IEA Wind Task 40, WP3-1, RP Candidates [A]

2019/05/07 Kiyoki, S. (Hitachi), Yoshida, S. (KU)

1. SCOPE
The candidates of Recommended Practices (RP) are listed up.

REVISION RECORD
[A] T40WP3-001A, 2019/05/07, passive yaw was separated into the conditions and the model. Power curve correction and noise/infrasound were added. Some of the information was updated.

2. OUTLINES

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3. RP CANDIDATES
(Following pages)
1. Relevant Regulation
IEC61400-1

2. Outlines
Tower shadow effects have to be considered in the load calculation, but no specific method is defined for the aeroelastic simulations.

3. Status
Load equivalent model [Yoshida, S., Kiyoki, S., Load Equivalent Tower Shadow Modeling for Downwind Turbines, EWEC2007] is applied for 2MW and 5MW turbines. Massive CFD is necessary to each operation condition.

4. Proposed Approach
1) Standard evaluation (WP3-1)
2) Model formulation (WP1-2)
3) Verify the model by CFD/experiment (WP1-2)
4) Implement in BEM/aeroelastic code (WP1-2)
5) Evaluation of the effect (WP1-2)
6) RP (WP3-2)

Truss tower?
(2) Nacelle-Rotor Interaction Model (WP1-3)
   Proposed by Yoshida, S. (KU)

1. Relevant Regulation
   IEC61400-1

2. Outlines
   Nacelle-rotor aerodynamic interaction affects to the performance and loads. But no specific method is defined for aeroelastic simulations.

3. Status
   GBEM based model was proposed, but it is still not validated.

4. Proposed Approach
   1) Standard evaluation (WP3-1)
   2) Model formulation (WP1-3)
   3) Verify the model by CFD/experiment (WP1-3)
   4) Implement in BEM/aeroelastic code (WP1-3)
   5) Evaluation of the effect (WP1-3)
   6) RP (WP3-2)
(3) Passive Yaw Model (WP1-4)

Proposed by Kiyoki, S. (Hitachi)

1. Relevant Regulation

IEC61400-1

2. Outlines

+/-15 deg (steady wind model) and +/-8 deg (turbulent wind model) of yaw misalignment are required for active yaw controlled wind turbines in DLC6.1.

![Fig 2 IEC61400-1 ed.4 CDV (7.4.6) Extract of Active Yaw Control](image)

Simulation with turbulent wind models are required for passive yaw controlled turbines. Although, it is pointed out that yaw misalignment is governed by wind direction change and yaw dynamic response, a specific design method is not defined.

![Fig 3 IEC61400-1 ed.4 CDV (7.4.6) Extract of Passive Yaw Control](image)

3. Status

For wind direction changes, only short term change are considered, and long term change (changes in average wind direction) is not considered. The long term change was shown to affect to the storm loads.

4. Proposed Approach

1) Standard evaluation (WP3-1)
2) Model definition and validation (WP1-4)
3) Sensitivity analysis (inertia, static/dynamic frictions) (WP1-4)
4) RP (WP3-2)
(4) Passive Yaw Condition (WP1-4)
Proposed by Kiyoki, S. (Hitachi)

1. Relevant Regulation
IEC61400-1

2. Outlines
 +/-15 deg (steady wind model) and +/-8 deg (turbulent wind model) of yaw misalignment are required for active yaw controlled wind turbines in DLC6.1.

![Fig 4 IEC61400-1 ed.4 CDV (7.4.6) Extract of Active Yaw Control](image)

Simulation with turbulent wind models are required for passive yaw controlled turbines. Although, it is pointed out that yaw misalignment is governed by wind direction change and yaw dynamic response, a specific design method is not defined.

![Fig 5 IEC61400-1 ed.4 CDV (7.4.6) Extract of Passive Yaw Control](image)

3. Status
For wind direction changes, only short term change are considered, and long term change (changes in average wind direction) is not considered. The long term change was shown to affect to the storm loads.

4. Proposed Approach
1) Standard evaluation (WP3-1)
2) Statistical analysis of SCADA data (wind speed and direction change rate) in typhoon conditions (WP1-4)
3) Proposal of wind direction change rate over V1 (WP1-4)
4) RP (WP3-2)
(5) Yaw Measurement Accuracy (WP1-4)
Proposed by Kiyoki, S. (Hitachi)

1. Relevant Regulations
IEC61400-1

2. Outlines
+/-15 deg (steady wind model) and +/-8 deg (turbulent wind model) of yaw misalignment in DLC6.1 can be reduced for downwind turbines as it is expected to be more accurate than that of upwind turbine, due to the position of the yaw sensor in front of the rotor. But, the condition is dependent not only on the yaw measurement accuracy, but also wind direction change and yaw control.

In DLC 6.1, for a wind turbine with an active yaw system, a yaw misalignment of up to ±15° using the steady extreme wind model or a mean yaw misalignment of ±8° using the turbulent extreme wind model shall be imposed, provided restraint against slippage in the yaw system can be assured.

Fig 6 IEC61400-1 ed.4 CDV (7.4.6) Extract of Active Yaw Control

3. Status
+/-8 deg of yaw misalignment is considered in the turbulent wind model as described. No evidence is shown for smaller yaw misalignment.

4. Proposed Approach (Lower Priority)
1) Standard evaluation (WP3-1)
2) Investigation of evidences of +/- 8deg (WP3-1)
3) Sensitivity analysis of the yaw misalignment (WP1-4)
4) Yaw accuracy comparison between downwind and upwind turbines (WP1-4)
5) RP (WP3-2)
(6) Noise/Inrasound (WP1-?)
   Proposed by Yoshida, S. (KU)

1. Relevant Regulations
   IEC61400-11

2. Outlines
   Measurement and evaluation of infrasound and amplitude modulation which are downwind turbines.

3. Status
   Same as upwind turbines.

4. Proposed Approach (Collaboration with Task 39)
   1) Standard evaluation (WP3-1)
   2) Measurement and evaluation method (Task39)
   3) Estimation model (WP1-4/Task39)
   4) RP (WP3-2)
(7) **Helicopter Deck (WP1-?)**

Proposed by Kiyoki, S. (Hitachi)

1. Relevant Regulations
   CAP 437 (Standards for offshore helicopter landing areas)

2. Outlines
   Nothing can be placed in the "No obstacles" region between the rotor and the helicopter deck. It is desirable to install anemometers and wind vanes in the forward position and higher position than the helicopter deck, where is designated as “No obstacle” area. Upwind turbines can place them between the blade and helicopter deck (1.5-3.0m above he nacelle roof).

   ![Diagram](image)

   **Fig 7 CAP 437, Extract of Chapter 10 Figure 3**

3. Status
   Anemometers and wind vanes are installed in the area specified by the standard.

4. Proposed Approach (Hitachi studies internally)
   1) Standard Evaluation (WP3-1)
   2) To be investigated (Hitachi)
   3) RP?