

Protect Wind Project Profitability

# COMPREHENSIVE WIND MANUFACTURING SERVICES



Our team of experts protect clients' long-term profitability with tailored manufacturing services for onshore & offshore wind projects, including:

- + Preparation, review and validation of quality documentation & inspection procedures
- + Comprehensive non-destructive testing
- + Supplier audits
- + Factory inspections across main markets

# A Global Technical Partner for Onshore & Offshore Wind Projects

As part of the Applus+ Renewable Energy Services unit, our wind manufacturing services team of experts **protect clients' long-term profitability** by thoroughly reviewing wind design documentation and overseeing the production process of key wind farm components at the manufacturing facility. Our team takes the necessary steps to **mitigate performance-predictability risk, ensure quality, and facilitate long-term client return on investment**, while maintaining **independence** from manufacturers.

**+20**  
years

Experience in wind manufacturing inspection



AMIS Quality Management Software to ensure excellence

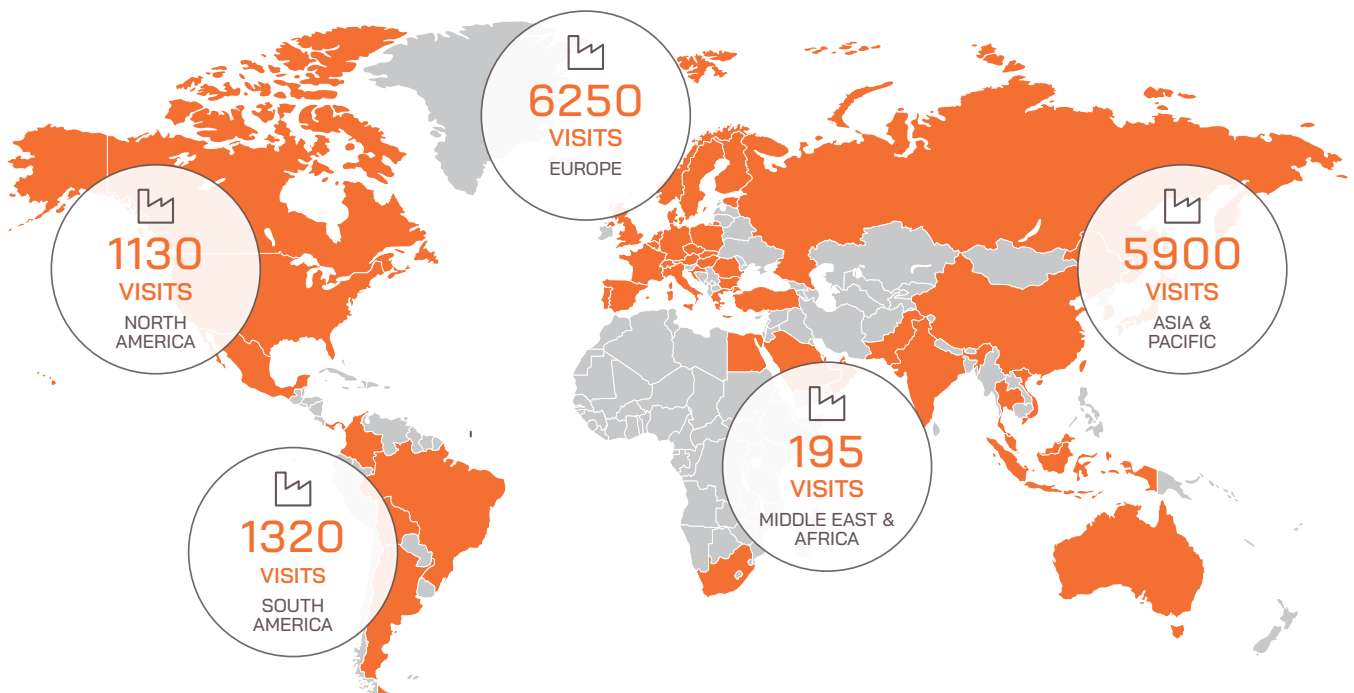


Expert ultra-advanced NDT operators

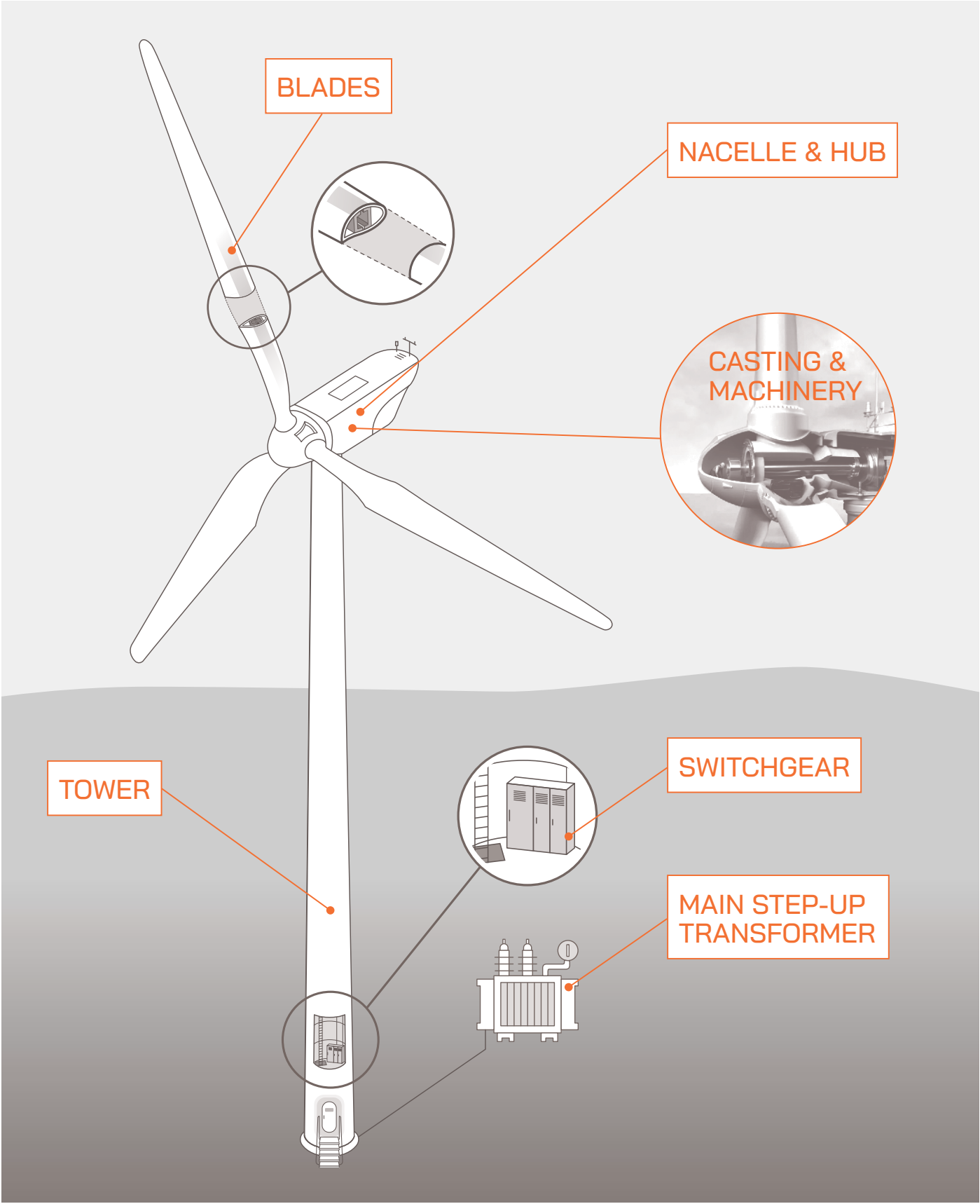


Skilled vendor inspectors in key industrial hubs worldwide

Our **extensive international experience in factory visits** can be summarized as follows:

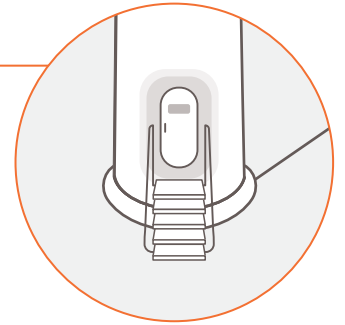


# Specialized wind manufacturing services for every key component



## WIND TOWER

Given the large size and the environmental stresses on wind towers, our wind manufacturing services help verify that every component is manufactured to precise specifications and is able to withstand factors such as strong winds, temperature fluctuations, and corrosion.



### IWEX technology for ultra-advanced UT NDT inspection

Our in-house developed Inverse Wave Field Extrapolation (IWEX) technology is based on full matrix capture (FMC). It allows locating and sizing defects in welds with great accuracy thanks to its 3D resolution. This technology is applicable to onshore and offshore wind projects.

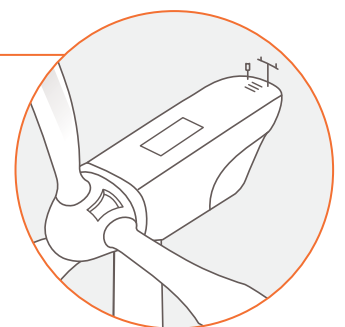
We support our clients **throughout the main phases** of wind towers manufacturing process\*:

Material verification	Welding Inspection ISO 5817	Internal verification	Sand-blasting	Painting inspection	Final release authorization
<ul style="list-style-type: none"> <li>• Steel plate assessment: corrosion; lamination</li> <li>• Dimensional verification</li> <li>• Beveling check</li> <li>• Flanges assessment (seamless or welded)</li> <li>• Documentary review / Lab tests (mechanical &amp; chemical properties)</li> </ul>	<ul style="list-style-type: none"> <li>• Visual inspection</li> <li>• Ultrasonic testing ISO 17640, ISO 11666, ISO 23279</li> <li>• Magnetic testing ISO 17638, ISO 23278</li> <li>• Dimensional verification between section after circumferential welding</li> <li>• Flanges dimensional verification (Laser track)</li> </ul>	<ul style="list-style-type: none"> <li>• Visual inspection &amp; dimensional checking</li> <li>• Electrical testing &amp; verification</li> </ul>	<ul style="list-style-type: none"> <li>• Surface roughness &amp; visual inspection</li> </ul>	<ul style="list-style-type: none"> <li>• Final visual check ISO 8501, ISO 8503</li> <li>• Salt testing</li> <li>• Thickness coating inspection</li> <li>• Adherence test</li> <li>• Brightest verification</li> </ul>	<ul style="list-style-type: none"> <li>• Loading &amp; storage process supervision</li> </ul>

\*A similar process applies to piles, mono-piles, transition pieces and jackets.

## CASTING & MACHINERY

The manufacturing of casting and its machinery is a very important phase especially for offshore wind projects. With our wind manufacturing services, we help our clients detect and correct imperfections early in the production process to extend the lifespan of wind turbines and maximize energy output.

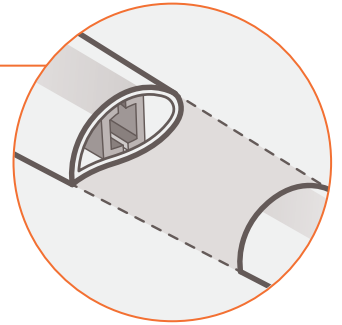


During **casting and machinery manufacturing process**, our experts inspect the following activities:

- Surface & internal inspections (NDTs)
- Surface inspections (NDTs)
- Material certification
- Casting process: molding – cooling – demoulding
- Surface condition
- Material quality testing
- Machining
- Dimensional control
- Corrosion protection

## BLADES

During the blade manufacturing process, defects that are not properly detected can cause cracks and cavities in the leading and trailing edges, as well as delamination at the blade root, thus negatively impacting the operation of the wind turbine.



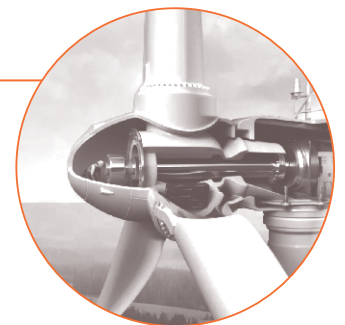
Our inspectors support our clients **throughout the main phases of blades manufacturing process:**

Raw material verification	Lay-up	Resin Infusion Process	Curing	Mould preparation /demoulding	Finishing
<ul style="list-style-type: none"> <li>• Visual inspection for damage or contaminants</li> <li>• Verification of supplier certification fiber &amp; adhesives, certificates 3.1</li> <li>• Verification of tests for strength &amp; mechanical properties certificate</li> <li>• Viscosity &amp; chemical properties testing</li> </ul>	<ul style="list-style-type: none"> <li>• Visual inspection of the placement of each layer</li> <li>• Control of overlapping &amp; alignment</li> <li>• Verification of fiber dimensions &amp; orientations</li> <li>• Verification of resin quantity &amp; uniformity</li> <li>• Impregnation tests</li> </ul>	<ul style="list-style-type: none"> <li>• Verification of vacuum tightness</li> <li>• Inspection of vacuum configuration &amp; infusion lines</li> <li>• Control of resin flow &amp; infusion times</li> <li>• Visual inspection during the process to detect possible bubbles or non-impregnate</li> </ul>	<ul style="list-style-type: none"> <li>• Control of temperature &amp; curing time</li> <li>• Verification of oven parameters</li> <li>• Post-curing visual inspection to detect deformations or defects</li> </ul>	<ul style="list-style-type: none"> <li>• Visual inspection of cleanliness &amp; condition</li> <li>• Verification of dimensions &amp; tolerances</li> <li>• Inspection of uniform coverage</li> <li>• Adhesion test</li> <li>• Visual inspection for damage during demoulding</li> <li>• Verification of surface integrity</li> </ul>	<ul style="list-style-type: none"> <li>• Inspection of final dimensions</li> <li>• Visual inspection of the surface</li> <li>• Check painted Leading Edge Protection (LED)</li> <li>• Lighting Protection System (LPS) resistance check</li> <li>• Check auxiliary systems (Ice Detection Device, Individual Pitch Control etc)</li> <li>• Balancing</li> </ul>

During the blade manufacturing process, other tests can be carried out, such as **END, UT, Thermography, LPS conductivity**, as well as load and stress tests, with verification of structural strength under simulated conditions.

## NACELLE & HUB

The key mechanical components in the nacelle, particularly bearings and gears, must be dimensionally precise, properly lubricated, and maintained with contamination-free oils and greases (as per ISO 4406 and ISO 12925 standards).



During the gearbox manufacturing process, **serial production testing is an essential activity and it includes:**

- |                                   |                                  |
|-----------------------------------|----------------------------------|
| • Flushing without load test      | • Temperature test               |
| • Load test                       | • Press test                     |
| • Gearbox lubrication system test | • Oil cleanliness test           |
| • Vibration test ISO 10816        | • Visual inspection by endoscopy |
| • Sound pressure test             | • Gear contact pattern test      |

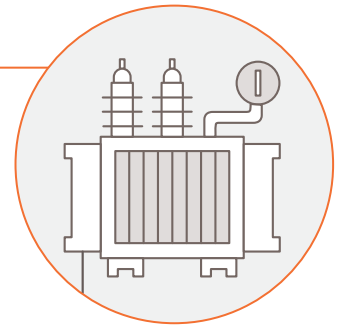
All nacelle components are assembled at the factory, and once assembly is complete, **Factory Acceptance Testing (FAT) is conducted on the nacelle and hub**. Our expert inspectors assist clients by witnessing FAT and providing guidance on the critical activities that must be closely monitored during these tests.

## MAIN STEP-UP TRANSFORMER

Quality control on main step-up transformers is essential as it verifies performance, durability, and adherence to industry standards, ensuring regulatory compliance and operational safety.

**Routine tests** are conducted on every transformer before leaving the factory to confirm compliance with required specifications. Additionally, **type tests** are performed on representative units to validate that the design meets international standards such as IEC or IEEE.

In addition to the routine tests, in accordance with IEC-60076, the following tests are recommended:



- Physical-chemical, dissolved gases & corrosive sulphur analysis of the insulating oil
- Capacity & power-factor of the insulation system
- Peak Efficiency Index (PEI)
- Zero-sequence impedance. (special)
- Line terminal AC withstand test
- Induced-voltage test with partial discharge measurement
- Temperature rise test
- Fan motors power consumption (type test)
- Noise Level Measurement (type test)
- Low-frequency test on auxiliary devices and control and current transformer circuits
- Operation tests of all devices
- Control (auxiliary) & cooling consumption losses
- Visual & dimensional check (type test)
- Check of the external coating (thickness & adherence)
- Sweep Frequency Response Analysis (SFRA)
- Frequency Domain Spectroscopy (FDS)

## SWITCHGEAR

The manufacturer must certify that the equipment to be supplied qualifies in all mandatory **type tests** established in section 6.1 of standard IEC 62271-200 and verification can be made by means of documentation.

**Routine tests** will be carried out on fully assembled cells previously tested by the manufacturer, in accordance with the recommendations of IEC standard 62271-200 section 7. These tests include:



- Mechanical tests & verification of interlocks (62271-200 sect. 7.102)
- Functional test of auxiliary electrical devices and/or elements (62271-200 sect. 7.104)
- Insulation test with voltage at industrial frequency (60694 sect. 7.1)
- Test on auxiliary & control circuits (60694 sect. 7.2)
- Resistance test on the main circuit (60694 sect. 7.3)
- Gas tightness & pressure testing, if applicable (60694 sect. 7.4 & 62271-200 sect. 7.103)
- Dimensional verification & general inspection (62271 sect. 7.5)
- Verification of paint & galvanization
- Field testing (62271-200 sect. 7.105 & 7.106)

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