speaks for itself. Successfully operating in markets which pose high demands on customizing and call for bespoke solutions is one of our great strengths at L'Orange.

## Product and development optimization

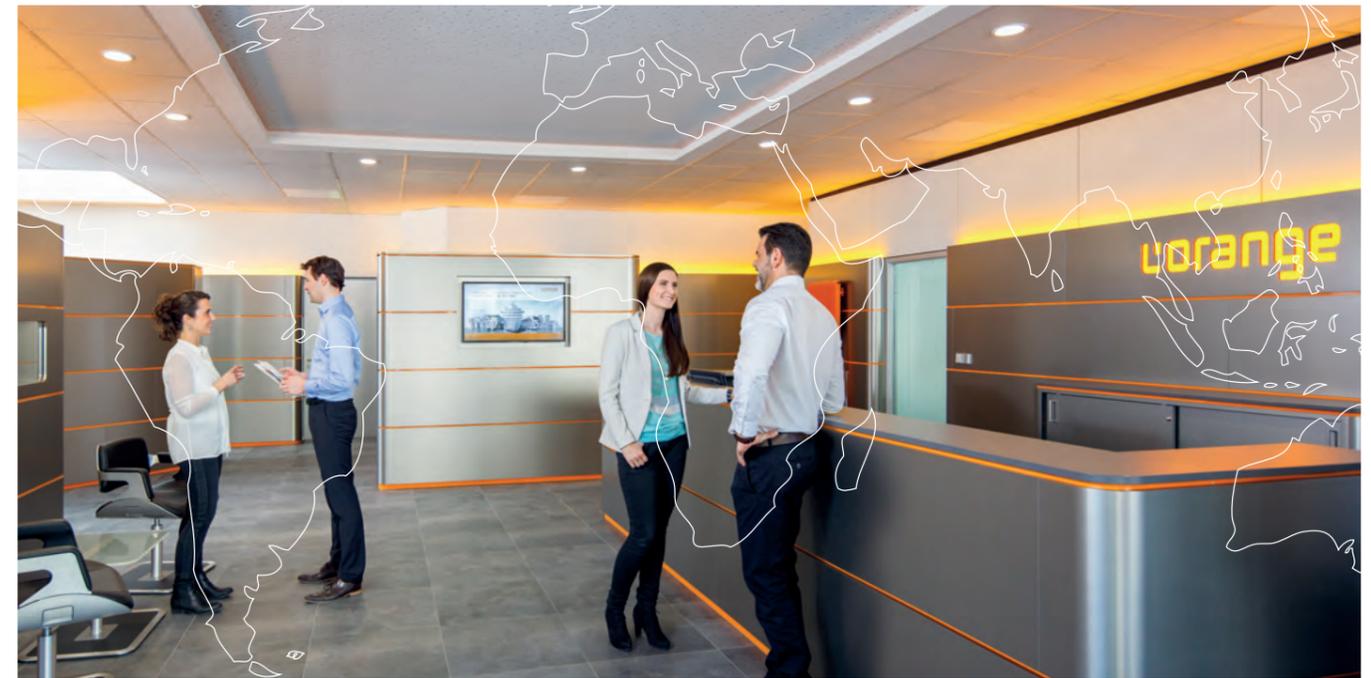
Time isn't just money, it can give you a significant commercial advantage. That's why we never stop streamlining our planning, development and production processes. Initiating and successfully validating a new product concept, and attaining series-production maturity in the space of two short years is just routine business for us these days. And that goes for projects in a complex technological environment as well. Specialist suppliers and premium materials play a crucial role in our high-tech manufacturing processes. All these factors contribute to expediting product launch to give our partners a head-start on the market.



From vision to series maturity with experience and innovative power



The product is our mutual success: you set the task, we provide the solution



Global availability, innovative capability and continuous dialog determine your market success

## Life-cycle management

Fuel injection components have to meet the highest standards if they are to operate reliably in extreme environments. Technological support well beyond delivery, comprising maintenance, repair and spare parts services, is a matter of course.

## Development and system partnerships

We also cooperate closely with partners in all the relevant fields of technology. These include universities and colleges, as well as highly-specialized companies at home and abroad. The transfer of knowledge is an important offshoot of these cooperations, which enables us to develop new products meeting specific criteria for quality, functionality, longevity and economy.

## Internationality

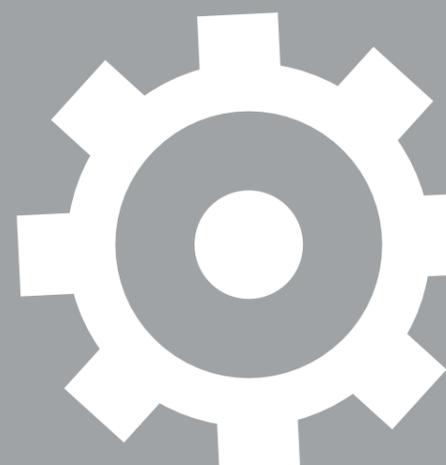
L'Orange keeps close ties with its customers to secure success on both sides. And our understanding of customer orientation goes well beyond the services provided at our bases around the world. We also maintain an international network of companies and distributors enabling us to respond rapidly and directly. Partnered by L'Orange experts, these companies round off the service & support we offer close at hand.



## product development

### Bespoke solutions are our standard

In cooperating closely with our customers we follow the common goal of realizing a system at the pinnacle of performance. We coordinate each step of the way and every milestone in this creative and technologically challenging development process. At the end of the road, our components and systems help you create products capable of maintaining that decisive lead in technology and efficiency.



## Generating and handling high pressures

Generating and handling pressures as high as 3,000 bar places high technological demands upon the materials used, and on the pumps, metering valves, piping and safety components involved. We develop and produce these components for you, and ensure that they work reliably in the microsecond range, delivering quantities of just a few mm<sup>3</sup> with highest precision and stability.

## Platform and family concept

Our range of products is as widely diversified as the needs of our customers. And quick solutions, which are reliable and cost-effective at the same time, are the order of the day. A strategy based on platform and family concepts has proven to be best approach. It doesn't just fulfill all the aforementioned criteria, it also allows us to offer the full scope of distinct specifications our customers need.

## Product qualification processes

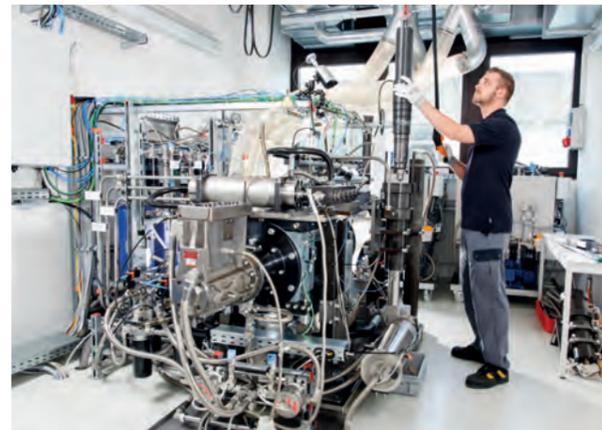
Our products pass through a series of intensive qualification processes to make sure your system is mature in all respects. These include verifying agreed performance data, computer-aided simulation, practical validation and rigorous endurance testing. We never approve series production until all the results meet our high quality standards.

## Prototype production and testing

High-quality, powerful new injection systems can only be realized by the perfect interplay of each and every mechanical and electronic component part. We can build and test prototypes in the various stages of development to steadily optimize this interaction. Before approving series production, we verify all performance data and quality characteristics in an elaborate sequence of practical trials and endurance tests on specifically developed test stands.



At 7,000 frames per second, high-speed image analysis reveals even the tiniest deviation in dynamic processes



Compulsory program for any product: highly-specialized test stands simulate the demands of practical use

## Measuring technology and simulation

The highly specialized testing and measuring equipment we need to meet our quality standards is not available off-the-shelf. So we go ahead and just design and build it ourselves. This allows us to realistically measure pressures, temperatures, motion sequences, forces and mechanical loading in the micron range, and compare the results with our simulations. Hydraulic calculations, backed up by meticulous CFD analyses and FEM strength calculations, help us optimize the features of the system and scale its component parts to best advantage. Findings on wear make it possible to accurately predict life expectancy. For this very reason, we analyze and evaluate even minor indications of wear-and-tear noted in practical use.

## Failure analysis and materials expertise

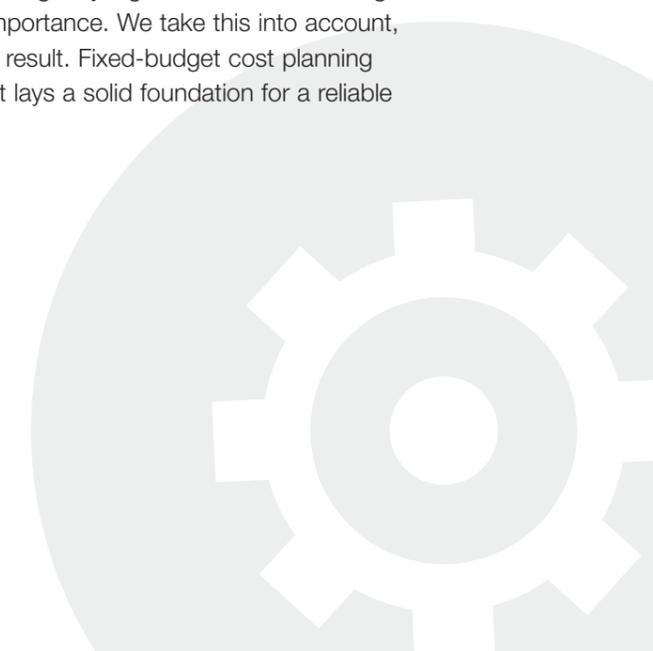
We systematically underpin experimental research with extensive failure analysis techniques. A profound understanding of material properties plays a pivotal role in this. We investigate any failure by means of scanning electron microscopy or computer tomography using our own state-of-the-art equipment. The findings and feedback we gain in this way also help us to take targeted steps to continuously improve our systems.

## Fundamental research and development

We are nationally and internationally networked with successful, specialized companies and institutions which assist us in implementing new concepts thereby contributing to our innovative power. We also engage in university and college research projects to make sure the latest knowledge is soon put to practical use.

## Profitability analysis

Developing any new product generally involves shouldering very high initial costs. Planning certainty for project expenditure is therefore of great importance. We take this into account, and are very mindful of cost-efficiency in all areas as a result. Fixed-budget cost planning for the system development process is our standard. It lays a solid foundation for a reliable efficiency analysis of the overall development.





## production and assembly

### Near-zero tolerances. **As a series-standard.**

Designing a high-precision injection system and seeing it through to the prototype stage is one thing. Perpetuating such precision in series production is quite another. A thousandth of a millimeter is decisive for performance and endurance – the two main reasons why you should be choosing our products.



## Production technology

Injection systems are extremely sophisticated products. They integrate mechanical components and an electronic control system, which in turn interacts with the electronic engine management system. To offer you these systems in consistently high quality, we only ever manufacture those components where a thousandth of a millimeter makes a big difference ourselves. As a result, we gain great depth of production incorporating all the metrology needed to guarantee us – and you – 100% dependability.

## Product planning and manufacturing processes

Increasingly demanding market requirements call for the introduction of new procedures which we dovetail into our ongoing manufacturing processes as needed. Our own hardening shop with its versatile heat-treatment facilities is a prime example of this. And we naturally follow a LEAN strategy to make certain that our high-grade products are commercially viable to manufacture as well. This allows us to systematically enhance our production processes at a marketable price.

## LEAN strategy

Value stream design methodology determines the ability of an enterprise to respond more quickly and flexibly to the wishes of its customers. This has always been a matter of great importance to us, and we address it by applying process chain management to all our logistics operations in a company-wide optimizing process. This involves determining the best possible solution for the system as a whole, while carefully reconciling the diverging interests of the various stakeholders. The benefit of all this to you as a customer is a faster, more flexible response to your needs.



Intelligent use of automation technology assures consistent quality every step of the way



Clean-room assembly protects highly sensitive products from contamination

## Materials know-how

Decades of experience using a wide variety of materials in manufacturing the component parts of our systems allows us to specify and select materials according to our own in-house standards. We scrutinize metallurgical structure and hardness profiles using a scanning electron microscope in our metallography laboratory, just for example. Spectrometric analysis and microload testing are other indispensable methods we use to safeguard material quality.

## Assembly processes

Manufacturing and assembling components with tolerances in the micron range requires special procedures to reliably manage the complex processes involved in serial production. Highly-qualified staff, clean-room assembly and 100%-testing of each and every system on our function test stands ensure flawless quality.

## Process engineering

Based on years of experience with highly diverse production processes, we can offer you qualified support in using a wide range of process technologies. In addition to standard processes such as lathing, milling, hard turning and grinding, we've also mastered special processes for series, small batch and prototype applications (niche production):

- **Autofrettage:** up to 10,000 bar
- **Low-pressure carburizing/hardening:** case depth  $\leq 1.2$  mm; batch weight  $\leq 800$  kg
- **Laser welding for axially symmetrical parts:** laser power  $\leq 2000$  W
- **5-axis composite machining:** cutting fluid oil
- **Deep-hole drilling:** diameter/length ratio 1:80; surfaces with roughness depth  $< R_t 10\mu\text{m}$
- **Injector bore EDM:**  $\varnothing 0.05 - 1$  mm; to K factor 7
- **Flow grinding:** flow rates at Q100, 0.2 – 50 l/min
- **Precision machining of sealing surfaces:** def. contouring of plane faces, 0 – 10 $\mu\text{m}$



## quality assurance

### Quality: more than just a superficial interest

Creating top quality is a mission which defines every stage of the entire product engineering process. It takes the right test facilities run by the right people with the right attitude. Only the very highest quality leaves our gates. There's no other way of gaining and keeping your trust. To keep this promise we apply well-aimed means and measures with a persistence which is most likely unparalleled in the industry.

## Integrated management system

We achieve excellence in all corporate sectors using an integrated management system. Product quality, environmental compatibility, health and safety at work, and the conservation of energy resources are all parts of this system. They are certified on an annual basis keeping a close eye on compliance.

## Supplier management

We assist our suppliers in meeting the quality criteria we insist on in order to meet the quality requirements we set ourselves. Highly-trained quality-assurance engineers implement this proactive, multi-level supplier development policy. A modern CAQ system helps us to evaluate supplier performance at regular intervals.

## Purity and media analyses

Our laboratory conducts purity analyses to establish technical cleanliness as per VDA vol. 19 and monitors cleaning facilities, cutting fluids and cleaning agents as an essential part of quality management.

## Product acceptance, distributor qualification

When it comes to acceptance, we naturally observe all the relevant rules and regulations, e.g. of classification societies for marine applications, or the German Federal Motor Vehicle Authority (KBA) when seeking approval for clients in the automotive industry. And we'll happily comply with your own acceptance procedures as well. We also encourage our distributors around the world to provide quality in service and support coupled with expert guidance. Which is why we routinely review their activities by performing audits at regular intervals.



Purity and media analyses are conducted in the laboratory parallel to the process



The white light interference microscope checks surface roughness, planarity and surface contour with an accuracy to 13 nm

## Complaint management

We use an integral CAQ system featuring an ERP interface to address any complaints. Centralized response management, incorporating progress monitoring and failure analysis, controls fast and efficient complaint handling. Should you have any cause for complaint, we will deal with it swiftly and to your complete satisfaction.

## Measuring technology

Consistently tight tolerances in the micron range can only be achieved using highly-developed testing and measuring methods. That's why our modern test facilities conform with VDI/VDE 2627, grade 3, with a temperature change over time of max. 1°C/1h. The laboratories are equipped with 3D multi-sensor coordinate measuring equipment, CT scanner, white light interferometer etc.

### ■ Tactile, optical measuring technology and airflow measuring technology

We use state-of-the-art tactile, optical and airflow measuring systems offering a measuring accuracy of below 1.5µm on average in an air-conditioned test room in line with VDI/VDE 2627 requirements.

### ■ White light interference microscopy

This measuring system offers guaranteed accuracy to 13nm for surface roughness, contour and planarity. Surface structures are well visualized to clearly reveal any deviations from the ideal geometry.

### ■ Computer tomography

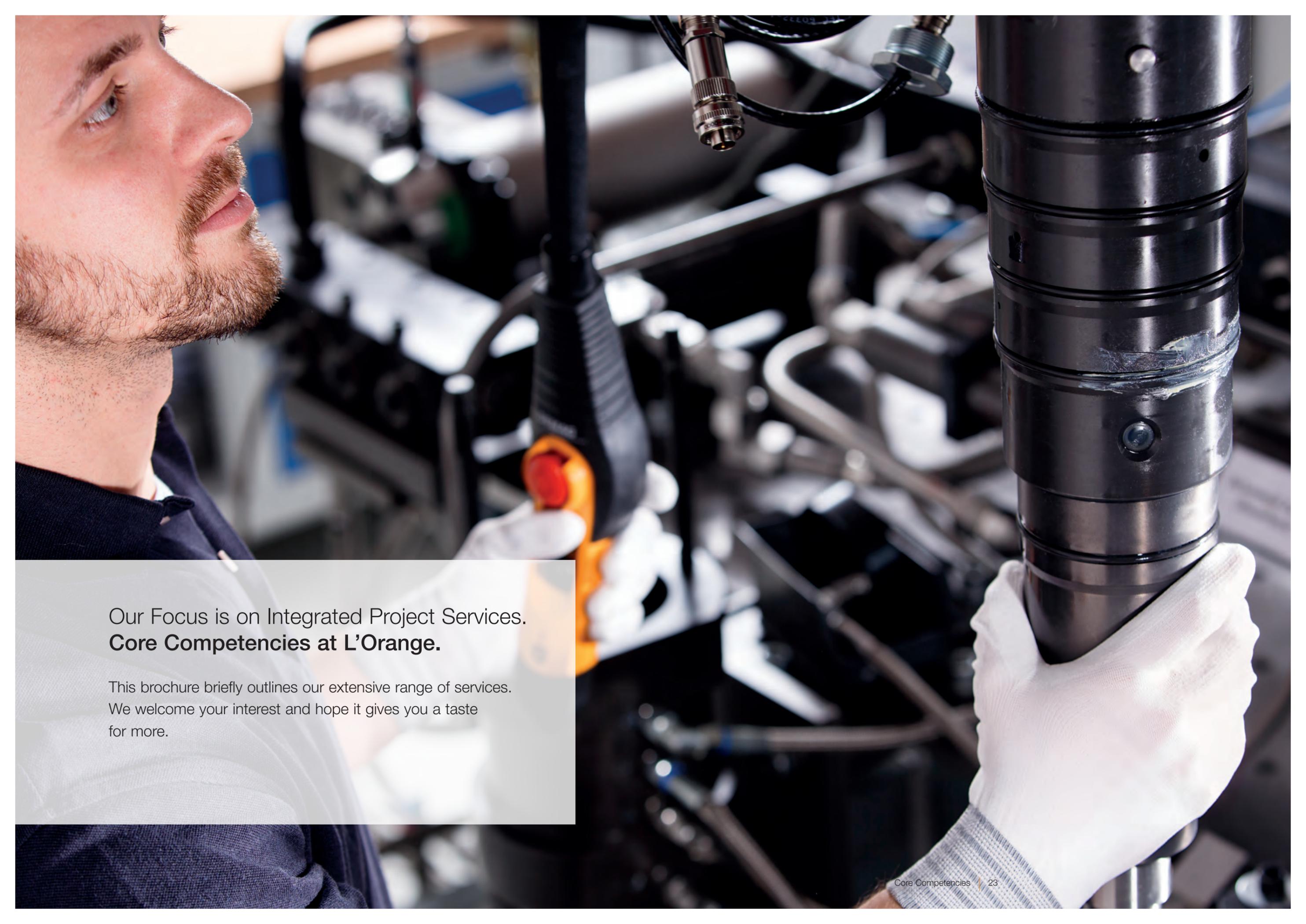
We measure complex, three-dimensional interior geometries using non-contact X-ray technology. High-resolution visualization penetrating material through to 20 mm takes measurements which are accurate to 4.5 µm. The ability to relate tomographic measuring results to tactile measurements is of great significance.

### ■ Function testing

We subject each and every system, and all its component parts, to 100%-testing for satisfactory functionality. All the relevant parameters are monitored and documented by special test programs on test stands which have been specifically designed to meet the high standards we require. When you take receipt of one of our systems you can be certain it will be absolutely flawless.

### ■ Hydraulic test stand testing

Our hydraulic test stands generate pressures of up to 3,000 bar handling injection quantities ranging between 10 and 50,000 mm<sup>3</sup>/cycle – just one of the many investments we have made to secure our quality policy.



Our Focus is on Integrated Project Services.  
**Core Competencies at L'Orange.**

This brochure briefly outlines our extensive range of services.  
We welcome your interest and hope it gives you a taste  
for more.

## L'Orange – **Your Reliable Partner**

Challenge us – our experts will find the best possible solution.  
Contact the L'Orange Service Team for more information about  
our competencies and how you can benefit from them.

We look forward to hearing from you.

Email: [innovation@lorange.com](mailto:innovation@lorange.com)

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