Qualification of Additive Manufactured Materials for Demanding and Regulated Markets

Solutions that guarantee quality, safety and create confidence in new technologies

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TÜV SÜD at a glance

- **150+** YEARS OF QUALITY, SAFETY & SUSTAINABILITY
- **1,000+** LOCATIONS WORLDWIDE
- **€2.4 BILLION IN ANNUAL REVENUE**
- **24,000+ EMPLOYEES***
- **574,000 CERTIFICATES**
- **100% INDEPENDENT & IMPARTIAL**
- **42% OF REVENUE OUTSIDE GERMANY^**
- **1-STOP SOLUTIONS PROVIDER**

*As of 2017-12-31
^Based on clients’ locations
Note: Figures have been rounded off.
Independence and impartiality

TÜV SÜD E.V. 74.9%
TÜV SÜD FOUNDATION 25.1%

GESELLSCHAFTERAUSSCHUSS GBR (SHAREHOLDER COMMITTEE)

TÜV SÜD AG

BUSINESS ASSURANCE
INDUSTRY SERVICE
MOBILITY
PRODUCT SERVICE
REAL ESTATE & INFRASTRUCTURE

Subsidiaries in:
AMERICAS
CENTRAL & EASTERN EUROPE
GERMANY
ASEAN, SOUTH ASIA, MIDDLE EAST & AFRICA
NORTH ASIA
WESTERN EUROPE

TÜV SÜD INDUSTRIE SERVICE GMBH
Oct. 18th, 2018

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Our heritage: 150+ years of business success

1866
On 6 January, 22 industrialists united to establish the Steam Boiler Inspection Association Baden in Mannheim.

1881
The first binding standards related to boiler safety were agreed, paving the way for uniform technical inspections.

1906
Our first vehicle periodic technical inspection was carried out.

1921
Environmental advocacy began with our publication of a report addressing dust pollution.

1938
The launch of a standardised nationwide system created 14 regional inspection associations named TÜV. There were 17 TÜVs by 1941.

1951
TÜV organisations were tasked with performing regular inspections of all motorised vehicles.

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The launch of a standardised nationwide system created 14 regional inspection associations named TÜV. There were 17 TÜVs by 1941.

1951
TÜV organisations were tasked with performing regular inspections of all motorised vehicles.

1964
Expansion beyond Europe began with a cable car accident investigation in Cape Town, South Africa.

1989
TÜV Product Service GmbH was launched, pioneering the concept of worldwide approvals.

1991
Asian subsidiaries launched in Hong Kong then Japan, Taiwan and China, with North American subsidiaries set up around the same time.

1996
The TÜVs from Germany’s southern states united to form TÜV SÜD.

2006
Singapore’s PSB Group is acquired, with TUVTÜRK launched the following year.

TODAY
Footprint in Spain expanded with acquisition of ATISAE, and launched 2 Digital Service Centres of Excellence in Singapore and Germany.
Key services for the Components & Equipment Manufacturing industries

- Component Certification Process
- Specific AM Characteristics
- Feedstock Qualification
- AM Machine Qualification
- AM Process Certification
- Summary: Certification of AM Components
Demanding and Regulated Markets

Pressure Equipment

Conformity Procedure

- Material Certification
- Design [Appendix I PED]
- Manufacturing, Welding
- Final Inspection PED
EN/ISO Selection Pressure Equipment, Welding

- EN 10208: Flat products made of steels for pressure purposes
- EN 10216: Seamless steel tube for pressure purposes
- EN 10217: Welded steel tubes for pressure purposes
- EN 10222: Steel forgings for pressure purposes
- EN ISO 9606: Approval testing of welders – Fusion welding
- EN ISO 19614: Specification and qualification of welding procedures for metallic materials
- EN 286: Simple pressure vessels
- EN 279: Refrigerating systems and heat pumps – Safety and environmental requirements
- EN ISO 4126: Safety devices for protection against excessive pressure
- EN 13761: Industrial valves – Shell design strength
- EN 12652: Water tube boilers
- EN 12653: Shell boilers
- EN 13445: Unified pressure vessels
- EN 13445-1: Industrial piping
- EN 12476: Pressure equipment for refrigerating systems and heat pumps
- EN 13456: Cryogenic vessels – Static vacuum insulated vessels
- ISO 2960: Welding consumables. Covered electrodes for manual arc welding of non-alkali and fine grain steels. Classification
- ISO 3583: Covered electrodes for manual arc welding of creep-resisting steels - Code of symbols for identification
- ISO 3581: Covered electrodes for manual arc welding of stainless and other similar high alloy steels - Code of symbols for identification
- ISO 3834: Quality requirements for fusion welding of metallic materials, five parts.
- ISO 4932: Welding and allied processes – Nomenclature of processes and reference numbers
- ISO 5817: Welding. Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded). Quality levels for imperfections
- ISO 8938: Qualification test of welders – Fusion welding, parts 1 to 5
- ISO 13847: Petroleum and natural gas industries – Pipeline transportation systems – Welding of pipelines
- ISO 13919: Welding – Guidance on the measurement of preheating temperature, interpass temperature and postpass maintenance temperature
- ISO 13919: Welding – Guide and ceramic forms for arc stud welding
- ISO 13920: Welding – General tolerances for welded constructions – Dimensions for lengths and angles – Shape and position
- ISO 14112: Gas welding equipment – Small kits for gas brazing and welding
- ISO 14341: Welding consumables. Wire electrodes and deposits for gas shielded metal arc welding of non-alkali and fine grain steels. Classification
- ISO 14548: Resistance welding
- ISO 14744: Electrogas welding, six parts
- ISO 15057: Specification and qualification of welding procedures for metallic materials - General rules
- ISO/TR 16508: Welding - Guidelines for a metallic material grouping system
- ISO 15610: Specification and qualification of welding procedures for metallic materials – Qualification based on tested welding consumables
- ISO 15611: Specification and qualification of welding procedures for metallic materials – Qualification based on previous welding experience
- ISO 15612: Specification and qualification of welding procedures for metallic materials – Qualification by adoption of a standard welding procedure
- ISO 15613: Specification and qualification of welding procedures for metallic materials – Qualification based on pre-production welding test
- ISO 15614: Specification and qualification of welding procedures for metallic materials – Quality assurance requirements for welding operators
- ISO 15615: Gas welding equipment. Acetylene manifold systems for welding, cutting and allied processes. Safety requirements in high-pressure devices
- ISO 15616: Qualification of welders for underwater welding. Welders for hyperbaric wet welding
- ISO 15616-1: Qualification of welders for underwater welding. Welders for hyperbaric dry welding
- ISO 15616-2: Qualification of welders for underwater welding. Welders for hyperbaric dry welding
- ISO 15616-3: Qualification of welders for underwater welding. Welders for hyperbaric dry welding
- ISO 15616-4: Qualification of welders for underwater welding. Welders for hyperbaric dry welding

Additive Manufacturing

Under development:
- ISO/TC 261 Additive Manufacturing
- CEN/TC 54 PED

ISO 17296 Additive manufacturing - General principles
- EN ISO/ASTM 52921 Standard terminology for additive manufacturing – Coordinate systems and test methodologies
Feedstock Qualification

Bulk Material

Powder
Certification of AM Components

- Requirements on the Material (PMA)
- Design [Appendix I PED]
- QA-Process
- Manufacturing Technology
- Final Inspection

Raw Material (Powder)
Basic Quality Requirements:
• The manufacturer must comply the following approvals: PED / W0

Review of the:
• Quality Requirements
• Manufacturing programme
• Manufacturing equipment
• Test procedures
• Calibration and validation of measuring, monitoring and testing equipment
• Maintenance

Completion of Certification
Requirements from product standards and guidelines are fulfilled.
• Term of validity: 1 years
• Monitoring audit: after 1 year
• Repeat audit: after 1 year
• Term of validity: 3 years

RECOGNIZED MANUFACTURER OF FEEDSTOCK MATERIALS [POWDER]
Feedstock Materials Certification (Powder)

Dynamic Image Analysis
- Particle Size
- Particle Size Distribution
- Partikel Shape
- Spericity/Morphology

Chemical Analysis
- X-Ray Fluorescence Analysis
- O / N / H Carriergas Melt Extraction Method
- C / S Combustion Analysis

Dynamic Flowability
TÜV SÜD uses the measurement of the Avalanche Angle to determine the flowability.

Agglomeration
- Agglomeration
- Morphologie
- Spericity
- Scanning Electron Microscope SEM

DIN 65122, DIN EN ISO 17296-3 and VDI Guideline 3405 Sheet 2.3
Manufacturing Process Certification

**Basic Quality Requirements:**
- The manufacturer must comply the following approvals: PED / W0 / HP0 / ISO 3834-2
- Powder (Requirements, Labelling, Transport, Storage and Handling)
- AM Machine Qualification
- Process qualification
- Qualification of AM System user
- Further requirements from additional regulations

**Review of the:**
- Quality Requirements
- Manufacturing program
- Manufacturing equipment
- Test procedures
- Calibration and validation of measuring, monitoring and testing equipment
- Maintenance
- Other manufacturer approvals (W0; PED; HP0; ISO 3834-2,..)

**Completion of Certification**
Requirements from product standards and guidelines are fulfilled.
- Term of validity: 1 years
- Monitoring audit: after 1 year
- Repeat audit: after 1 year
- Term of validity: 3 years

**RECOGNISED MANUFACTURER OF ADDITIVE COMPONENTS FOR PRESSURE EQUIPMENT FROM FEEDSTOCK MATERIALS (POWDER)**
AM Machine Qualification

**Mechanical-Technological Values**

Build space analysis of the expected anisotropy and the mechanical-technological properties in the build space. Tensile and Impact Test Specimens at different angles (polar and azimuth) 0°/45°/90°.

**Geometric Capability**

Build space analysis of the capabilities of the AM machine to the geometric requirements (profiles, radius, surface, angle, etc).

**Process Parameters**

Computer Tomography (CT) can be used to determine information about the optimum settings of the process parameters.

_VDI 3405 Part 2 Build space with specimens_

_NIST Test specimen ISO/ASTM 52902_

_DIN 35224 and DIN EN ISO / ASTM 52902_
Evaluation of the printing process is performed using destructive- and non-destructive testing on the products.

Conventional X-Ray-Technology is not satisfying → Computer Tomography for complete evaluation.

Non-Destructive Examination

parameters for fast printing

optimal print parameters

absorption coefficients (µ)
Evaluation of the printing process is performed using destructive- and non-destructive testing on the products.

**Destructive Examination**

Material Samples are taken in adequate positions and size:

- Tensile Test
- Charpy Test
- Metallography
Process Qualification

Reproducibility and Process Documentation

Parameters include

- Exposure Strategy
- Laser Output
- Number of Laser Sources
- Powder metal group acc. to CEN/ISO TR15608
- Coating thickness
- Scan speed
- Shielding Gas
- Post-heat treatment
- Component Dimensions
- In-Process Monitoring available?
- Sample Position – Angles (Azimuth and Polar) and Quadrant in the build space
Summary: Certification of AM Components

Raw Material (Powder)
Requirements on the Material (PMA)
Design [Appendix I PED]
QA-Process
Technology
Final Inspection

Feedstock Certification
Manufacturing Process Certification
Component Inspection
Single Case Evaluation

Design Inspection
Final Inspection
Thank You for Your Attention

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