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# Haliade 150 6MW RAMS process for reliability improvement and validation

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RAMS / Technical Excellence / Alstom Wind

## Abstract

The Haliade 150 wind turbine has been developed according to specific reliability and availability targets. Those targets have been breakdown to the main systems and subsystems and have been used by the engineers as a driver for the development of the systems. As part of the RAMS model definition, in a first step, a system functional diagram (SFD) is generated with the list of all the components and their interrelation. In a second step a failure mode effects analysis (FMEA) is conducted and finally a reliability block diagram is model in a commercial software introducing the reliability data (MTBF, MTTR) of each component. As a conclusion for this loop a comparison with the requirements was performed and in case of deviation the necessary design loops were executed to meet them. In the second phase of the project a DRACAS system was defined where the main information of field operational data is stored: identifications (Wind farm, wind turbine), time of stoppage, cause of the incident (by system / subsystem), visit required to the wind turbine, spare part required for repair. In the third phase of the project as a validation of the methodology the full process is applied for a ECO122 wind turbine obtaining a comparison between the theoretical RAMS model and the field data.

## Objectives

Improving future designs requirements feeding RAMS model with field data (Data Recovery and Control Action System)

Improving Reliability of systems designs at most early phases to minimize costs of changes

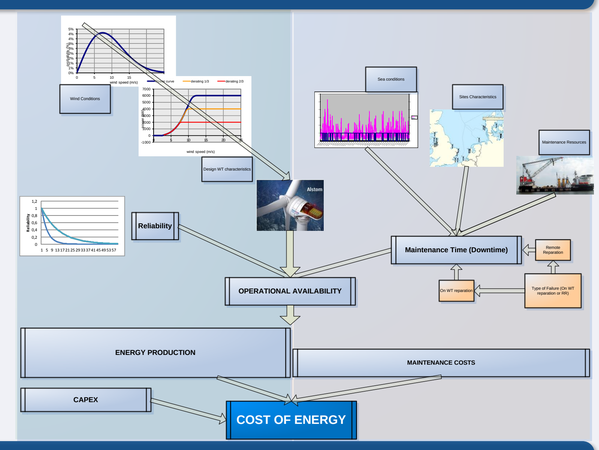
Reducing Corrective Maintenance Frequency and consequenlty Maintenance Costs

Improving Predictive Maintenance knowledge and Spare Parts prediction

Improving Production Yield → Considering costs to reach Optimal **Cost of Energy**

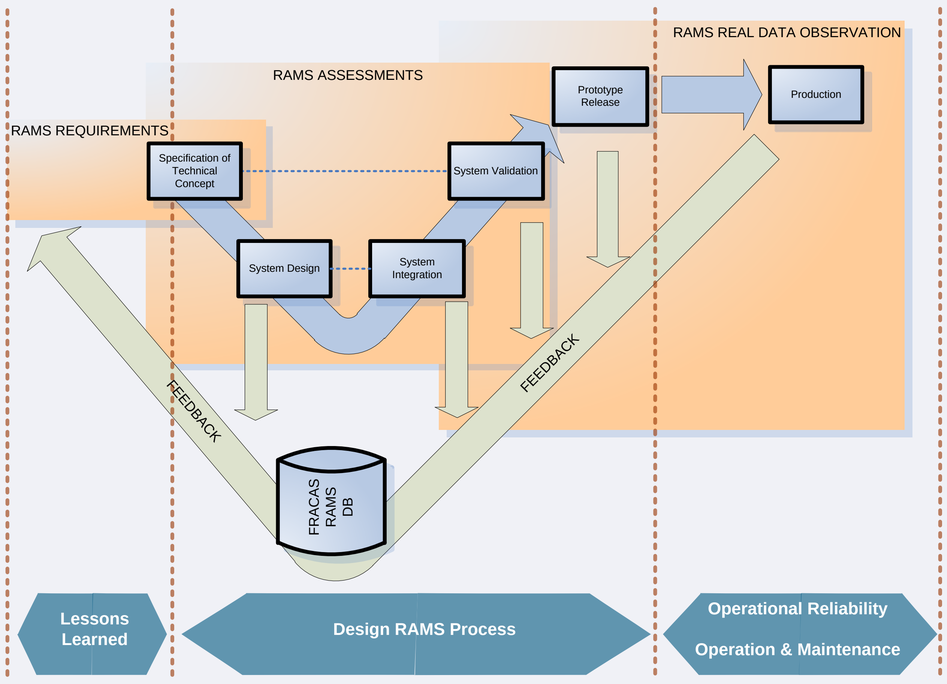
Improving time to Repair

Functional Safety Certification (iso 13849, iec 62061)




## Methods

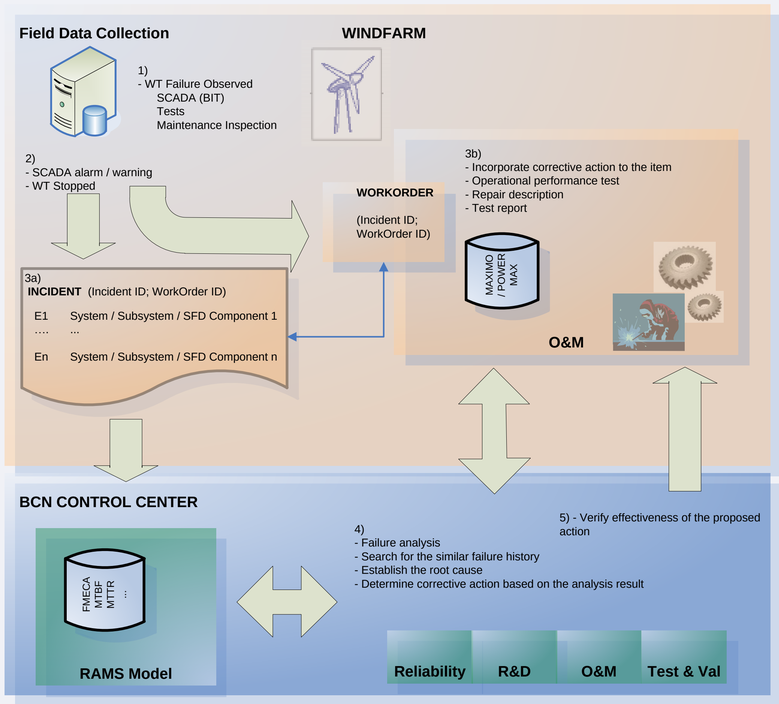
### RAMS and Product lifecycle

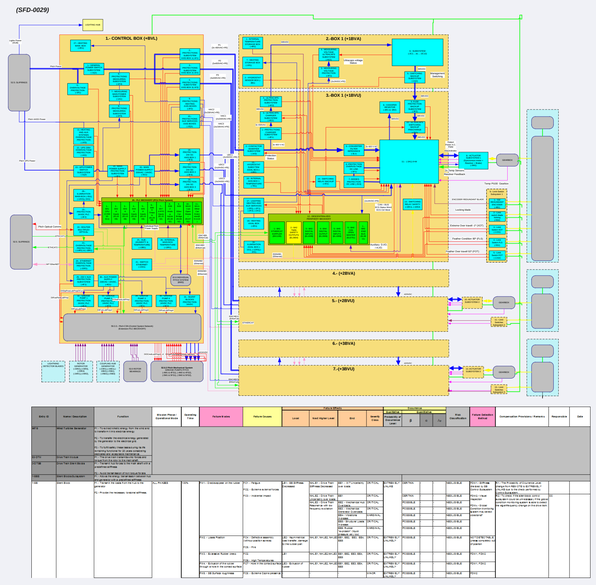



By means of RAMS process and methods like FMECAs, SFD, Reliability data bases and DRACAS process that provides the current field data is possible to feed the current theoretical RAMS model allowing to predict Reliability (taking the oportunity to improve design), Maintainability (taking oportunity to design better acces), Safety (to reach the most high Safety standardsfor Safety Integrity Level).

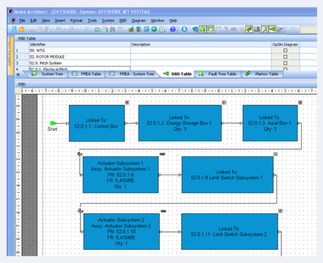
At the first loop for Offshore the main data comes from onshore data bases.

### DRACAS

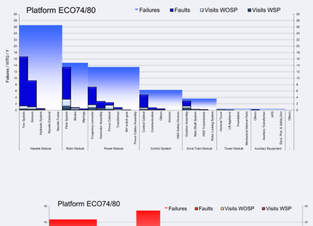


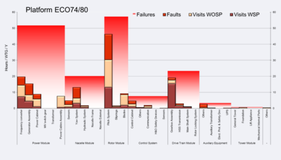




**System Functional Diagrams & FMECAs**



Reliability
Availability
Maintainability
Safety
**Results**




**Reliability Block Diagrams & Assessments**




**Feedback and GAP Analysis**

## Conclusions

The presented process of theoretical RAMS model development for new designs and later comparison of the model to the field data through the developed DRACAS systems shows to be accurate to perform a qualitative comparison that pointed the more critical system and advance future design strategies to achieve the global objective of improving wind technology reliability. More effort and future work are required to analyse the quantitative differences between theoretical and field models and to extend the validation of the process to the offshore environment.

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