



Quality guaranteed!

Quality and environmental management

BÖLLHOFF

Quality management as a key feature of our company profile



Michael W. Böllhoff and Wilhelm A. Böllhoff
Managing Partners

Making what's already good even better in a continual, sustainable process – that's our definition of "quality".

In the Böllhoff Group, the aspects of occupational safety and health protection, environmental and quality management and our continuous improvement management with the Optimized Böllhoff System (OBS) come together in an integrated quality management system (IQM).

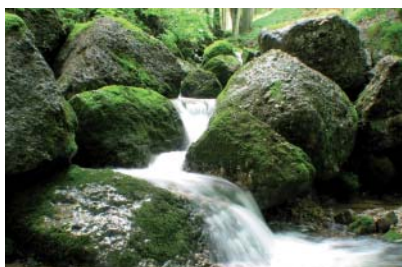
We want to reach several goals with one consistent logical and systematic approach: economical and ecological success based on the highest product quality, optimum processes and the greatest possible occupational health and safety protection.

We are pleased to provide you with an overview of our integrated quality management system on the following pages. Your feedback in this regard is important to us, whether in terms of our cooperation or in an audit. Your ideas help us improve continuously.

With our best wishes,

Michael W. Böllhoff

Wilhelm A. Böllhoff



Highest product and process quality

Fulfilling the quality specifications of our customers – high as they may be – has always been particularly important to us.

Böllhoff has always been among those companies which see customer-specific requirements as a challenge and have always been certified to the latest specifications in quality and environmental management. Our customers benefit directly from the resulting continuous improvements.

Böllhoff was among the first companies to be successfully certified to **ISO/TS 16949** – the world's highest standard for the automotive industry. Böllhoff has its own accredited test laboratory certified to **DIN EN ISO/IEC 17025** and the company is certified to **DIN EN ISO/IEC 14001**, further proof of our strong commitment to quality and the environment. These certifications attest to the highly competent testing of our products and our environmentally conscious actions that protect resources.



Extensive certification

- 1993** → Certification to **DIN EN ISO 9001**
- 1997** → One of the first companies in Germany to be certified to **QS 9000**
- 1998** → Laboratory accreditation to **ISO/IEC Guide 25**
- 1999** → Certification to **DIN EN ISO 14001** demonstrates Böllhoff's green policy of conserving resources
- 2003** → Certification to **TS 16949**, the world's highest standard in the automotive industry
 - Certification to **EN 9100**, the standard for the aerospace industry
 - Laboratory accreditation to **DIN EN ISO/IEC 17025**
- 2006** → Certification to **IRIS** (International Railway Industry Standard)
- 2014** → Planned certification of our energy management system to **ISO 50001**

Quality from day one



We don't leave good quality to chance – at Böllhoff it is systematically planned. Interdisciplinary teams working very closely with customers ensure advance quality planning for all new processes and products. We define measurable objectives for all areas of activity, involving all members of staff.

These target agreements are based on customer expectations and are redefined each year because yesterday's benchmarks are often not sufficient for new applications.

Thanks to systematic process control and continual improvement in all areas we can edge closer and closer to the ideal of the zero defect philosophy.

In 2003 the ISO/TS 16949:2002 quality management system was successfully implemented throughout the whole company. The certification testifies to the fact that Böllhoff has introduced and implements a quality management system (QM system) with the following features:

- Customer orientation
- Customer satisfaction
- Defect prevention instead of defect correction
- Zero-defect philosophy
- Continuous improvement
- Separate customer representative
- Involvement of all employees in all business processes
- Accredited test laboratory conforming to DIN EN ISO/IEC 17025

We work to
**ISO/TS
16949**



Qualified suppliers and incoming goods and material inspection

The first important step for ensuring the highest quality specifications is selecting suitable suppliers for raw material, semi-finished products and fasteners.

Long-term partnerships with suppliers is our guarantee of our products' safety and reliability. In clearly defined audits we regularly check that all processes are being adhered to on site at our suppliers.

New suppliers must undergo a multi-stage qualification procedure before being authorised as a vendor.

Site visits to supplier facilities play an important part in this process. We like to inspect manufacturing processes, quality management, process reliability and test equipment in person, on site.

If first impressions are positive we then perform tests and controls on various trial deliveries. Only if all trial deliveries have passed our technical incoming goods inspection without any discrepancies, the supplier will be approved and incorporated into our QM rating system.

This means that we are enabled to exempt our customer from the duty of technical incoming goods inspection as per HGB [German Commercial Code] § 378. Not only does this reduce quality inspection costs for our customers, it also accelerates the internal flow of goods.

Reliable production thanks to preventive quality management planning of processes and products

Before production, an interdisciplinary team systematically plans and specifies all the production, assembly and test processes which could have an effect on the quality of manufactured components or environmental factors.

We implement the following processes in this respect:

- | | |
|---|-----------------------------------|
| ■ Failure mode and effect analysis (FMEA) | ■ Creation of QM inspection plans |
| ■ Initial environmental assessment | ■ Machine capability studies |
| ■ Preparation of detailed Production and work plans | ■ Process capability studies |
| | ■ Preventative maintenance |

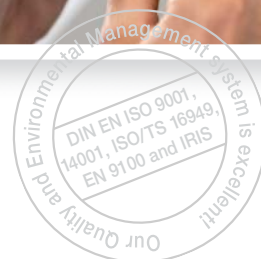
Specially trained employees check day-to-day production at SPC measuring stations using detailed inspection plans and strict specifications. At the customer's request we also perform an additional 100 % check using state-of-the-art digital technology.

Clearly defined quality standards implemented by expert, committed employees

The success of our business depends on the quality of our products, the performance of our staff and consequently, the satisfaction of our customers. Our process-oriented quality management system is based on this principle.

Our employees are expert, motivated and well trained. They receive regular further training as part of their on-going commitment to fulfilling the quality specifications of our customers day in, day out.

Our products must be just as reliable when used in a household appliance as in a car or for the aerospace industry. Maximum product and service quality is therefore a matter of course for us.



Worldwide production

As an international leader for fastening and assembly technology, the Böllhoff Group is present in all major markets.

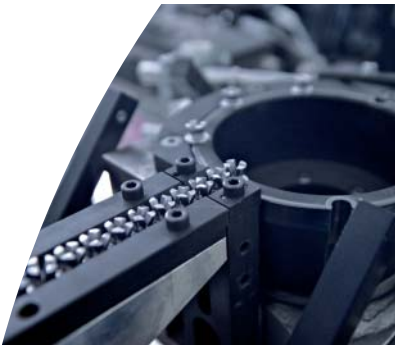
With its innovative products and assembly systems, Böllhoff is constantly expanding its range for its customers in existing and new markets.

Böllhoff has its own production facilities on five continents. Our production range includes plastic injection moulding technology, coiling of thread inserts, the production of thread inserts, the manufacture of sealing nuts as well as blind rivet and self-piercing rivet elements. Other key areas include the development and production of self-piercing rivet and screw systems and systems and elements for high-speed joining.

All manufacturing processes are certified to current quality and environmental standards. Our international company philosophy, "always better than the standard" with the aim of achieving "zero defects" is the foundation of the high quality of our products and ultimately contributes to our customers' quality.

5 continents
41 companies
23 countries
37 sites
2.300 employees





Böllhoff quality



Böllhoff's technical test laboratory has been certified by the German accreditation body, DAkkS, under D-PL-18304-01-00.

Test procedures accredited to DIN EN ISO 17025:

- Mechanical-technical testing
- Metallographic testing
- Surface and dimensional testing of fasteners made from metal materials
- Spark emission spectrometry of low and high alloy steels
- Salt spray testing

The test procedures in our technical test laboratory are accredited in accordance with the guidelines of DIN EN ISO/IEC 17025.

State-of-the-art measuring and test equipment forms the basis for reliable quality assurance and perfect product quality.

Our services in the area of fastening technology include:

- Testing mechanical values
- Testing physical values
- Chemical material analyses
- Corrosion testing
- Dimension measurement
- Damage inspections
- Manufacture of prototypes
- Individual customer seminars, also at the customer's company

In the event of particularly complex, out of the ordinary challenges, our customers benefit from our close cooperation with colleges and universities.



Test methods at a glance

Mechanical-technological testing

- Tensile strength and compression testing up to 400 kN test force
 - Tensile testing of finished bolts and screws
 - Tensile testing of wires
 - Component tensile testing / thread inserts / machined tensile specimens
 - Tensile testing of wires at elevated temperature
 - Tensile testing under wedge loading of finished bolts and screws
 - Proof load testing of nuts
- Hardness testing
 - Preparation for hardness testing
 - Hardness testing according to Vickers (HV 10, HV 30)
 - Microhardness according to Vickers (HV 0.2, HV 0.3), surface hardness, case hardening depth
- Screwing tests
 - Torque, angle of rotation, preload force / single measurements / 15 cycle screw fastening, stripping torque, breaking torque
- Friction analysis*
 - Friction coefficient investigation μ_{total} , μ_{head} and μ_{thread}
- Metallography
 - Microscopic testing, microsection (microstructure, purity, carbonisation state) determination of carbonisation state by hardness testing
- Surface discontinuity inspection
 - Determination of surface condition (surface defects, geometrical testing)
- Sealing tests*
- Cleanliness testing*
- Fatigue testing up to 150 kN \pm 75kN*
 - Wöhler curve, dynamic strength (fatigue)
- Damage inspection*
 - Analysis of the fracture structure, clarification of the cause of damage

Physical tests

- Coating thickness measurement – X-ray fluorescence analysis
 - Non-destructive testing of coating thickness
- Optical emission spectroscopy (OES)
 - Spectrum analysis Fe, Al, Cu-Zn, Cu-Sn, Ni
- Dimensional testing and accuracy to gauge
 - Thread testing, length measurement, geometric and visual testing

Chemical testing

- Corrosion testing
 - Salt spray testing using sodium chloride solutions (DIN EN ISO 9227)
- Alternating climate test*
 - (-70 ... 180 °C, 10 ... 98 % rel. humidity)
- Chrome VI content testing of surface coatings*

Preparation of mechanical samples / preparation / Test rig and equipment

- Sawing, turning, milling, drilling, grinding

Sampling of joints*

- Selection of joining parameters, in-situ testing, microsection preparation and evaluation, tensile testing of riveted sheets

* non-accredited procedure

Quality guaranteed



Dr.-Ing. Jens Bunte
Member of the board of management.
Product Safety Officer of the Böllhoff
Group



Dr.-Ing. Jens Bunte

Product safety is our top priority at the Böllhoff Group.

Products of the Böllhoff Group are designed to fulfil and exceed our customers' expectations with regard to innovation, quality and safety.

The basis for this is the development, production and procurement of fasteners and processing systems, whereby the engineers of the Böllhoff Group and its suppliers are responsible for achieving our ambitious objectives.



High-performance quality assurance

Our technical test laboratories are specialized in testing fasteners according to standards. We use the most advanced devices and measuring technology to inspect our own fasteners and those of other suppliers for existing and new applications. Well trained employees generate detailed inspection reports that our customers use as documentation and for decision making purposes. In cooperation with our customers, we develop new solutions with fastener technology and test these solutions in conditions found in practice.

Measuring and testing equipment

Tensile and compression testing machine 400 kN (40 t)

Tensile testing to **DIN EN 10002-1** and **DIN EN ISO 6892-1**

Examples:

- Testing of screws up to M24.
Tensile test (under wedge loading)
testing in accordance with
DIN EN ISO 898-1.
- Tensile testing of thin wire samples
- Shear, peel and cross tension
testing of riveted sheets
- Nut proof load test up to M24
according to DIN EN 20898-2
and DIN EN ISO 898-6 (class 6)
- Pull-out and push-out testing
for thread inserts



Universal hardness tester for hardness testing according to Vickers HV 0.1 - HV 30

Hardness profiles:

Can be tested automatically with programmable X-Y-table

Indentation measurement:

Automatically by camera image evaluation or manually on screen

Tests available:

Core hardness, surface hardness, case hardening depth, case hardness



Screw fastening test bench

For investigation of the torque – Angle of rotation – curve, preload forces* and thread and head friction coefficients e.g. friction analysis to DIN EN ISO 16047*, customer standards.

Measuring ranges:

0 to 200 Nm (M 4 – M 16) 20 to 200 rpm
Minimum length of control screws: 30 mm

Sensors:

Torque: up to 5 Nm, 50 Nm, 200 Nm, force: 100 kN 150 Nm

Application:

- Testing of tightening, stripping and breaking torques
- Practice-oriented testing of large components, swivel device allows easy access to screw fastening points
- Programmable test procedure, computer-aided data acquisition, graphical representation, evaluation and data export possible



* non-accredited procedure

Measuring and testing equipment

Optical emission spectroscopy

Proof of chemical elements in metals



Analysis test routines:

- Low-alloy steel (Cr < 5 % and Ni < 5 %)
- High-alloy steel (Cr > 5 % and Ni > 5 %)
- Machining steel (e.g. 11SMnPb30)
- Al-based
- Ni-based
- Cu-based brass
- Cu-based bronze

Programmable material identification

e.g. steel to

- DIN EN ISO 898-1
- DIN EN ISO 898-2
- Special qualities

Coating thickness measurement using X-ray fluorescence analysis to DIN EN ISO 3497



e.g. coating thickness measurement according to DIN EN ISO 4042 and customer standards

Applications:

- | | |
|---------------|--------------------|
| ■ Zn/Fe | ■ Zinc flake |
| ■ Zn/Ni | - Dacromet/Fe |
| ■ Ni/Cu/Fe | - Geomet/Fe |
| ■ Cr/Ni/Cu/Fe | - Delta Tone/Fe |
| | - Delta Protekt/Fe |

Reflected-light microscope type: Zeiss, Axio Imager A1m



Lenses:

50x to 1,000x magnification

Hardware configuration:

CCD colour camera with PC port and evaluation software, connection to DHS image database

Application:

- Determining the carbonisation state of screws
- Failure analysis testing
- Length measurements
- Microstructural analysis, grain size analysis
- Documentation
- Residual contamination analysis

Measuring and testing equipment

Temperature and climate test chamber

Temperature range: -70°C up to +180°C
Test room capacity: 64 litres

Climate test:

Temperature range: +10°C to +95°C
Humidity range: 10 to 98 % relative humidity

Application:

- Preload force losses can be measured under the influence of temperature using the measurement amplifier system with the relevant temperature-resistant force measuring rings.*
- Alternating climate test (corrosion testing)*



Vibration test machine using the Junker test principle

For the dynamic testing of the fastening behaviour of threaded connections to DIN 65151.
Determining the loss of preload force over time following the effect of transverse displacement.

Screw size: M 8 – M 16 x 1.5
Preload force: 0 – 200 kN (ideally approx. 20 kN – 160 kN)
Transverse displacement: max. ± 2 mm (infinitely variable)
Test frequency: 12.5 – 59 Hz



Fatigue testing machine for fatigue testing

For calculating dynamic strength values such as term strength and fatigue strength (Wöhler curves) of screws, riveted sheets and components under alternating or pulsating axial tensile or compressive load e.g. to DIN 969.*

Operating principle: High-frequency resonance testing
Max. static test force: 150 kN
Max. dynamic test force: +/- 75 kN
Frequency: 45–260 Hz
Sample dimensions: Round specimens and screws approx. M 4 – M 16
Flat specimens up to 10 mm thick



Joining technology



Applications:

- Sampling of joints *
- Selection of rivet geometries and parameter settings for specified applications
- Taking customer boundary conditions into account
- Creation of shear, peel and cross tension specimens and prototypes
- Testing of mechanical properties of joints*
 - Cross tension testing
 - Peel tension testing
 - Shear load testing

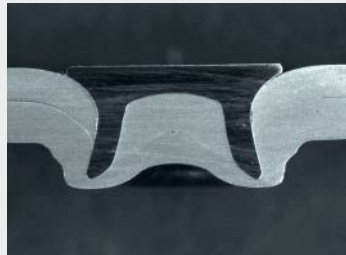


Shear load testing



Peel tension testing

- Testing of cut joints*



Chemical laboratory



Applications:

- Manufacture of metallographic microsections
- Sample preparation
 - Clamping, embedding
 - Cutting
 - Grinding
 - Polishing
- Microstructure development
 - Macroetching
 - Microetching
- Residual contamination testing*
- Verifying that surface layers are free from Cr(VI) *
- Hardening, annealing, tempering (heating furnace up to 1,000°C)

Continuous improvement throughout the company

The Böllhoff Group is always working on the continuous improvement of its products and processes – for the benefit of our customers.

To advance this process systematically, the Optimized Böllhoff Systems (OBS) was created.

Underpinning the OBS concept is our philosophy of supporting our customers right the way along their value-added chain by providing innovative products and services which reflect the best possible quality, performance and value for money.



The objective of OBS is to design production, assembly, logistics and management such that customer requests can be met quickly and efficiently.

Our principles here are:

- Concentration on adding value
- Elimination of waste
- Staff involvement
- Production in accordance with customers' requirements

Specifically, this means that in regularly held workshops our employees standardise testing processes and develop possibilities for reducing assembly time.

We include our suppliers in our improvement measures, to adapt packaging units, optimise internal transport and even reduce packaging costs.

OBS promotes advancement and intensification of improvement management. In the meantime, we implement up to 100 improvement measures, large and small, every month.



Quality standards at Böllhoff

An interview with Klaus Dirkschnieder



Klaus Dirkschnieder
Quality Management Representative
of the Böllhoff Group

Why do you attach so much importance to quality at Böllhoff?

Our products create fastening technology in virtually every industry, for example in automotive, general industry, the railway industry and in aerospace. The reliability and safety of our products is our top priority – for the benefit of our customers and their end customers because product failure can reflect badly on the image of our customers and even put lives at risk. We want to avoid this in any case.

How do you ensure that your quality standards are always fulfilled with 100,000 different products?

The QM system of the Böllhoff Group has a strict focus on prevention. Error prevention through careful advance quality planning, the selection and auditing of suppliers and the use of state-of-the-art production facilities and testing options are our customers' guarantee of quality.

And does that work on a global scale?

The QM system applies to all 37 sites of the Böllhoff Group across the world.

The QM methods and standards implemented regularly undergo benchmarks. The Group communicates using shared IT solutions such as advance quality planning, FMEAs, SPC etc.





Are customers happy to pay for premium quality?

Not all of them. Just like in the private sector, there are always customers in the B2B sector who are geared towards the lowest price. The short-term saving on the purchase price is then quickly negated by follow-up costs, for example in the form of production losses, complaints, repairs and downtime costs. As our customers are learning to appreciate the total cost, the purchase price alone is no longer at the forefront when it comes to selecting suppliers.

Böllhoff's commitment to quality goes far beyond the actual product. In what other areas do you ensure quality for your customers?

To start with, we ensure that products fully meet the quality standards. But problems with quality can also arise, in particular, because the complexity of fasteners is often underestimated. The old perception that "it's just a screw" still has some hold today.

Yet now it is more important than ever to view the system of screw, nut, the components to be joined and assembly in the context of engineering, design and environmental conditions as a whole. Quality planning, therefore, starts right from when we are advising our customers about the design.

What form does your actual service take?

As a producer of fasteners and manufacturer of assembly systems we have extensive technical know-how. We support our customers from design right through to assembly and cover areas such as standardisation, mechanical and geometric design, surface technology and reducing assembly times. We share our knowledge as a matter of course by offering training seminars at our premises or even consumer fairs directly at our customers' premises.

How do you expect the issue of quality to develop for you and your customers over the next 10 years?

I am certain that quality will become increasingly important in the near future. This partly has to do with our customers' short product cycles, but also with more complex products, for example platform technology etc. International statistics show an increase, for example, in product recalls, this trend can be stopped only by consistent compliance with the quality requirements.

Environmental management/sustainability

Taking responsibility

In their daily work, the members of staff must not only act in accordance with the quality management system, but also the environmental management system. In 1999, we attained our initial certification to the environmental standard DIN EN ISO 14001, demonstrating our contribution to resource conservation, which is part of our company philosophy. Not only quality, but also aspects regarding energy, the environment and occupational health and safety set benchmarks in the definition of our business objectives.

To realize these goals, we use advanced, state-of-the-art methods, processes and machines that are also economical.

At Böllhoff, we record information about the power sources used in order to analyze all processes with regard to power consumption so that we can discover and eliminate energy waste.



Certified to
**DIN EN ISO
14001**



All stages of purchase, development, production and the distribution of products and services are carefully planned and carried out taking into account existing standards, rules and legal regulations.

A rigorous approach to environmental protection not only reduces waste and unnecessary pollution, but it also saves energy and materials over the long term, creating economic benefits for us and our customers.



Böllhoff International with companies in:

Argentina
Austria
Brazil
Canada
China
Czech Republic
France
Germany
Hungary
India
Italy
Japan
Korea
Mexico
Poland
Romania
Russia
Slovakia
Spain
Switzerland
Turkey
United Kingdom
USA

Apart from these 23 countries, Böllhoff supports its international customers in other important industrial markets in close partnership with agents and dealers.



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