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ENERGY & INDUSTRY DIVISION

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Risk Mitigation & Life Assessments

In-service Wind Farms

Mechanical Inspections

ENERGY & INDUSTRY DIVISION

Mechanical Services for Wind Farm

Risk Mitigation & Life Assessments

Today, with a significantly large number of wind turbines about to reach their life expectations, it is important to consider the probability of failure of mechanical components that may suffer from fatigue or a considerable wear. To reduce this probability, periodical inspections of main components are highly recommendable.

- **Blades .** It is one expensive component to maintain. Some studies show that blade damage accounts for more than 25% of the annual costs. Adding the cost of breakdowns, the blades regular inspections become necessary.

- **Gear Box.** Regular gearbox inspections are a cost-effective way to ensure low breakdowns of wind turbines and to prevent minor faults from resulting in costly gearbox replacements.

Blades inspection: UAV/drone inspection

Visual **inspection of blades** by drones consists of the following stages:

- Numeration (1-3) of the blades of the wind turbine, taking the hub cap as reference.
- Inspection of the blades by drones: the pilot sits in the passenger seat of a car. The camera operator sits behind the pilot. Together they operate the unmanned aerial vehicle (drone) allowing the pilot to concentrate on navigation and positioning system, while the camera operator focuses solely on inspecting and obtaining the correct pictures.

  The drones can operate up to a distance of 1.2 km from the pilot, and have a flight time of 40 minutes.
- Record of any significant defect:
- Number of the blade where the defect is, and distance from the root of the blades.
- Characterization and classification of defects into 5 categories (small to critical).

Gearbox inspection:

- **Gearboxes** in wind turbines, more than those in any other application, tend to fail prematurely. An increasing focus on wind farm operations and maintenance has led to a sharp improvement in gearbox performance over the last years.

- In Applus + we have more than 1GW experience in internal inspection with almost all WTG manufacturers using video endoscope with a front and side optical equipment to reach inaccessible areas.
  - Defects identification under **ANSI/AGMA** 1010/E95 code and **ISO 15243:2004** norm
  - **Gear Box Oil analysis** included by accredited lab

- Technical specifications of the endoscopies: **GE Mentor Visual IQ** Videoprobe with diameter probe **4 mm** (*) and 2 m in length.

- Oil Sampling and Analysis

Multichannel Vibration analysis:

- Using **vibration measuring equipment**, the status of the corresponding part of the main axis of the powertrain of the wind turbine can be inspected in order to detect any possible anomalies.
- The analysis is conducted by measuring the effective value of vibration with ICP accelerometers in the fixed points of the main bearing, gearbox, and nacelle.
- For the acquisition and evaluation of the vibration values in the wind turbines, the international standard VDI 3834-1 will be taken as reference, as it is specially designed for this type of wind turbine inspections.
- Most of the mechanical anomalies of rotating machines can be diagnosed if a correct analysis of the vibration spectrum is performed. Below are listed the components of the slow axis and the anomalies that can affect them in a wind turbine:

Shaft
- ✓ Static / dynamic imbalance
- ✓ Misalignment
- ✓ Deformation

Bearings
- ✓ Clearances
- ✓ Wear
- ✓ Misalignment
- ✓ Eccentricity

Gearbox
- ✓ Wear or breakage of teeth
- ✓ Eccentricity in gear
- ✓ Misalignment in gear

Mechanical Inspections for Wind Farm

Other inspections - As part of wind farm **life-extension plans**

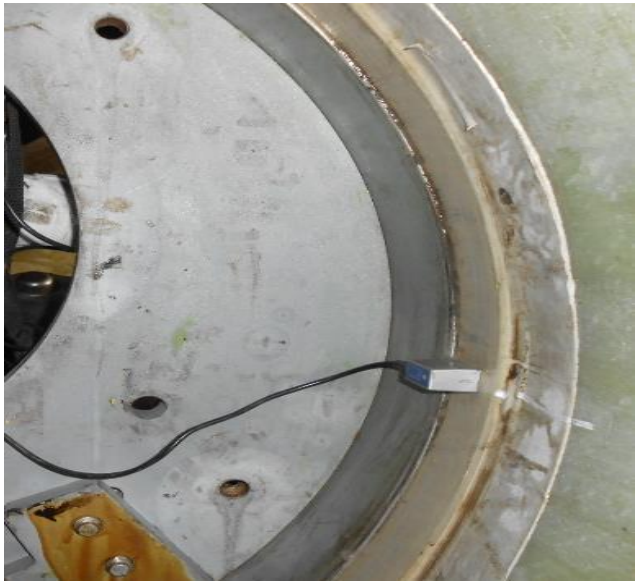
- **Welds inspections (Conventional & advance NDT techniques)**
  - Visual Inspection
  - Magnetic testing
  - Ultrasonic testing

- **AluRing Inspection:** Inspection of the union of the blade to the hub. Looking for fatigue cracks on the aluminum ring. Inspection based on Phase Array (PA) UT advance technique.

- **Power Shaft inspection:** Preventive inspection "Go / No-Go" in order to identify cracks in the material that may compromise the integrity. Inspection based on Phase Array (PA) UT advance technique.

- **Torque wind turbine bolts verification**
  - Mechanical or hidraulic/Electrical tools

- **Alignment power shaft-line verifications**



Mechanical Inspections for Wind Farm

Risk Mitigation & Life Assessments

- Mechanical inspection assessments:
  - To avoid unavailability losses
  - To life extension after the amortization period
  - To prevent main failures due aging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