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WIND ENERGY SCIENCE DISCUSSIONS

Interactive comment on "Systemic hazard analysis of offshore service operations" *by* Romanas Puisa et al.

Romanas Puisa et al.

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The response to the reviewer is attached as a pdf file. Also pasted here:

Interactive comment on "Systemic hazard analysis of offshore service operations" by Romanas Puisa et al. Anonymous Referee #2 Received and published: 10 July 2020

General comments: The authors points out that SOV operations constitute a complex socio-technical system, consisting of several subsystems. Each subsystem has specified safety procedures, but the authors argue that potential hazards resulting from the interaction of subsystems might not be properly accounted for with the existing approach, which focus on potential hazards for each subsystem. Instead, they propose to use the systemic method STPA, where the starting point is to identify hazards on

the system level. The topic of the paper is relevant, and it is generally well structured. However, I see some issues in the quantitative outcome of the analysis, as given below. The authors make conclusions about the risk in the abstract, however, they do not actually do a risk analysis, as they do not consider the consequences/potential losses, and also not directly the likelihood. 1. Author's response to the preceding paragraph

Indeed, risks associated with the identified hazards, in terms of likelihood and consequences, are not presented in the paper. The scope of the paper is limited to hazard prevention/control, i.e. hazard mitigation is outside the scope. To make sure the message is unambiguous, appropriate changes will be made in the abstract and elsewhere in the paper.

However, based on other review comments, the paper has updated and doesn't not use the hazard likelihoods either. Instead, the comparison is done by using a systemic indicator – system variability.

They write in line 224-225: "As incident prevention is the focus on this paper, the likelihood alone can be used to rank the hazards, provided the consequences all considered hazards are similarity intolerable." However, there is no justification that the hazards are similarly intolerable. In fact, according to the reference for the applied STPA analysis (Leveson and Thomas 2018), the first step of the analysis should be to identify losses (before hazards are identified). However, the authors seem to omit this part of the analysis. I suggest the authors to either modify the analysis to include the losses, or to clearly state in the paper and abstract that this part of the analysis is omitted, and not to make conclusions on the risk. 2. Author's response to the preceding paragraph

The quotation from the paper refers to worst-case consequences of the hazards, and they are quite certain. As stated in the paper (Section 4.2, lines 176-177), all analysed hazards will lead to the same accidents /consequences: injuries and life losses, and damages to SOV, gangway, or turbine. Because consequences are the same for all hazards, we only rank hazards based on their degree of exposure – the proxy for

likelihood. We agree it should be stated more clearer what accidents/consequences are considered and that all analysed hazards are assumed to lead to them.

However, based on other review comments, the paper has updated and doesn't not use the hazard likelihoods either. Instead, the comparison is done by using a systemic indicator – system variability.

The hazard exposure is quantified through the number of scenarios leading to each hazard, and results are presented in tables 3-5. It is not clear to me, whether this is this the number of different scenarios, or if it is some frequency of exposure. It is also not clear to me how these scenarios were actually found – e.g. were they found using some documents, in dialog with Kongsberg Maritime, using incident reports, or other? If the number of scenarios is to be understood as the number of different scenarios that can potentially lead to a hazard, I do not follow the argument, that it can be seen as a measure of exposure. The exposure would depend on the probability/frequency and duration of the "scenarios". 3. Author's response to the preceding paragraph

In this paper, the exposure refers to the number of scenarios in the lead up to a hazard (see Section 4.4). In other words, it is the number of pathways to a hazardous state. Some of these pathways are addressed by design and management measures, while others may be overlooked or intentionally discounted as being unlikely. Thus, the exposure is not time related in the context of this paper, and the dictionary definition of exposure does not imply the link to time. The dictionary definition of exposure is "the state of being in a place or situation where there is no protection from something harmful or unpleasant" (ref. Oxford English Dictionary).

However, based on other review comments, the paper has updated and doesn't not use neither the hazard likelihood or exposure to hazard anymore.

The number of scenarios seem to depend mainly on how things are defined, and how exhaustive/imaginative the analyst is. 4. Author's response to the preceding paragraph

That is correct. The analysis was performed based on the technical documentations available, and discussions with designers and operators. There is indeed a real possibility that some scenarios were overlooked. However, it is a common practice in safety engineering when the analysis is done manually. Unfortunately, automated analysis that could exhaustively explore all scenarios is unavailable.

As indicated in responses above, we adopted a systemic indicator to be less sensitive to this problem.

The assumption that the hazard exposure can quantified through the number of scenarios leading to each hazard seems to be made, in order to come up with a quantitative outcome of the analysis, but I cannot see the need (or justification) for coming up with a quantitative outcome. In the abstract, it is written: "The objective of this paper is to bring awareness of hazards that may have been overlooked in earlier assessments, and allow for a preliminary comparison of various operational stages." Specifically, they wish to "explore hazardous scenarios caused by flawed interactions between system components". Based on this, I believe that the main outcome of the analysis, and the main result to be presented in the paper, should be the identified "hazardous scenarios caused by flawed interactions between system components" If such scenarios were not found, the abstract and conclusion should reflect this.

5. Author's response to the preceding paragraph

All hazardous scenarios in Tables 3-5 are of interaction nature. The quantification in terms of number of scenarios is not actually done, and it is never claimed that it has been. The exposure (vulnerability) to hazards is used only to give guidance as to what priority of the follow-up, more detailed and potentially quantitative analysis should follow. This is stated on Line 258-259: " The comparison is, nevertheless, preliminary and should be used as a preface for a more detail, potentially quantitative, comparison."

Thus, the paper delivers system level hazards and associated information.

Specific comments: Line 32-33: “It is normally a motion-compensated (3 or 6 DoF) gangway system, which allows for relatively safer (based on experience so far) and time-efficient (within some 5 minutes) transfer.” I believe that the bump-and-jump method is significantly more time-efficient, if conditions allow for transfer this way - this could be mentioned. (see e.g. Nikki Twigt, Access Systems for Offshore Turbines - A review of conventional and walk-to-work transfer methods, 2020)

6. Author’s response to the preceding paragraph

It is indeed can be more time efficient, but less safer, based on our opinion. We’ll familiarise with the publication and cite it if relevant.

Technical corrections: Line 72: Reference to Section 0 The paper needs a language check.

7. Author’s response to the preceding paragraph

The corrections will be made. Thank you.

Please also note the supplement to this comment:
https://wes.copernicus.org/preprints/wes-2020-15/wes-2020-15-AC2-supplement.pdf

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