Material testing and Failure Analysis
The Institute for Material Testing can help you solve problems in the operation of your plant and manufacture of your products. We are a test institute accredited to DIN EN ISO/IEC 17025:2005 and certified to ISO 9001, offering you competent and comprehensive one-stop material-related testing.

Our services range from testing of material properties or of the quality of weld seams up to the extensive investigation and analysis to find the causes of technical failures. Additional services are constantly added based on individual enquiries and the demands of our customers.

We examine materials of all kinds. Based on our wealth of experience, we assess steel and nickel alloys and also non-ferrous metals and plastics.

Our engineers and technicians have the expertise to meet your needs efficiently, with the focus on solutions. Continuous training programmes guarantee a level of knowledge which is truly state of the art, and we also make use of the know-how available in other technical departments of TÜV NORD.

Please contact us for further information.

When investigating failures to your plant or equipment, our experts concentrate on the distinct identification of the causal factors, as well as on actions to avoid them in the future.

Our failure analysis are based on the results of destructive and non-destructive material-related tests and on our wide-ranging experience. Based on the test results and the conclusions drawn from them, our experts determine the damage at the root of the problem.

Our solutions are characterised by an interdisciplinary approach. TÜV NORD offers comprehensive one-stop services, utilising the experience of our numerous engineers which come from a wide-spread variety of technical subjects.

With our extensive library of technical literature, and based on the latest legislation and standards, we supply robust and sustainable findings and conclusions.
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Mechanical-technological tests

Tensile testing
We determine the mechanical properties of all kinds of materials, e.g. using static tensile testing according to DIN EN ISO 6892-1 test procedure A (strain rate) – with and without continuous elongation measurement, and test procedure B (stress rate) or ASTM E 370. Our test machines offer a load capacity up to 1,200 kN.

Tensile tests at elevated temperature according to DIN EN ISO 6892-2 are possible up to 1,000°C, down to -150°C or at -196°C in liquid nitrogen.

Specimen can be machined from raw material such as strips, sheets, tubes, rods, pipe bends, elbows, valves and fittings, forged and cast parts, chains, weld seams, soldered and adhesive-bonded joints.

Dynamic fatigue test
The dynamic strength of materials or of complete components subjected to pulsating or cycling loads is determined by fatigue tests on standard specimen according to DIN 50100.

Therefore we have servohydraulic test devices with test load capacity of 200 kN to determine the fatigue strength of your materials as well as of your welded or adhesive-bonded joints.

Bend tests
Bend tests on various materials and weld seams are carried out in the form of three- or four-point flexural tests. For testing of formability, sheets or tubes are subjected to extreme bend tests at room temperature in their as-delivered state or after annealing.

Charpy pendulum impact testing
In order to determine the impact material properties, the Institute for Material Testing performs Charpy pendulum impact tests in accordance with DIN EN ISO 148 (ASTM E 370, ASTM E 23, ASME IX). Pendulum rigs with impact energy of 300 J and 450 J are available for testing at high and low temperatures.

Drop weight test
In the drop weight test according to Pellini (SEP 1325. ASTM E 208), the crack arrest behaviour of materials is tested by determining the NDT (Nil Ductility Transition) temperature.

Hardness testing
The Institute for Material Testing has a wide variety of hardness testing equipment at its disposal, enabling testing of metallic materials and polymer materials according to:

- Brinell
- Rockwell
- Vickers
- Shore
- Barcol

On-site measurements (TIV, UCI methods) can be taken quickly if damage occurs on construction sites or during actual plant operation.

Reasons for measurement on-site include:

- Verification of specified hardness values
- Control of the results of heat treatment
- Testing for changes of material properties, e.g. in case of fire damage
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Metallographic tests and investigations

Examination of metallic micro structures
Based on many different metallographic preparation and recording techniques of the laboratory, the Institute for Material Testing is able to make you a tailor-made offer for examination of the macro- and micro-structure of your materials. Both traditional and modern preparation techniques are used in order to visualise the micro-structures.

As a result of microstructure preparation, phase fraction or the level of purity can be shown by means of image analysis. Additionally, the laboratory is able to determine ferrite content by measurement device based on magnetic induction.

Our low-load hardness test machine allows it to determine the depth of hardening and to generate hardness profiles, e.g. for monitoring of welding parameters.

The metallographic test methods are used, among other things, for:
- Quality assurance
- Material appraisal
- Review of delivery conditions
- Optimisation of welding procedures
- Qualification testing of welders, e.g. welding procedure test
- Failure analysis

Scanning electron microscopy and analysis in the micro range
Scanning electron microscopes (SEM) allow more than 100 times the magnification of traditional optical microscopes, and the images exhibit much greater depth of field, which is of great importance when assessing fracture surfaces (failure analysis and assessment). The additional subsequent energy-dispersive analysis (EDX) of extremely small areas provides data to determine the chemical composition of the smallest material areas and areas of covering.

Possible applications:
- Examination of fracture surfaces (in the case of damage)
- Analysis of inclusions, corrosion products, surface layers
- Determination of the distribution of alloy elements within the material (mapping, line scan), e.g. to qualify the depth of mix-up of a cladding with the base material

Metal analysis
With its stationary optical emission spectrometer (OES), the Institute for Material Testing offers you a reliable method for rapid determination of chemical composition of alloys based on iron, copper, nickel and aluminium.

The minimum sample size is 5 mm in diameter. Medium-sized specimen of appropriate geometry (up to 20 kg) can be analysed without any cutting work thanks to the open spark stand.

Metal powder or metal chips from drilling can be analysed after re-melting in an inert gas atmosphere (min weight 50 g).
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For analysis of components from which no samples should be taken, we have a mobile optical emission spectrometer (OES) which can determine material composition on site. This is suitable for material analysis, rapid sorting and positive material identification (PMI) of ferrous and nickel based alloys.

Non-destructive analysis (without damaging the surface area) is realized using the X-ray fluorescence analysis device (XRF). This is primarily used for positive material identification (PMI) of components which have already been installed in larger plant and equipment. The equipment allows to determine elements from atom number 20 (calcium) upwards in the periodic table. In particular, austenitic steels are analysed with the XRF device to determine the major elements they contain.

All metal analyses (OES or XRF) could be performed by qualified personnel.

Corrosion testing
In our corrosion laboratory, we examine the corrosion resistance capabilities of metallic materials and their general corrosion behaviour in aggressive media. Corrosion mechanisms clarified in our laboratory – which are often quite complex – frequently provide valuable information for the assessment of corrosion-based damage.

In addition, the Institute offers standard test procedures for determining the resistance to intergranular corrosion of stainless steels, for example in accordance with DIN EN ISO 3651-2.

Component testing

Heat exchanger following a burst pressure test

Pressure testing
The Institute for Material Testing has a bursting chamber for performance of strength tests or burst tests on pressure components (pressure vessels, valves, fittings and other pressurised parts) which are possible at hydraulic pressure up to 4,000 bar and gas pressure up to 600 bar.

In addition, hydraulic cyclic tests up to 450 bar are possible. By measuring additional features, such as increase in volume and changes in shape and form, the onset of plastification and the extent of progressive permanent deformation can be determined in relation to pressure.

Leak testing
We have a mobile helium leak detector for leak testing using the tracer gas method (DIN EN 13185). This enables location of local leaks, and also total leak aggregation up to $10^{-12}$ Pa m$^3$/s.

Possible applications:
- Valves and fittings
- Heat exchangers
- Pumps
- Pipings

Metal analysis of different samples

Heat exchanger following a burst pressure test

Component testing
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Component testing

Fatigue testing
The lifetime and dynamic load capacity of components is determined using fatigue testing. At the Institute for Material Testing, dynamic load testing can be performed with loads up to 200 kN.

Using a short testing time by high cycle frequency, the behaviour of the component after several years of operation can be forecasted.

Possible applications:
- Fan components
- Escalator treads
- Trailer couplings
- Load-bearing furniture elements

Static load testing
In order to test the strength of parts and components, loads can be applied which test the elastic and/or plastic behaviour of materials up to the break or fracture point.

Possible applications:
- Bosun’s chairs
- Ropes
- Retaining and fixing systems

Fatigue testing of an escalator tread

Strain measurement
By measuring elongation (strain), we are able to determine the strain changes in your components when there is a change of loading. The strain states are therefore determined by means of practical experiments (also on-site) and the information gained can be used to support and verify the results of construction calculation.

In the case of static or slowly-changing processes, we use control pulses and time signals from multi-point measuring systems in order to determine elongation and other parameters such as pressure, temperature and movement. These systems can be used independently of mains electricity.

In addition, the Institute for Material Testing has measuring equipment with sampling rates of up to 200 kHz for determination of processes involving rapid change and variation, e.g. shocks, impacts or vehicle vibration.

Strain gauges and many other methods are available for the wide variety of applications in this area, allowing measurements in the temperature range between -196°C and +800°C and also under water.

Possible applications:
- Underground pipelines
- Pressure vessels
- Power plant components
- Process vessels
- Cranes and other hoisting devices

Strain gauges with two orthogonally located measuring grids
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On-site metallography

The metallographic inspection methods of the Institute for Material Testing can be used both in the laboratory and for components which are already installed and in use at your own site.

Tests like
- Microstructure replica
- Mobile hardness testing
- Mobile metal analysis
- Geometric measurements
are used with the focus on quick solutions with minimal expense.

Mobile metallography is used to examine non-transportable parts and components for purposes of
- Quality testing
- Failure analysis
- Investigation of temperature-related impacts/damage

Aging monitoring

The safety and optimum availability of industrial plant and equipment are determined against the backdrop of legal requirements. One of the major influencing factors in this area is the condition of the materials that have been used in the plant construction. Systematic evaluation of the condition of these materials is therefore essential in order to avoid unplanned downtimes.

With the help of on-site test methods, the Institute for Material Testing assesses parts and components that are subjected to aging in order to achieve optimum levels of utilisation and safety. We also recommend a “zero inspection” to generate a reference level for future measurements.

Non-destructive material testing

The Institute for Material Testing performs non-destructive testing both in our own laboratory and at your site. Test methods include
- Ultrasonic testing
- Magnetic particle testing
- Radiographic testing
- Liquid penetrant testing
- Visual testing

These tests can be performed during or at the end of the production process, and also for regular monitoring and surveillance according to all relevant standards or your own specifications. Our test personnel are qualified and certified to DIN EN ISO 9712 and also to the EU Pressure Equipment Directive (2014/68/EU).

The variety of modern machinery and equipment allows us to examine difficult and demanding testing. The Institute also has a fully-equipped laboratory vehicle for instant development and evaluation of X-ray films.

Thanks to our experience in phased-array technology, we are able to find the best solutions for ultrasonic testing of weld seams of austenitic stainless steels and nickel-based alloys.

With our state of the art video endoscopy technology it is possible to precisely examine areas with difficult access.

In addition, we can create suitable test instructions based on your specifications and the relevant standards. Detailed advice on selection of the most suitable test methods for your application and rapid delivery of test reports are naturally also integral to the services we offer.
With more than 10,000 employees, TÜV NORD Group is one of the largest technical service providers in Germany, with operations in over 70 countries. The Group owes its leading market position to its technical competence and its broad range of advisory, testing and other services in the areas of Industrial Services, Mobility, Certification, Energy and Systems Technology, Natural Resources, Training, and International.

We would like to tell you more.
Why not contact us.

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