How do things run smoothly even in rough winds?

Rotor blade inspection during production and ongoing operation
Rotor blades must satisfy the most stringent strength and quality requirements. Poor bonding or, even worse, structural failures will directly lead to profit setbacks. Since our experts have inspected far more than 1000 rotor blades, we can say that four out of five damage events in the field are related to the production process. This is hardly surprising because, for the most part, rotor blades are still produced manually. Manual production processes involve risks that require increased attention and thorough inspection of the final product. Once they are operated in the field, the rotor blades are subject to enormous strain. The extremely high mechanical loads acting on the rotor blades as well as meteorological influences result in rapidly progressing wear and tear. A full picture can therefore only be obtained by third party inspection (TPI) and recurrent inspection (RI) in combination.

Rotor blade quality – essential for energy yield

Visual inspection inside a rotor blade

Aerial rotor blade inspection
Are the requirements stipulated by regulatory authorities enough?

Regulatory authorities require that wind turbines should be inspected and their condition be checked at regular intervals. This applies above all to the rotor blades. As a general rule, these inspections and checks should be made every two years. As per the principles of the Bundesverband Windenergie BWE (German Federal Wind Energy Association), the inspections should be conducted both inside and out: “The rotor blades should be inspected for relevant damage to the surface and for structural defects of the blade body in the immediate vicinity of the rotor blades, both inside and out.”

The recurrent inspection (RI) covers “the current technical condition” of the rotor blades at the time when this inspection is made. However, about 80 percent of the damage occurring during operation originates from the production process. Isn’t it therefore obvious to assure the quality of the rotor blades already when they are manufactured?

Rotor blade quality is a challenge

Design
- Uncertainties as to the material properties
- Uncertainties as to the design loads incurred during more than 20 years of operation
- Uncertainties as to the failure criteria of composites

Production
- Mainly manual operations
- Very low automation degree
- High cost and time pressures

Operation
- Material aging wear and tear
- Exceptional load impacts
- Lightning
- Erosion of the blade leading edge

Maintenance
- Timely damage detection
- Projectable repair work
- Increased availability
**Third Party Inspection (TPI)**

Most rotor blades are made of fiber-reinforced composites. Contrary to products that are made of metallic materials, composites obtain their outstanding properties during the production process. This means that the quality of a rotor blade is established while it is being manufactured. Thanks to the third party inspections (TPI) performed by our experts, you can be sure that your rotor blades are produced according to applicable standards and quality criteria. Our proven and tested TPI concept consists of three stages:

1. General supervision of blade production within the scope of process audits
2. Project-specific supervision of rotor blade production according to our witness point concept
3. Factory acceptance test of project-specific rotor blades

The results of the supervision of the production process are laid down in a systematic documentation and can therefore be consistently used for recurrent inspections. This considerably reduces the time and effort required for the RI.

**Tip!** Ideally, the supervision of the blade production process should be agreed with the manufacturer already when the contract is being designed.

“Wölfel’s inspectors have given proof of their high professional and social expertise in the fields of (...). The high degree of flexibility and readiness for action as well as the solution-focused approach complete Wölfel’s expertise.”

Alexander Schneeweiß
Team Leader, Wind Turbines and Logistics,
EnBW Energie Baden-Württemberg AG
Recurrent inspection (RI)

During operation, the high loads acting on the rotor blades result in wear and tear and initiate damage events which have their origin in blade production. In addition to being required by statutory provisions, regular inspections and checks of the rotor blades during ongoing operation are of utmost importance to detect any damage to the rotor blades as soon as possible and to prevent subsequent damage by concerted maintenance measures.

We provide a complete documentation of all damage events and offer well-founded recommendations for how to proceed in the future. If the blades are supervised as early as during their production, their quality status is already defined. This simplifies recurrent inspections which can then be focused on nothing but the wear and/or modifications of the blades.

Tip! If sufficiently good empirical data on the quality condition of the rotor blades in offshore wind turbines operated in the exclusive economic zone are available, inspection intervals other than the annually defined ones can be used. This is expressly allowed as per BSH Standard No. 7005 of 2015, “Standard Design”, issued by the Bundesamt für Seeschifffahrt und Hydrographie (Federal Maritime and Hydrographic Agency), and in agreement with the authorized testing representative.

“Our cooperation with Wölfel’s inspectors was characterized by a high degree of technical expertise, reliability and ability to work in a team. We wish to emphasize not only the inspectors’ systematic and responsible approach, but also their genuine commitment which has significantly contributed to the success of the project. In addition, their flexibility in handling short-term special topics is an extremely positive attribute.”

René Kaufmann
Project Manager Wind Turbines,
Sandbank Offshore Wind GmbH
Minimum-cost inspection methods

The inspection method to be used depends on the necessary application and the specific requirements:

- External rotor blade inspection using visual and haptic methods, incl. lightning protection test (low-impedance test according to VDE 0100) and test of the drainage well, preferably using rope access technology or, alternatively, an aerial work platform (onshore)

- Internal blade body inspection using visual and haptic methods (in the accessible area)

- Internal inspection with carriage support and integrated camera system up to the tip of the blade (in the non-accessible area)

- Drone inspection or ground based inspection (GBI) for fast damage detection or intermediate inspection after repairs

- Endoscopic examinations

- Other nondestructive testing methods as required (e.g., thermography, ultrasound, etc.)

Documentation of existing damage
Other services around the rotor blade

- Condition-based testing
- Inspection before warranty expiration
- Expert report on the rotor blade
- Damage analysis and expert report
- Document review
- Support and supervision of repairs
- Advisory service in the field of process control
- Advisory service in the field of contract design with respect to rotor blade requirements
- Due diligence
- Training courses for operators and inspectors
- Preparation of documents, test instructions and standard operating procedures, risk analyses

Our team

To be successful is not only a question of one’s knowledge and experience but also, and in particular, of one’s personality. Our inspectors therefore stand out not only due to their many years of experience and their extensive expertise in the field of wind energy and rotor blade production, but also have the necessary “stability” to move around this working environment in a qualified and competent and yet cooperative manner. This is what our customers appreciate.
Vibrations, structural mechanics and acoustics – this is the Wölfel world. Here we are experts, this world is our home. More than 90 employees daily do their best for complete satisfaction of our customers. For more than four decades we support our customers with engineering services and products for the analysis, prognosis and solution of tasks in the fields of vibrations and noise.

Are vibrations really everywhere? Yes! That’s why we need a wide variety of solutions! Whether it is engineering services, products or software – there is a specific Wölfel solution to every vibration or noise problem, for example:

- simulation-based seismic design of plants and power stations
- measurement of acoustic emissions of wind turbines
- universal measuring systems for sound and vibrations
- expert reports on noise immission control and air pollution forecasts
- dynamic occupant simulations for the automotive and aviation industry
- and many other industry-specific Wölfel solutions …