Recommended practices for wind farm data collection and reliability assessment for O&M optimization

Berthold Hahn[a], Thomas Welte[b], Stefan Faulstich[a], Pramod Bangalore[c], Cyril Boussion[d], Keith Harrison[e], Emilio Miguelanez-Martin[f], Frank O'Connor[g], Lasse Pettersson[h], Conaill Soraghan[e], Clym Stock-Williams[i], John Dalsgaard Sørensen[j], Gerard van Bussel[d], Jørn Vatn[k]

[a] Fraunhofer IWES, [b] SINTEF Energy Research, [c] Chalmers University of Technology, [d] Delft University of Technology, [e] Offshore Renewable Energy Catapult, [f] Atkins, [g] ServusNet Informatics, [h] Vattenfall Research and Development, [i] ECN Energy Research Centre of the Netherlands, [j] Technical University of Denmark/Aalborg University, [k] Norwegian University of Science and Technology

IEA Wind Task 33

re•li´•a•bil´•i•ty (ri, līə 'bilətē) *n.*
a person or thing with trustworthy qualities. Task 33 · Reliability Data

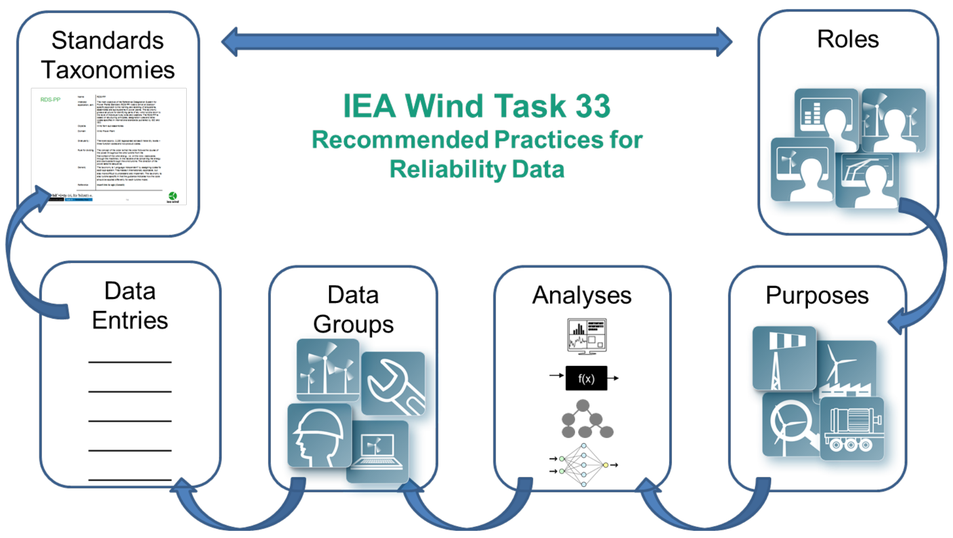
IEA Wind Task 33 commenced in 2012 with focus on data collection and reliability assessment for O&M optimization of wind turbines. The task 33 group finalized the work in September 2016 and the results will be published in 2017 by IEA Wind in the recommended practices (expert group report) for "Wind farm data collection and reliability assessment for O&M optimization"

IEA Wind Task 33 has strived at finding answers to the following questions:

- *Which information do operators and other stakeholders need?*
- *What analyses can provide the requested information?*
- *Which data has to get recorded to feed these analyses?*

Task 33 Approach

1. *Role and purposes (use cases)*
   Identify your individual circumstances and reliability objectives
2. *Analyses*
   Identify analyses that support your purposes and objectives
3. *Data groups and data entries*
   Identify data groups and data entries required for the intended analyses
4. *Standards and taxonomies*
   Identify useful standards, guidelines and taxonomies



Levels of complexity:

Level	Possible application	Possible analyses	Needed data groups	Requirement on organizational foundation of reliability
A	Performance, Availability	Simple statistical calculations (average values, histograms, …)	Equipment data, Operational data Measurement values	Assessment of assets is recognized as important.
B	Plus: Root cause analysis	Fault-Tree-Analysis, Pareto-analysis, Basic physical models (e.g. Miner's rule)	Plus: Failure data	Reliability is recognized as important, some processes around reliability exist.
C	Plus: Design optimization, Maintenance optimization, Degradation monitoring	Degradation models, Advanced physical models (e.g. modelling fluid-structure interaction), Maintenance and logistics optimization, Data mining, Vibration analysis, Optimization (renewal, stock keeping, etc.)	Plus: Maintenance and inspection data (Costs)	A clear and formal reliability process is defined and regularly reviewed with stakeholders.

Data groups and examples of sub-groups:

Data groups	Sub-groups
Equipment data (ED)	Identification, time data, technical information
Operating data / Measurement values (OP)	Time stamp, measurement values (SCADA, etc.), operational states
Failure data (FD)	Identification, time data Failure description, failure effect, failure detection, fault properties
Maintenance & inspection data (MD)	Identification, time data, task/measure/activity, resources, maintenance results

Data groups and related taxonomies:

Taxonomies	ED	OP	FD	MD
RDS-PP®	o			
NERC GADS	o	-		-
Reliawind	o			
ISO 14224	(o)		(+)	(+)
FGW ZEUS		o	+	+
IEC 61400-25		+		
IEC 61400-26		o		

+ wind-specific entries with a high level of detail
o wind-specific entries with a high level of detail, but not complete
- wind-specific entries on a more general level
(+) entries with a high level of detail, not wind-specific
(o) entries with a high level of detail, not wind-specific, but not complete
(-) entries on a more general level, not wind-specific

Conclusions and further work

- There is a strong demand for making better use of operational experience to improve O&M as well as other applications.
- The recommended practices of IEA Wind Task 33 mean an important step towards making use of operational experience for reliability improvement.
- The IEA Wind Task 33 results have been developed and reviewed by experts from research and industry in the field of reliability.
- The results may be adopted in part or in total by other standards developing organizations and one of the IEC working groups dealing with availability and reliability has already announced to base their future work on these results.

Task 33 Recommendations

Developers / owners / operators	**1. Make sure you get access to all relevant data** Consider reliability data to be of high value from the early stages of wind asset development and a key operational factor throughout the life of the wind asset. Ensure access to reliability data and required data are factored into negotiations with developers / OEMs / suppliers / service providers.
	2. Identify your use-case and be aware of the resulting data needs Identify use cases linked to your organizational reliability ambitions and use these to define data collection requirements.
	3. Map all WT components to one taxonomy / designation system Map all wind asset components and maintenance activities to one of the taxonomies / designation systems identified in the Task 33 recommended practices. This will allow for improvements in both the consistency and integrity of reliability data throughout an organization and at the interfaces with the supply chain.
	4. Align operating states to IEC 61400-26 Align operating states with those specified in IEC 61400-26, the standard for a time- and production-based availability assessment for wind turbines.
	5. Train your staff understanding, what data collection is helpful for All staff engaged directly, or indirectly, in the production, collation and analysis of reliability metrics should be educated on the strategic significance of reliability data and empowered to improve related business processes and practices.
	6. Support data quality by making use of computerized means Whenever practical, seek to automate the data collection / collation process as a means of reducing the risk of human error and improving data quality.
	7. Share reliability data to achieve a broad statistical basis Wind farm owners / operators should engage in the external, industry-wide sharing of reliability and performance data. This will align data collection methodologies, drive organizational improvements and achieve statistically significant populations of data for reliability analyses.
Development of standards for the wider wind industry	**8. Develop comprehensive wind-specific standard based on existing guidelines/standards** Develop a comprehensive wind specific standard based on ISO 14224, FGW ZEUS, and other existing guidelines/standard. This would provide a core standard for the language and scope of reliability and maintenance data for the wind industry (based on accepted reliability data best practice in oil and gas industry), while minimizing the time and cost associated with the development of the standard.
	9. Develop component- / material-specific definition of faults, location, and severity As a longer-term recommendation, there is a need to develop standard definitions for damage classification and severity for structural integrity issues.

Countries represented in IEA Wind Task 33:

Task 33 Operating Agent:
Fraunhofer IWES