

# ***Interactive comment on “A review of wind turbine main-bearings: design, operation, modelling, damage mechanisms and fault detection” by Edward Hart et al.***

**Edward Hart et al.**

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Received and published: 21 October 2019

Dear Babak,

We would like to start by thanking you for taking the time to review our article and make very valuable comments and suggestions. Your points highlight some of the differences between industry practises and existing literature, the identification of which will make this paper all the more relevant to wind energy research as well as the wind industry itself.

We reply to each of your comments specifically below.

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Regarding Section 3.2: We agree that more detail regarding this derivation would improve clarity here, these relevant steps will therefore be added into the revised manuscript. In terms of the reference frame used we have used the reference frame of the text (The Wind Energy Handbook) from which this description is taken, showing how fluctuations in hub loading can be expressed as fluctuations about a mean with deterministic and stochastic components. The current version of the paper does this consistently with the original source and we feel it could create more confusion to deviate from that original description. Therefore on this point we would like to keep the existing reference frame, although we are happy for the editor to have the final say here.

Regarding Section 4.1: You raise the very important point of maintainability as associated to the various drivetrain designs. We agree that a discussion of this should be included and will add this into the revised manuscript. Published literature that discusses these aspects in detail is somewhat thin on the ground but we have found some good references which will allow us to bring it into the conversation.

Regarding Section 6.1: Thank you for raising this point. Again this highlights the lack of discussion of these maintenance approaches in the academic literature. We will revise this sentence as you have suggested and have also found sources which describe these systems which will also be included.

Regarding Section 6.2: An excellent suggestion. We will expand this section to include failures related to materials and manufacturing including influences of steel cleanliness and heat treatments, inclusion microstructures etc.

Regarding Section 8: Just to clarify, we had not been claiming that AE is used for wind turbine main-bearings. This part of Section 8 was outlining the common techniques (vibration and AE) and discussing the difficulties both can have in lower speed applications and for MBs in particular. The insight into AE attenuation is very helpful and we will add this to that section. Section 8 is the main one for which there is a large

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discrepancy between industry practise and the academic literature. You are quite right of course about the available CMS softwares, interestingly there is very little cross-over between them and the current literature (which this section covers). Therefore, it seem this discrepancy needs to be discussed directly in the paper to point out that academic research is not aligned well to what is happening in the field. We will therefore discuss some of the existing products and the signals on which they make predictions. You specifically mention the ball-pass frequency as a detection method. We assume that this is measured using processed vibration data, and so does align with the techniques we discuss in this section, but we'll make sure to mention it more specifically. From discussions with industry partners we have found a general opinion that for younger turbines the detection of these faults is relatively easy as you have mentioned, but that as a fleet ages it becomes more difficult as false-positives start to creep in. In this latter situation a broader knowledge base and range of techniques driven by academic research may well give valuable detection improvements, and so we feel there is value to this area being given research focus and hence being included in the paper here. We will try and bring out some of the nuances of this discussion when revising the manuscript, although as ever there is limited literature discussing this.

Again, we thank you for the time and effort you have put into appraising our paper. We believe that your comments have been most valuable and will significantly improve this work.

If you have any further questions or points which you would like clarified then we'll be happy to respond.

Many thanks on behalf of all co-authors,

Edward Hart (corresponding author)

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Interactive comment on Wind Energ. Sci. Discuss., <https://doi.org/10.5194/wes-2019-25>, 2019.

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