Quality built in
LESER Quality and Production system

Objectives of this Presentation.

- Explaining sample **elements of the LESER approach to quality**: Design principles, Qualitysystem LESER, LESER Production System and supplier management
- Highlighting **differences of LESER integrated qualitysystem** versus conventional quality inspections

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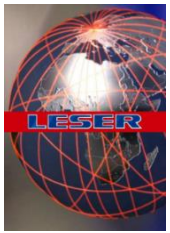
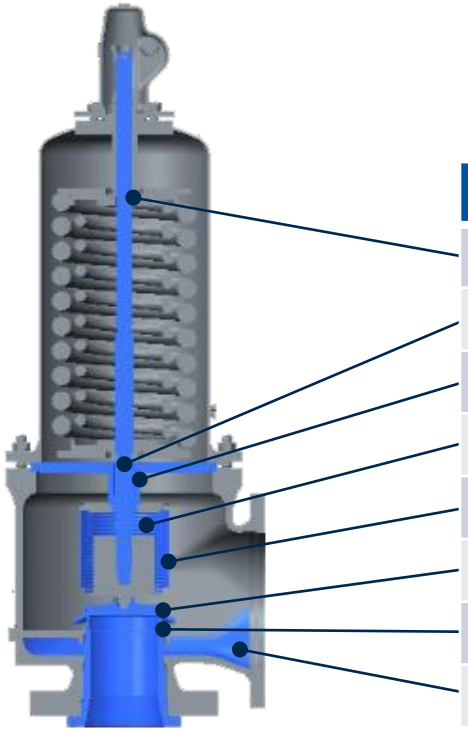
The three elements of the LESER quality. More than just inspections.



- LESER design principles
  - Durable Design
  - Tight Finish
- Qualitysystem LESER
  - Globally certified processes
  - Preventive quality assurance measures
    - Design process
    - Materials management supplier program
- LESER Production system
  - Order-independent manufacturing
    - Large quantities - high automation
    - Specialized machines
  - Assemble to order
    - Integrated SAP system
    - Integrated inspection program

Reliable valve function means: Durable design for longer life.



Critical components	Advantage
Needle bearings	Safe pressure setting
Roller-burnished spindle	Less wear and tear
Nitrocarburated guides	Less wear and tear
Long-life bellows material	Longer life
Shielded bellows	Protection of bellows
Stellited or hardened disc	Less damage when opening
Stellited or hardened nozzle	Less damage when opening
Self-draining body	Less corrosion

Reliable valve function means: Excellent tightness increases plant efficiency.

Seal type	Feature and benefit
Metal-to-Metal sealing with LESER Nanotightness	Smoothness and flatness of the sealing surfaces in the nanometer region ensure a tightness level with 50% less bubbles than API 527
O-ring disc	Optional: 10 different O-ring materials for zero bubbles in a sturdy disc design
Sealing plate	For temperature- and pressure ranges beyond possibilities of O-ring discs

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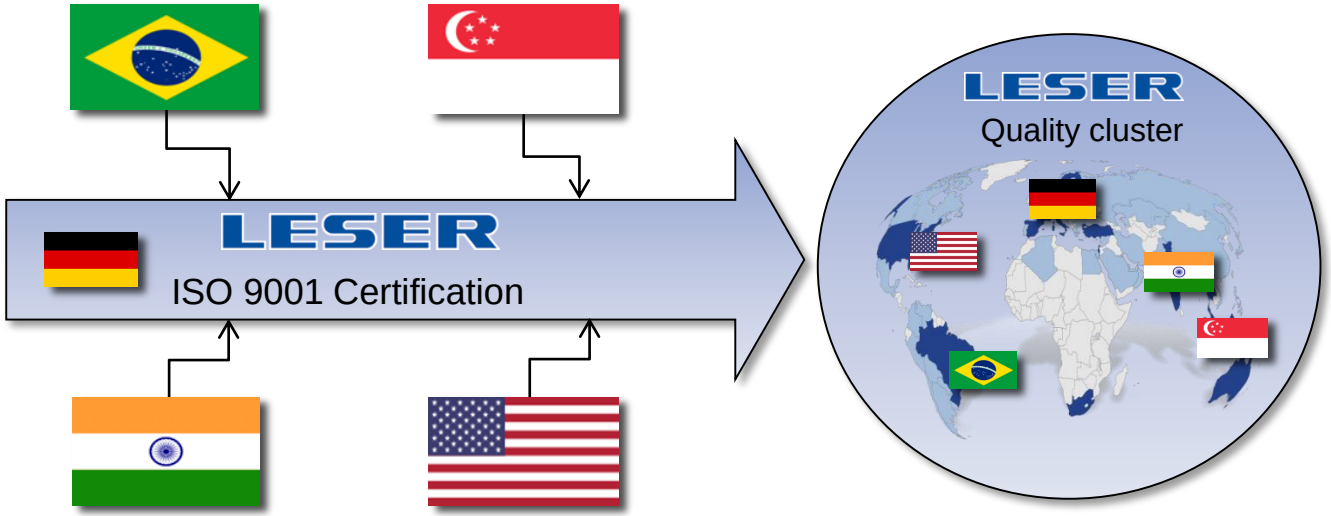
Qualitysystem LESER. ISO 9001 cluster certification.



The LESER group is certified in **one** certification according to ISO 9001.

- One system for the whole group
- Same processes for all locations
- Same high quality standards

The Qualitysystem LESER uses qualified, global and certified processes.

Feature	Benefit
Processes	The processes are internally standardized and spread out over the whole LESER world
Qualified	■ LESER has qualified its processes ■ Process ability: Reliable repeatability in a small range
Global	LESER‘s processes are documented in a global Quality Management System: ■ Process models ■ LESER Global Standards ■ LESER Local Standards ■ Work Instructions
Certified	LESER‘s processes are certified by many external certification societies according to many standards with many more globally existing regulations regarding organizational affairs (like ISO 9001) safety valve related demands (like PED or ASME)

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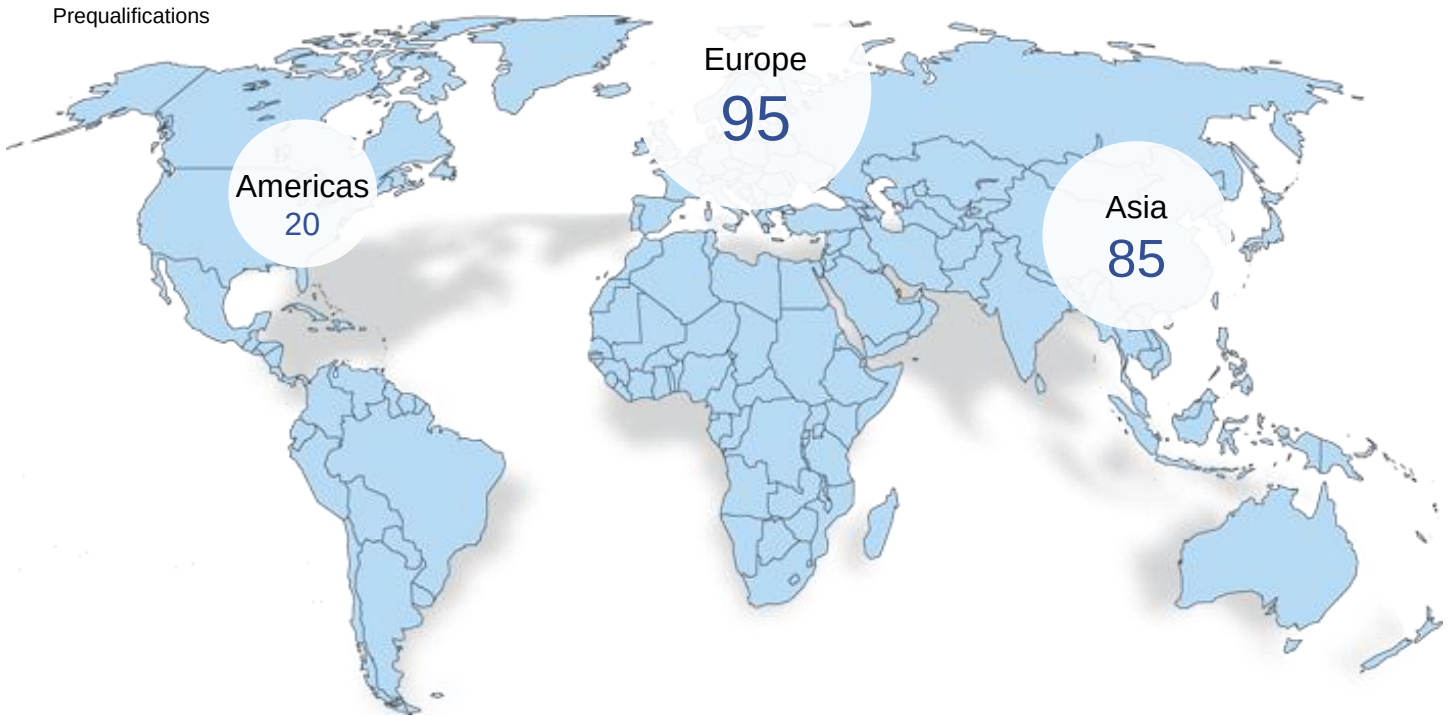
More than 200 individual approvals by top leading EPCs and end users.



More than 200 individual approvals by top leading EPCs and end users.

Prequalified at	Since
Bayer	1998
BASF	1999
Novartis Pharma	1999
Toyo Engineering	2001
Petronas	2002
Shell Global Solutions	2002
Bechtel	2011
Petrobras	2011
Exxon Mobile	2014
EIL	2015

Customer audits	Year
Voith	2010
Saudi Aramco	2011
Total	2012
Cameron	2013
Petrobras	2013
Stamicarbon	2014
Linde	2015
Cryostar	2015
BASF	2015

Frame contracts	Since
BASF	2004
DOW Chemical	2005
TetraPak	2005
Bayer	2007
Lurgi	2007
Linde	2009
GS E&C	2014

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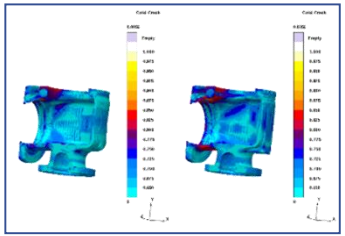
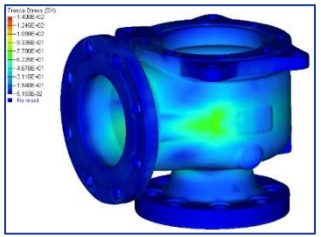
Qualitysystem LESER. Focus on preventive measures in the design process.

Design processes	
1. Quality function deployment (QFD)	2. Finite element method (FEM)
3. Computational fluid dynamics (CFD)	4. Solidification simulation
5. Failure mode and effects analysis (FMEA)	6. Design review
7. Test lab	8. Supplier management process

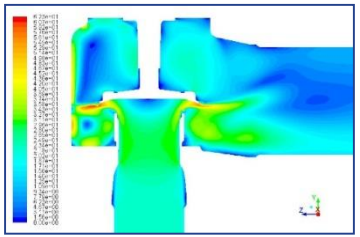


2. Finite element method

7. Test lab



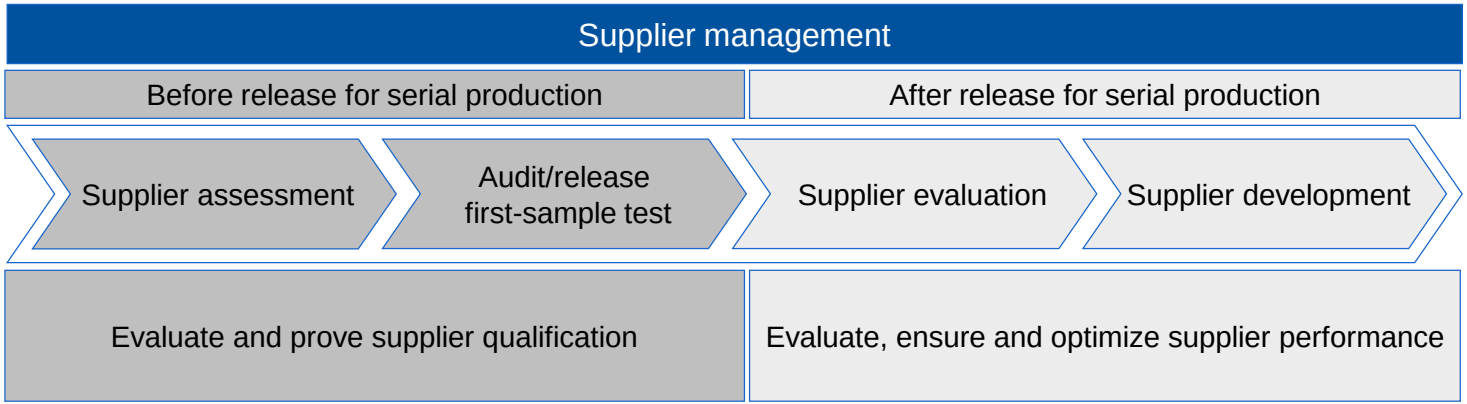
3. Computational fluid dynamics



4. Solidification simulation

Quality system LESER. Preventive measures – e.g. materials management.

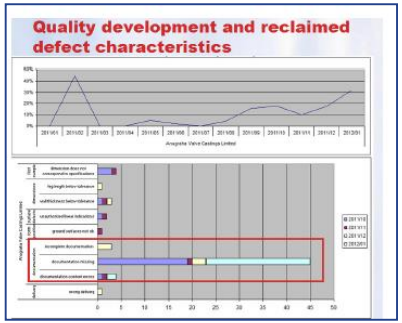
- LESER not only buys material but wants to develop and cultivate the relationships to its suppliers. This ensures high quality of raw material.
- In key supply markets like India, LESER uses only 1st tier suppliers with proven track record in valve industry
- Stringent supplier management process:



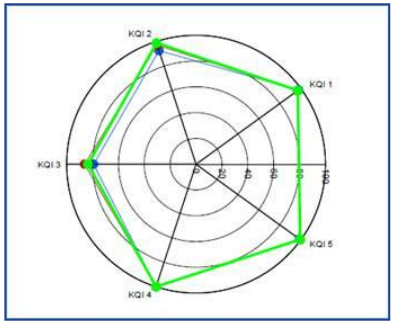
Supplier management

Continuous improvement of suppliers quality level through

- quality performance tracking
- comparisons between suppliers
- frequent onsite visits



Performance tracking



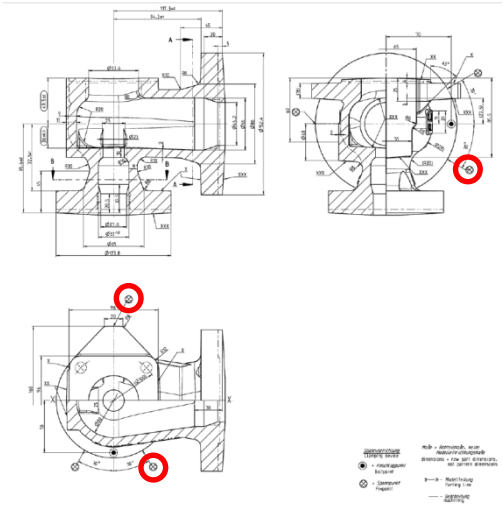
Compaison

Onsite visits

Qualitysystem LESER. Preventive measures – e.g. casting pattern design.

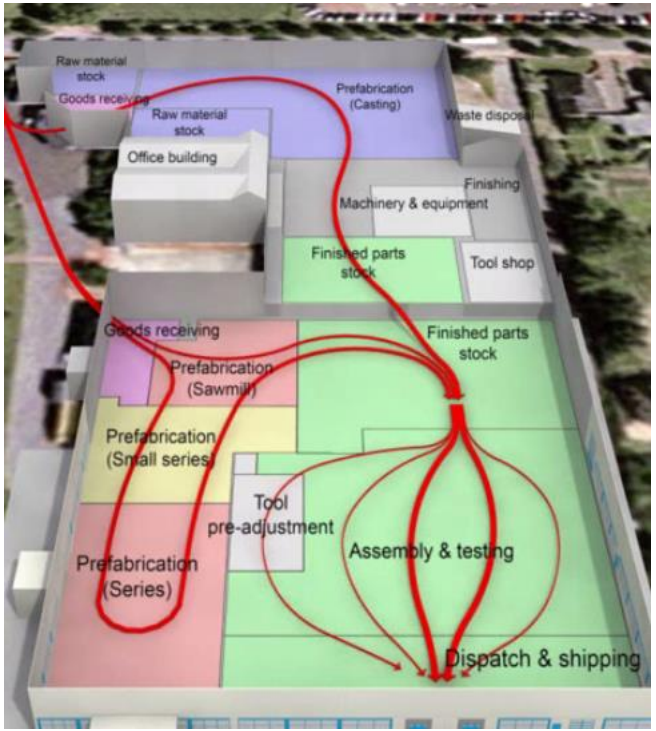
Preventive quality measurement at design features of casting patterns:

- Example: Locations relevant for machining (fix and bolt points) are designed in a way that generates optimal casting quality – no grinding allowed in these points
- See markings:



Qualitysystem LESER. Preventive measures – e.g. casting pattern design.

- Factory location Hohenwestedt/Germany
- Europe‘s largest safety valve plant and one of the largest production sites for safety valves worldwide
- Modern series production with a capacity of 130,000 valves per year
- All manufacturing technologies in-house:
  - Including heat treatment, hardening, pickling, electro polishing, welding, and painting
  - 100% of machining in Germany



Highly automated serial production for safety valves.

Precise machining in one clamping

IT-based commissioning

SAP-controlled assembly with full transparency

Machining | Stock | Assembly

Traceability of components through coding in the machine

Strong packaging for safe transport

- Automated manufacturing of all critical components ensures high repeatability
- All manufacturing technologies in-house, including all machining, welding and heat treatment
- 75% of orders can be assembled from 10 Mio. EUR raw material and component stock
- More than 5 Mio. EUR investment in new technologies and processes every year

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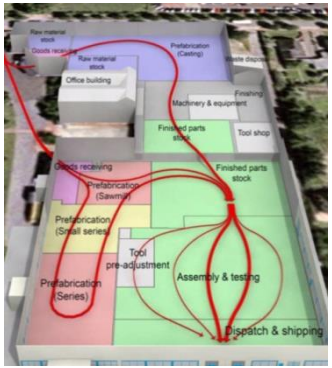
Assembly to order from finished parts stock ensures high part quality.



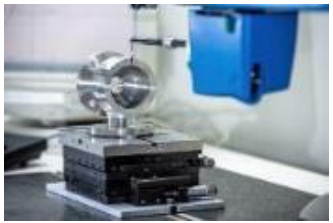
- 10 Mio EUR finished part stock ensure that most orders can be assembled without order-specific procurement or machining
- All components in stock fulfill the same high quality standards
- Serialialization starts after finished parts stock
- Benefit: efficient manufacturing of high quantities enables high automation

35 integrated quality checks for each and every valve.

Supplier development – Support on-site

Incoming goods inspection – Dimension check

Dimension check during production process



Tightness test after assembly

Suppliers | Incoming insp. | Machining | Assembly

Supplier development – Performance optimization

Spring test

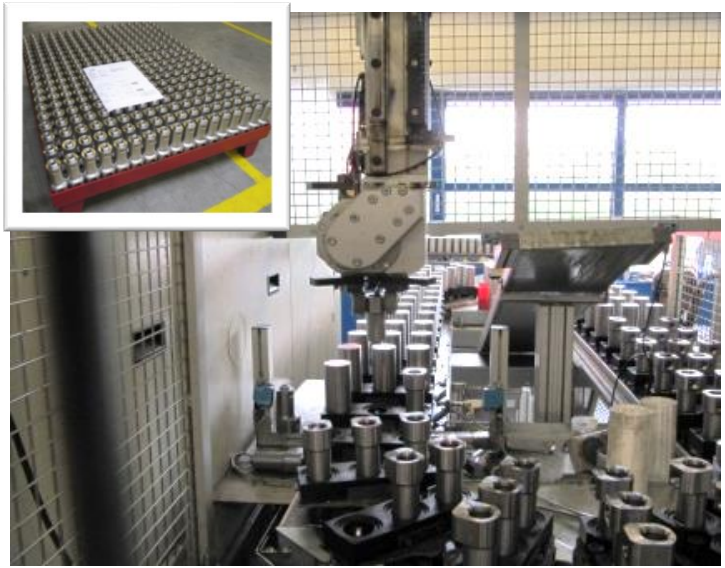
Hydrostatic test of inlet body

Final check

35 integrated quality checks for each and every valve.

- Worldwide cluster certification of each subsidiary with identical qualified and certified processes
- Comprehensive supplier development with own team
- 35 inspections for every safety valve as standard
- All inspection data is entered in SAP in real time and can be retrieved and analyzed

Order-independent manufacturing in high quantities enables automation.



- High quantities allow series production and thus a high level of automation.
- Higher level of automation causes high repeatability and process reliability.

Automated inspection centers for efficient and precise tests.

Automated inspection centers mean

- High throughput allows efficient 100% inspections
- No manual interference
- Absolutely identical inspection conditions

Full material and process traceability through seamless SAP ERP system.

Large quantities allow:

- Introduction of an ERP-System
- Process accompanying instruments like:
  - material identification
  - material traceability

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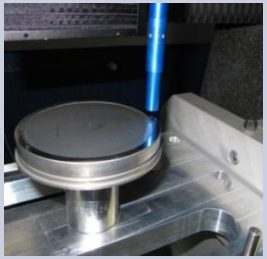
Independent customer request, tests and inspections take place 100%.

- 100% assembly inspection
- 100% Set pressure test
- 100% Tightness disc / seat
- 100% Tightness against atmosphere
- 100% Visual inspection

100% Tightness test

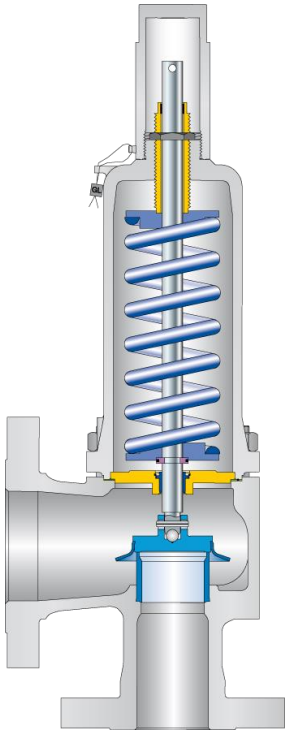
100% Final inspection

LESER production system. Optimised the production process.

LESER production system			
Detailed insight in requirement for roughness and flatness	■ Qualified processes ■ Process control of sealing surfaces ■ Optical measurement system ■ Accuracy: 20 nm		Results are used to control lapping and polishing process 
In comparison: Conventional safety valve production system			
Assumptions about requirements	■ Inspection Interference inspection of surface ■ Accuracy: 100 nm		Results are only used to reject parts. Manual hand-lapping process “trial and error”

LESER Production System. As standard: 35 tests at each valve independent.

Test	Amount
Marking	6 parts
Spring rate	1 part
Surface roughness	2 parts
Material identification	4 parts
Flatness of sealing surface	2 parts
Dimension inspection	14 parts
Hydrostatic test	4 parts
Tightness	1 part
Set pressure	1 part



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Conclusion.

The LESER approach differs in key aspects from conventional safety valve manufacturing which results in reliably high quality even without time-consuming order-specific measures.

- Up-to-date **product design** to minimize wear of critical parts
- Global certified **Qualitysystem LESER** which focuses on preventive measures, not just checks
- **LESER Production System** for high-quality automated component manufacturing to stock, then quick and efficient serialized assembly
- On customer request **many more tests** can be ordered

Quality built in

Thank you for your kind attention.