Closed Loop Wind Farm Control

New wind power plant control in the framework of existing certification schemes

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DO WE HAVE THE STANDARDS TO CERTIFY CL-WINDCON PLANT CONTROL (CLW-PC)?

Review on:
- Control System
- Grid Code Compliance
- Loads

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TYPE CERTIFICATE
WIND TURBINE LEVEL

Mechanical, structural and electrical design requirements
e.g. IECRE OD-501 or DNVGL-SE-0441

Grid Code Compliance (GCC) requirements
e.g. FGW TG8 or DNVGL-SE-0124
Mechanical, structural and electrical design requirements e.g. IECRE OD-502 or DNVGL-SE-0190

GCC requirements e.g. FGW TG8 or DNVGL-SE-0124
CONTROL SYSTEM
PRACTICAL RECOMMENDATIONS

• Commands from CLW-PC shall never override protection functions or parameters in WT control!

• Tune protection functions carefully!

• Add possible failures to WT failure analysis!

• Calibration of wind vane up to 40 ° yaw misalignment!

Change of standards not suggested
CONTROL SYSTEM
SUGGESTED CHANGES FOR STANDARDS

• Testing for certification:
  – all demand values from CLW-PC to wind turbine
  – all actual values from wind turbine to CLW-PC

• Commissioning:
  – all CLW-PC functions
  – all communication lines

• Inspections:
  – for maintenance of Project Certificate inspection
    program to be extended acc. to CLW-PC
GRID CODE COMPLIANCE

• Grid Codes request wind power plant control to ensure stability of electrical grid

• Wind farm receives set points from the network operator regarding
  – active power
  – reactive power, power factor or voltage control

• Functions implemented by Existing Plant Control (E-PC)

• E-PC and CLW-PC functions partly overlap and must be merged

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GRID CODE COMPLIANCE
SUGGESTED CHANGES FOR STANDARDS

Design
- Clear hierarchy between E-PC and CLW-PC
- Functionality for override of CLW-PC to be ensured
- Extension of electric simulation models including validation for CLW-PC

Testing
- FRT including tests for high yaw misalignment. Design loads!
- Priorities and co-ordination between CLW-PC and the E-PC
- Controllability of active power

➢ IEC61400-21-x should be changed!!!

Change of standards is suggested!!!
LOADS
SITE-SPECIFIC LOAD CALCULATION FOR CLW-PC

Conventional load calculation + Additional CLW-PC input

- Tools for load simulation
- Design load cases
- Control strategies

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LOADS

TOOL VALIDATION

Novel tools require validation

- Need of adapted and validated design tools and models for industry and certification
  - blade element method probably invalid for large yaw errors
  - wake location, DWM model
  - wind farm simulation

Change of standards not suggested
LOADS
DESIGN LOAD CASES

Additional load cases

- Consider all cases dependent on detailed control strategy acc. IEC61400-1 Ed.4
  - all possible actions and faults initiated by CLW-PC
  - wake operation
  - Distinction between acting turbines and affected turbines
  - Acting and affected turbines might change dependent on external conditions, e.g. wind direction

Change of standards is suggested!!!
LOADS
CONTROL STRATEGIES

Increased complexity

- Consider all load reduction strategies
- Identification of turbines with highest fatigue and extreme loads is laborious
- Need to define a subset of operational conditions to minimize the effort.

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CONCLUSION

• It is **possible NOW to certify CLW-PC** by proper interpretation of existing standards!
  – to be agreed with certification body in advance (e.g. tools, design load cases...)

• Changes of standards suggested for:
  – testing, commissioning, inspection
  – GCC
  – design load cases

• Step-wise introduction to gain more experience

• Good balance for level of requirements in comparison to “conventional” design
THANK YOU!

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