Wölfel

Inspection of Rotor Blades

Quality assurance during production and recurrent inspection during operation

Wind Energy

Rotor blade inspection by independent experts

Challenge rotor blade

As the heart of a wind turbine, rotor blades are decisive for the energy yield by converting the airflow into a torque and thus into mechanical power. Therefore, rotor blades must meet the highest requirements in terms of material strength and quality. The efficient operation of rotor blades is a very complex and challenging issue considering the difficult production process with a high level of manual labor involved and the high mechanical loads that are not known in detail.

Challenge quality

It has to be ensured that the rotor blades are produced to the highest quality standards and that their optimum condition is maintained during operation. Due to the high level of manual labor in the production process, the rotor blades often have defects which can develop into serious damage during operation. The justified requirement of the customer for perfect quality aimed at an error-free operation over a period of 20 years is in opposition to the usual warranty period of 5 years in the industry. Thus the customer bears the quality risk for 75 % of the calculated operating time!

Challenge design and loading

Already the design process of rotor blades is characterized by uncertainties: Material properties vary considerably and the design and analysis methods are very complex. In many cases further research is required. What makes it even more difficult is that the extremely high mechanical loads that act over a period of 20 years are not known in detail.

Documentation of existing damage

Challenge production

Most rotor blades are made of fiber-plastic composites. In contrast to products made of metal materials, the composite gains all of its main properties only during the production process.

However, this process is characterized by

- mainly manual work,
- a very low degree of automation,
- high cost and time pressure and
- partly semi-skilled personnel.

Defects are accordingly frequent, so that according to estimates by experts approx. 4 out of 5 damage events in the field are related to the production process.

Challenge operation

During operation, rotor blades are exposed to extreme mechanical loads, because they are guided through the air with high speed and they are subject to different wind speeds and wind directions as well as to a variety of environmental and operating conditions. Inspections contribute to the monitoring of the rotor blade quality and to the early detection of damage. Thus, repair measures can be scheduled and taken in time and serious damage or even loss of the blade can be prevented.

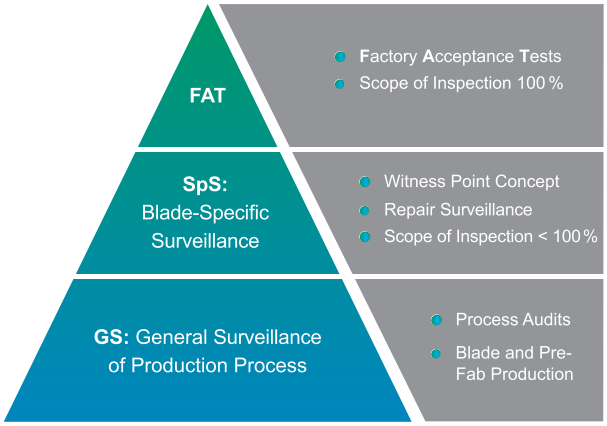
Visual inspection in the rotor blade

Third Party Inspection (TPI): Quality assurance during production

The TPI process: Comprehensive and effective

Our field-tested and proven TPI concept consists of three complementary elements:

1. General surveillance of the blade manufacture within the scope of process audits;
2. Specific surveillance of the blade manufacture for concrete customer projects according to our witness point concept;
3. Factory Acceptance Test: The project rotor blades are thoroughly tested from the in- and outside, including the lightning protection system and all mounting parts.



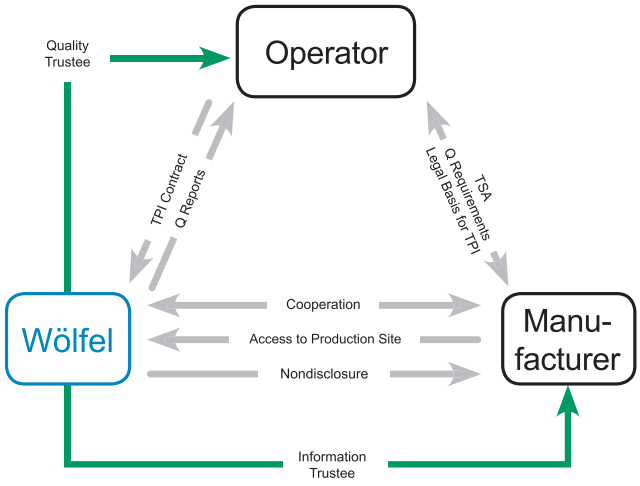
Our TPI concept

Important: Documentation

In line with the TPI concept, the documentation also has general and blade-specific components. Audit reports describe the general monitoring of the manufacture, while “at birth” every project rotor blade is provided with a List of Open Points (so-called LOP), where all quality-relevant observations are registered in a table and recorded in the form of text and pictures. So the LOP is the essential document with regard to inspections. On final acceptance, the handover condition is exactly documented in the finalized LOP.
Thanks to the tabular structure, the documentation remains clear and can be used for further evaluation. With this structure, any damage found during recurrent inspections can also be consistently added to the documentation.

Quality needs confidence, cooperation ...

For the TPI Wölfel extends the relationship between operator and manufacturer to a “quality triangle”, with Wölfel – as independent experts and in our self-image as “quality trustee” – representing the quality interests of the operator. At the same time, we cooperate with the manufacturer to achieve the mutual goal, namely the best quality possible. We will keep any information disclosed to Wölfel in the course of our work strictly confidential – as a sort of “information trustee”.



... and passion for fiber composite technology.

The efficiency of the TPI for quality assurance stands or falls with the qualification and experience of the quality inspectors – and with their enthusiasm for rotor blade technology. Therefore, Wölfel quality inspectors have

- a qualified and specialized education, mostly a degree in plastics engineering,
- additional, rotor blade-specific training,
- comprehensive specific experience in the inspection of different blades types and
- the ambition to contribute to the rotor blade quality with their work and thus to bring forward not only the project, but the wind energy as a whole.

Recurrent inspection during operation

The high loads acting on rotor blades cause damage during operation or lead to damage which for the most part originates already during the blade manufacture. Therefore, recurrent inspections during operation are essential to detect possible damage at the rotor blade at the earliest possible and to ensure the quality of the blade.

Due to various guidelines and recommendations, condition-oriented inspections at rotor blades of wind turbines must be carried out at regular intervals. BWE recommends rotor blade inspections at wind turbines with a capacity ≥ 300 kW every two years and yearly rotor blade inspections at wind turbines with a capacity ≥ 1.5 MW.

Services provided by our team of inspectors – onshore and offshore:

Recurrent inspection at the wind turbine

- External inspections of the rotor blade, preferably with economical rope access, alternatively by sky-lift (onshore)
- Internal inspections
  - Use of visual and haptic methods (in the accessible area)
  - Internal camera inspections up to the blade tip
- Lightning protection measurements
- Further inspections as required (e.g. thermography)

Camera for internal inspection

Inspection before warranty expiration

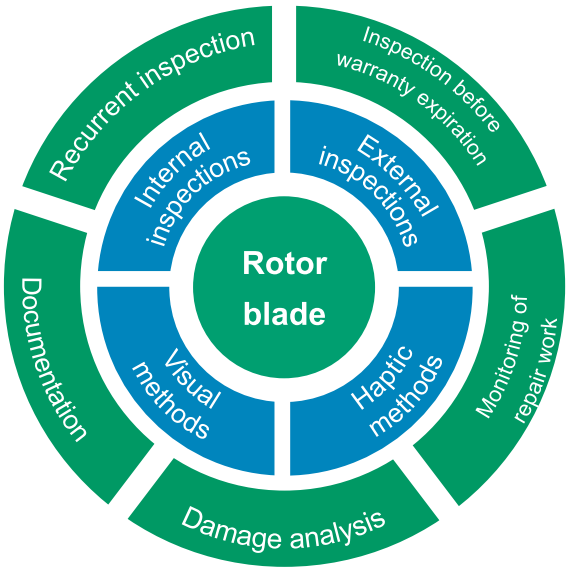
- Generally after 5 years
- Complete inspection of the blades, incl. lightning protection system

Repair

- Supervision
- Surveillance

Comprehensive documentation

- Expert report on the rotor blade
- Expert report on the damage detected
- Detailed report with photo documentation
- List of Open Points (LOP)



Your advantages

- Timely detection of damage already occurred and of damage which is in the process of occurring
- Safeguarding of trouble-free operation and thus of the best energy yield possible
- Cost savings as repairs can be planned
- Individual services tailored to your needs
- Flexible employment in Germany and abroad
- Competent and independent inspections
- Expert reports including video and photo documentation
- Compact documentation in tabular form

Wölfel – Expertise for rotor blades

Comprehensive competence for best service quality

Our competence and the high quality of our services are based on 40 years of experience in structural mechanics and dynamics and on our highly qualified employees, who always keep their knowledge base updated.
Especially in the wind energy sector our expertise is not limited to structural mechanics, material strength and dynamics, but also includes specialized rotor blade know-how. Our specialists in plastics engineering are well-acquainted with the rotor blade structure and its material properties and have vast experience regarding manufacturing processes and influences as well as regarding damage development and damage patterns occurring. This extensive competence provides ideal conditions for professional and comprehensive customer support when dealing with quality assurance, inspection and preservation of the life cycle of rotor blades.

Expert services from a single source ...

It is essential that a manufactured rotor blade corresponds to the design state at the best. Therefore, in view of the high complexity of the production process and its relevance for damage during operation, extremely thorough quality assurance by experienced experts is of utmost importance.

As an expert for vibrations, structural mechanics and rotor blades, Wölfel provides the following services from a single source:

- Process audits to evaluate the production plant
- Process monitoring of project-specific blade production
- Recurrent inspections at on- and offshore wind turbines
  - inside and outside inspections
  - visual and haptic inspections
  - camera inspections …

... plus intelligent systems and software

In the field of rotor blades we also offer the following systems and software:

SHM.Blade® / IDD.Blade®
System for structural health monitoring and ice detection at rotor blades, GL-certified

HyperSizer®
Space-tested program for the design, analysis and optimization of lightweight structures like rotor blades

Preventing serious damage – with Third Party Inspection and condition-oriented testing by independent experts

Selection of reference customers:

- Arise Windpower
- Bard
- EnBW
- EWE
- GE Wind
- LM Wind Power
- NEC Micon
- Nordex
- Power Blades
- RWE Innogy
- Senvion
- Vestas
- Wind Energy Institute of Canada
- WindMW

The company ...

Vibrations, structural mechanics and acoustics – this is the world we live in and focus on. Be that the numerical analysis and design of a production facility against earthquake, the measurement of acoustic emissions of a wind turbine, multi-purpose measurement systems for noise and vibrations or noise mapping software for immission control – our scope of services and systems always focuses on dynamics and acoustics.

In reply to this strong professional technical focus we offer a broad range of branches we are serving: Our activities extend from power engineering via mechanical and plant engineering through to environmental engineering and occupational safety. Our internal organization is based on these branches – in doing so we guarantee that we always are in the position to offer you an expert who will speak your language and will provide exactly the assistance that you need. This also applies to training seminars and technical support concerning our systems. At the same time we preserve personal flexibility that enables us to provide exactly the manpower that you need, even for large-scale projects.

Headquarters in Hoechberg near Wuerzburg

· Hoechberg · Berlin · Bremen · Vienna ·

Today, standing still means taking a step backward – for this reason we strive to maintain and continually expand our leading position in technology by strategically getting involved in research and development projects.

... its experience ...

Founded in 1971 by Professor Dr.-Ing. Horst Peter Wölfel today we look back to 4 decades of experience in the services and systems business.
At the very heart of our activities lie people: our more than 70 highly qualified employees - civil, mechanical and electrical engineers, complemented by information technology experts, mathematicians and research scientists. Benefit from our healthy mix of experienced engineers with their capability to assess and analyze your problem at first glance, and talented young professionals, who are efficient and effective at innovative areas as e. g. active vibration control!

... and its orientation

For all of us, the motivation for our daily work is the satisfaction and success of our customers. Our success in doing this is demonstrated by our stable and personal relations to our customers, well-established partly over decades, with our clientele being medium- as well as large-sized companies not only coming from Germany and Europe, but also from America and Asia.
The quality of our services and their constant improvement are guaranteed primarily by this focusing on the customers' success, but also by our ISO 9001-compliant quality management system, complemented by specific certifications and accreditations.

DAkkS Deutsche Akkreditierungsstelle D-PL-19254-01-00

Bundesverband WindEnergie e.V.

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