

A SOURCE OF PERMANENT INNOVATION:

DEVELOPMENT AT WOODWARD L'ORANGE

ACHIEVING PEAK PERFORMANCE AND MAXIMUM EMISSIONS REDUCTION: OUR DEVELOPMENT PUTS THE CUSTOMER IN THE FOREGROUND

One of the main challenges facing engine manufacturers is that of increasingly stringent emissions legislation. Injection systems need to fulfil three key requirements: reduced exhaust and noise emissions, reduced fuel consumption and a longer service life. And these are all actively pursued with our innovations. Our customers' specifications represent the platform upon which Woodward L'Orange initiates and develops solutions.

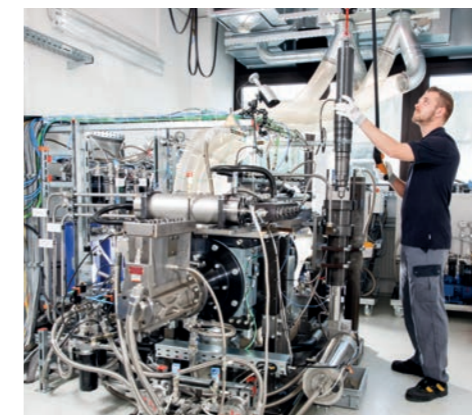
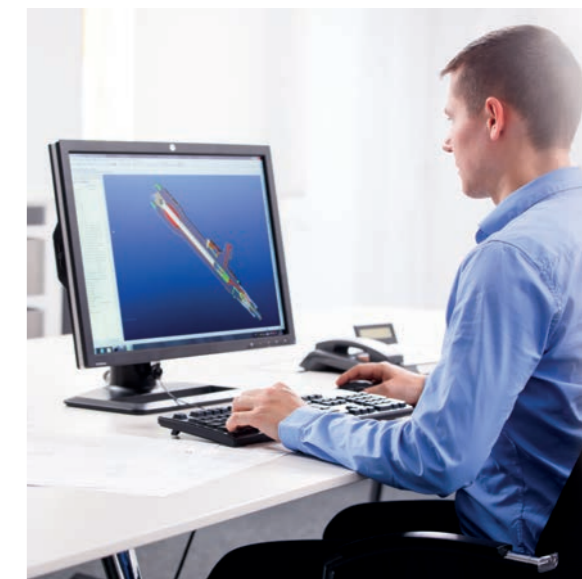
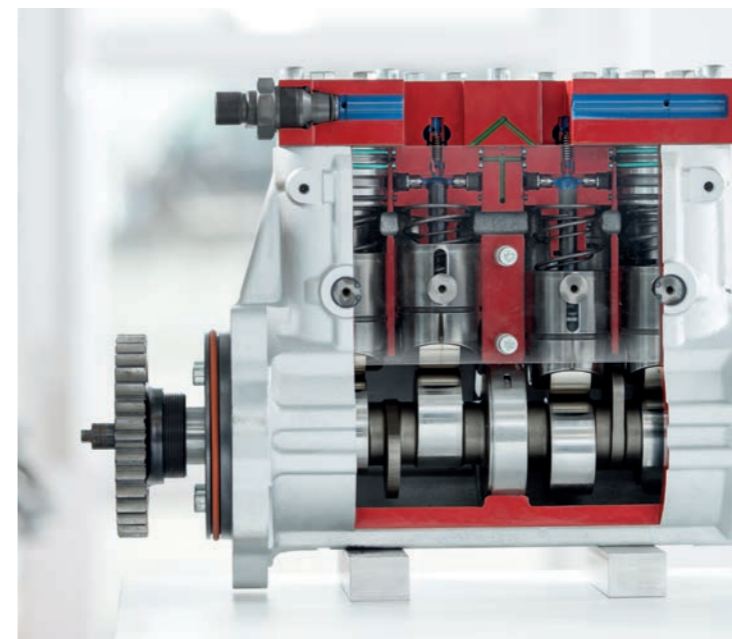
Being the innovation leader in this area has been a long-standing tradition. As world market leader, the organization is well known for its consistent orientation and focus. Each and every injection system developed by our engineers serves these three objectives. And their success is due in part to a clear focus on high injection pressures of over 2,500 bar and highly accurate multiple injection with an optimized focus on engine combustion. Precisely defined and implemented development processes lead us to the best results in all three areas. This is how we guarantee quick, cost-effective and high-quality implementation of our projects.

In order to develop increasingly powerful injection systems and to finetune them through to series production, new developments run through clear process steps, and throughout we involve our specialists with their broad range of varied skills. The close interaction of all functional areas, together with global and local closeness to the

customer, guarantee efficient work of the highest quality. At Woodward L'Orange, technological development spans the entire process from the first idea to pre-development, design and analytics, all the way through to testing. We use state-of-the-art design and simulation tools to assess a design's desired characteristics early on, before initiating extensive and costly testing. Most load and stress situations can be simulated with the computer quite realistically.

The close collaboration between design and testing with analytics and simulation guarantees ideal product design – making use of finite element analysis, hydraulic and flow simulation as well as programmes to optimize engine dynamics. A further example of our specialized development expertise is the spray diagnostic capability. During testing without combustion, spray patterns of the nozzles can be visualized. These injection images provide accurate information on the quality and fineness of fuel atomisation – a requisite for the optimal combustion achieved with our injection systems.

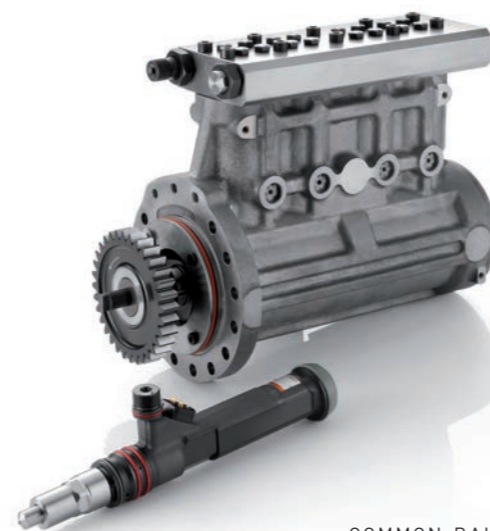
And finally, through the very close collaboration between suppliers and the various production areas at Woodward L'Orange, we can proceed quickly from prototypes to series production.



OUR GOAL IS TO SET NEW STANDARDS – AGAIN AND AGAIN – IN TERMS OF QUALITY, DURABILITY, FUEL CONSUMPTION AND EMISSIONS.



PUMP-LINE-NOZZLE SYSTEMS



COMMON-RAIL SYSTEMS



HFO COMMON-RAIL SYSTEMS

FROM CONSISTENTLY RUN DEVELOPMENT PROCESSES THROUGH TO PROGRAMMED MARKET SUCCESS

All development teams are in ongoing contact with each other, to ensure system conformity with predefined performance specifications. On over 26 functional and endurance test benches developed in-house, a new system's functions are put to the test, while endurance runs provide additional certainty against breakdown or wear. The next step is system validation at the customer's location on test engines and field-trial engines. Over and above our development teams and tools, standard process-supporting methods such as FMEA and risk analysis are deployed as well. The development results are safeguarded through seven Quality Gates, which need to be passed before a system can enter series production.



Our customers and their users know they can always count on optimally developed and finely tuned products of the highest quality. And we consistently honor the high expectations placed on Woodward L'Orange, as proven market leader, with our exceptional standard of development.

DEVELOPMENT ADVANTAGES YOU'LL BENEFIT FROM:

- State-of-the-art 3D design and simulation tools
- Proven reliability in multiple fuel type and multiple field applications
- Leading technology in the large engine field
- Many years of expertise using our in-house test stands
- Most advanced measuring technology available
- Spray diagnostic capability in the "cold chamber"
- Expertise through collaboration with universities and research projects



Images: deutsche CGI, Fröhner Photography, iStockphoto
All trademarks referenced herein, including Woodward and the Woodward logo, are registered trademarks of Woodward, Inc. or its subsidiaries

ALWAYS INNOVATING FOR A BETTER FUTURE

Woodward, Inc.
Corporate Headquarters
1081 Woodward Way, Fort Collins Colorado 80524, USA
www.woodward.com

Woodward L'Orange GmbH
Porschestraße 8, 70435 Stuttgart, Germany
sales.lorange@woodward.com
www.woodward.com/wlo

10/21 . IVS . 500

THIS PRODUCT IS PRINTED ON 100% RECYCLED MATERIAL.