PO.120

THE USE OF A LARGE CLIMATE CHAMBER FOR EXTREME TEMPERATURE TESTING & TURBINE COMPONENT VALIDATION

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Abstract

The wind turbine industry is rapidly expanding in remote areas where wind turbines need to work under extreme conditions. Operating temperatures can vary from -40°C tot +58°C depending on the location (Inner Mongolia, Finland, Canada, India, Africa,...).

Another trend is building turbines offshore or high in the mountains were maintenance tasks are more difficult. High reliability for every component is key for these machines to avoid expensive maintenance tasks in these remote locations. Advanced reliability testing is paramount in this evolving industry.

Remote located wind turbines in harsh environmental conditions: arctic wind turbine and offshore wind turbine

In General

Wind turbines and their individual components need to be tested to make sure they can withstand operational and extreme environmental conditions:

Mechanical environmental factors

- Shocks and impacts from strong blasts of winds and storms, turbulences, and emergency stops
- Low frequency vibrations from waves in offshore turbines
- Earthquakes
- …

Climatic environmental factors

- Temperature
- Humidity
- Salt
- Rain
- Pressure
- Ice/snow
- Solar radiation
- Sand
- …

In order to reduce the O&M costs two approaches can be defined:

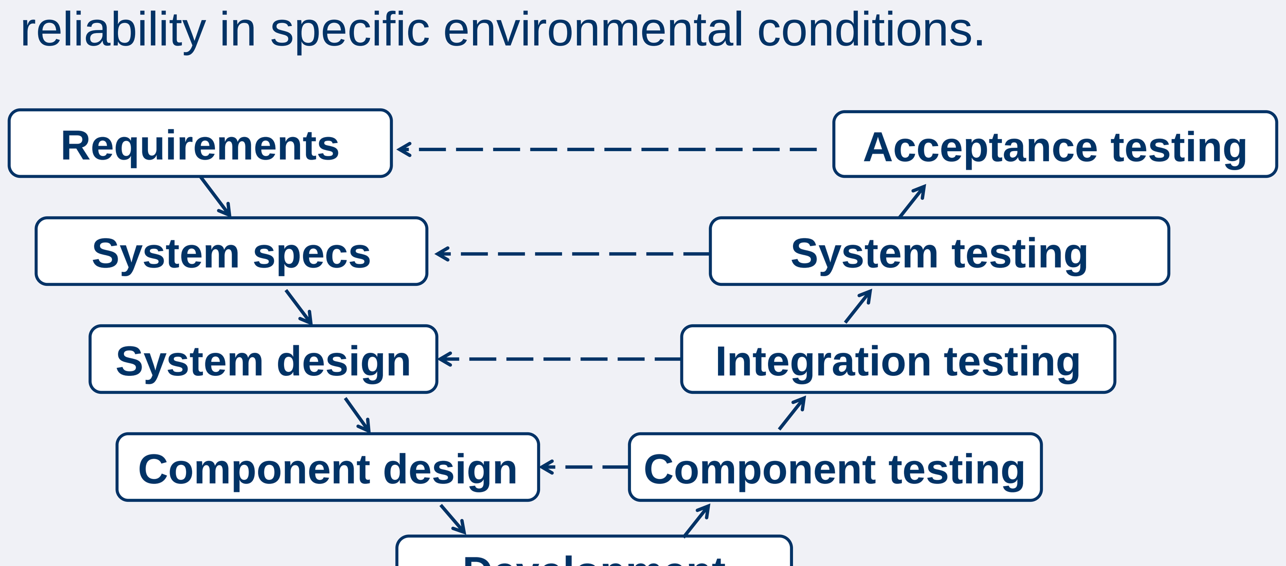
1. **Improving component reliability**
2. **Reducing costs to perform maintenance**

This poster will focus on the first approach and has a direct link with the activities of the OWI-Lab test facility which houses a large climate chamber for extreme temperature testing of wind turbine components.

Improving Product Reliability through Testing

Reliability means: *'the ability of a system to perform a required function, under given environmental and operating conditions and for a stated period of time'* .

Ideally, testing is done throughout the product development cycle. This allows model validation, product specification verification, and confirms robustness and reliability in specific environmental conditions.

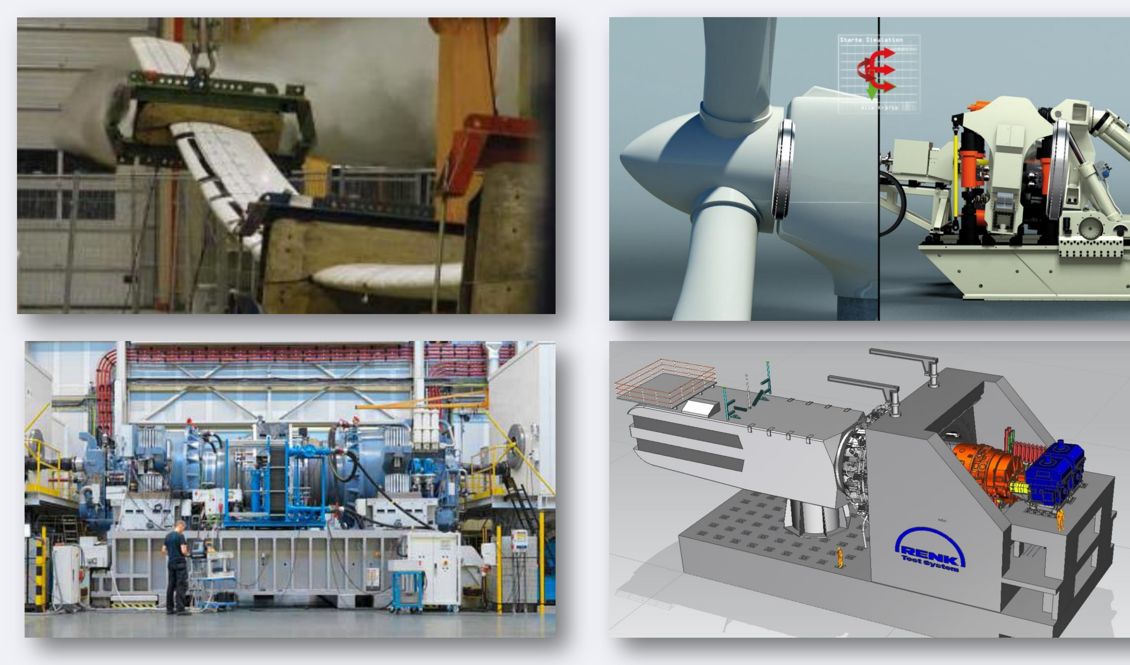


Product development cycle

Testing & Test Infrastructure

Wind turbines consist of different mechanical, hydraulic and electrical components. Obviously different system and integration tests need to be developed and performed for all these components in their specific working conditions:

- Wind turbine field testing
- Nacelle and drivetrain testing
- Drivetrain component testing
- Sub component testing (i.e. bearings, individual gears)
- Blade testing
- Tower & foundation testing



Risø National Laboratory blade test ; FAG bearing test stand ; ZF Wind Power Antwerpen NV gearbox test stand ; 7.5MW drivetrain test stand – Renk test systems

Because the time-to-market in wind energy systems is preferably as short as possible, and due to the lower costs associated with laboratory testing in comparison to field testing in remote locations, specialized test stand to perform advanced testing in controlled environments are needed. The advantage of controlling the mechanical and climatic loads in the laboratory is to apply new stress test methodologies like accelerated lifetime testing.

Different companies and knowledge centers are currently investing in dedicated test stands as an alternative for field testing in order to better understand the failure modes in wind turbines. The challenge here is to cope with the trend towards bigger multi-MW turbines which means large weights and dimensions, higher torques, power, cooling capacity, etc,…

Extreme Temperature Testing

Climatic environmental testing, in particular temperature testing is one of the essential tests for wind turbine components. Temperature difference, thermal shock and extreme temperature values can have their impact on:

- Differential thermal expansion of (sub)components and materials
- Lubricants can become more or less viscous which effects the oil flow in bearings and raceways
- Metals can become brittle at very low temperatures
- Cooling system can experience overheating problems during extreme heat
- Cold start problems and negative effect on energy yield

CG Power transformator in climate chamber & Cold start test ZF Wind Power Antwerpen NV

Usually on- and offshore turbines are designed to operate in a temperature range of -10°C to +40°C but in some locations low temperatures can reach -40°C. A proper cold start procedure, starting up the turbine after idling in cold conditions, has a big influence on the reliability and productivity of these turbines.

Large Climate Chamber OWI-Lab

OWI-lab's large climate chamber is available to test a broad range of current and future wind turbine components:

- Mechanical components (gearboxes, yaw & pitch systems,...)
- Electrical components (transformers, switch gears,...)
- Electro-mechanical equipment (generators, hybrid gearboxes,...)
- Power electronics (convertors, ...)
- Hydraulic components (hydraulic gearboxes, oil filters,...)
- Cooling and heating systems
- ...

<u>Facts and figures large climate chamber:</u>

- Maximum test dimensions **10 m x 7m x 8 m** (L x W x H)
- Temperature range for testing: **-60°C to +60°C**
- Located nearby a breakbulk quay to handle large and heavy objects (up to **150 ton**); capacity test chamber
- Floor capacity: **30 ton/m²**
- Large cooling and heating power
- **315 kW** drive and **intermediate gearbox (1:5)** to drive mechanical components (i.e. Gearbox cold start tests)
- **High power to feed any electrical components** for system testing can be foreseen by mobile generators up almost any required power range (including multi MVA)

Conclusion

- Reliability is key for wind turbines at remote locations
- Extreme environmental scenario's have to be tested
- Advanced testing becomes more and more important to reduce the time-to-market of turbine components, ensure reliability to clients and to obtain certification.
- (Extreme) temperature testing is needed for the validation of certain components
- OWI-lab invested in a large climate chamber in order to support manufacturers in the testing process

Project Partners

OWI lab Offshore Wind Infrastructure Application Lab; sirris driving industry by technology; ZF; 3E; Smart solutions. Strong relationships.; GeoSea Geotechnical Offshore Contractor; Vrije Universiteit Brussel; AGORIA RENEWABLE ENERGY CLUB; GENERATIES.NET; IWT; Met steun van de Vlaamse Regering