NDT standards and best practice guides

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Workshop on NDT and SHM requirements for wind turbines
Blyth Feb 2019
Overview

- Focus on composite blades
- Initial literature review of DNV & GL WTB guidelines conducted for BINDT composites group in 2015
  - Documents searched for NDT/inspection
  - Updated list compiled
- Practical examples where NDT specifications and guidance would have helped
- Requirements guidelines, best practice
High level documentation

• Plenty of documents out there
  • Many standards mentioned at this workshop
• Role of inspection/NDT largely clear within those standards
• But
  • Level of detail does not cover specific applications methods, techniques, approaches
Updated documents

• Search “Renewables Certification” on DNVGL website
  • https://www.dnvgl.com

Renewables Certification Guidelines and Technical Notes
DNV GL developed guidelines and technical notes for the certification of wind turbines, wind farms and other renewables.
Key documents

- All are updated documents from original 2015 searches
- Keyword search:
  - NDT, inspection, surveillance
Notes on NDT in guidelines

• Inspection and surveillance used interchangeably sometimes inferring NDT as the technique
• NDT often mentioned in connection with welding
  • Not surprising as many standards exist that deal with weld inspection
  • Very few (arguably none) exist for composite inspection
• Implied use of NDT to support life extension
• Comprehensive guideline covering CMS but not NDT
IEC 61400:22 standard withdrawn

• Function moved to IECRE
• http://www.iecre.org/documents/refdocs/

• Opportunity here for specific NDT guidance operational documents?
IEC 61400-23

61400-23 Full-scale structural testing of rotor blades.pdf

NDT mentioned in connection with testing blade is manufactured to required specs e.g.

“Non-destructive testing (NDT) techniques can, in some cases, be used to check that the blade is built in accordance with the design assumptions and to find manufacturing defects. NDT can be performed in connection with other tests. Some of the methods used are:

- measurements checking the geometry of the blade (e.g. dimensions, profile, etc.);
- coin-tap;
- acoustic transmission;
- ultrasonic testing;
- acoustic emission [9];
- thermal imaging [10].”
NDT examples where guidance would help

• These examples are ultrasonic EVALUATION techniques
• SHM and CMS methods are required to ensure that specific NDT techniques can be targeted
  • This is the NDT challenge !?
• Applying NDT alone is expensive, intensive, time consuming
  • Particularly when applied in-service
Case study 1 – wrinkles

- NDT requested by blade manufacturer
- Clear-ish specification on wrinkles 😊
  - Limited modelling/design/mechanical data to guide 😞
- Full access to manufacturer L3 😊
- Full access to NDT procedures 😊
  - But no existing techniques relating to wrinkles 😞
- Aerospace phased array qualification approach followed
  - Low severity measurement possible 😊
  - Material variation a problem on this product 😞
    - But not on test coupons 😋?
  - High severity wrinkles a problem cannot measure but can detect 😊😊
Phased array image (Aero)
Phased array image (WTB)
Waviness description

![Diagram showing Laminate angle sizing and Waviness description](image-url)
Acceptance criteria

![Wrinkle assessment criteria graph](image-url)

- **Acceptance line**
- **PASS**
- **FAIL**
- **OUT OF RANGE**

**Wrinkle width (mm)**

**Wrinkle height (mm)**

**Focus 1**

**Focus 2**

**Focus 3**

**Acceptance line**
Case study 2 – bonding

• NDT requested by wind farm operator
• No access to blade drawings 😞
• No access to NDT procedure used to manufacture blade 😞
• No specific guidelines on qualifying techniques 😞
• Some information on defect acceptance criteria 😊
• Good access to failed blades 😊
• Willingness to validate inspections 😊
Visual inspection: Root section (R16)
Large area C-scan result
Localised PA B-scan result

Root section (R16) pressure side: Cross-section view

- Trailing edge laminate
- Trailing edge web bonding
- Leading edge web bonding
- Leading edge laminate
Testing at 65 m
We should talk more often!!

- Turbine manufacturer
- Wind farm operator
- Blade manufacturer
- Inspection companies
- Structural certification
- Designer
- Regulatory bodies

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What is needed?

• Studies on combining SHM/CMS (detection/screening) and NDT (evaluation/measurement)

• Specific guidance on
  • NDT Technique development
  • Effect of defect studies (aid acceptance criteria reporting)
  • Qualification of inspection methods
  • Validation on structures

• Better linking/data exchange between
  • Manufacturer (production – stress/design)
  • Operators
  • NDT providers