



Errors of Commission in HRA – NPSAG Phase 1 project Presentation for PSAM 14

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About the NPSAG EOC Project

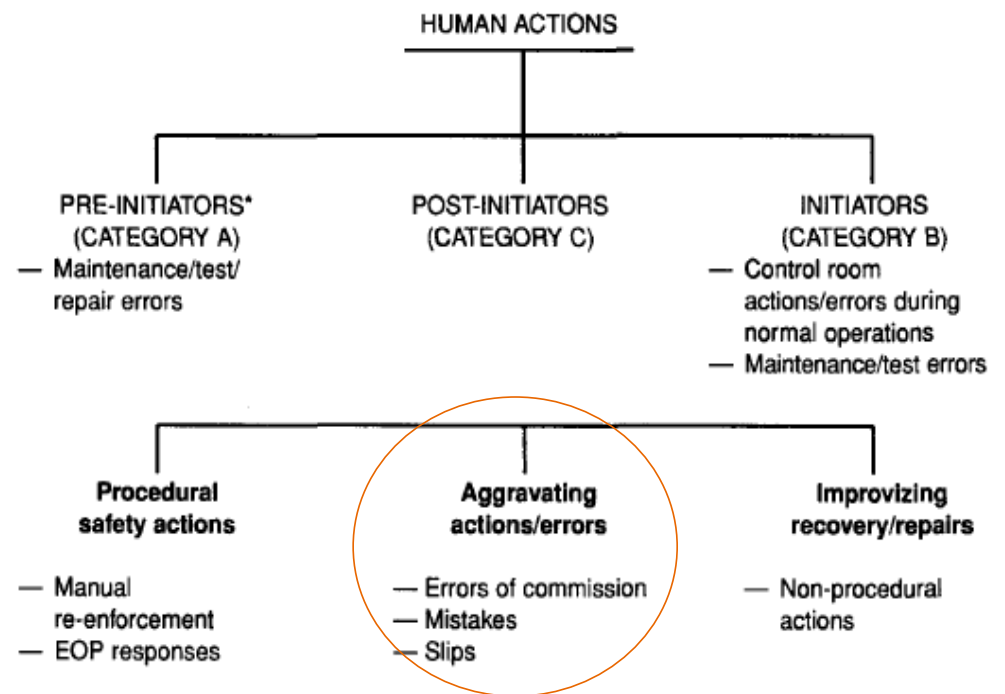
- The Nordic PSA Group (NPSAG, with SSM, Ringhals, Forsmark, OKG and TVO as stakeholders) fund the EOC project from the beginning of 2017.
- The project is expected to have multiple phases.
- Phase 1 is performed in 2017
- Phase 2 is ongoing in 2018 with case studies for a PWR plant

Project objective in 2017 Phase 1

- The objective of the current project in 2017 (Phase 1) is to:
 - Perform a thorough literature review on the requirements, methods and existing research and application studies related to EOCs
 - Perform an international survey on how EOC is included in the world wide nuclear power plants and the research works that have been performed in international organizations.
 - Provide preliminary recommendations on how to study EOCs in the PSA including identification, modelling, quantification and preventions.
 - Suggest a reasonable R&D plan for NPSAG stakeholders in relation with EOC issues

EOC and three categories of human actions defined in IAEA 50-P-10

- EOC can be any of the three categories.
- Quite many of the Category A and B human actions modelled in the plant PSA are EOC type.
- EOCs of Category C are historically not modelled
 - This is the type 2 'Aggravating actions/errors' of category C human actions.
 - They are the most difficult to identify and model.
 - The need to consider this type of EOCs has long been recognized and progress have been made to identify EOCs without performing an exhaustive search.



Literature review on the EOC requirements

HRA Guidelines	Relevant EOC Requirements
NUREG-1792 HRA Good Practices[2]	<ul style="list-style-type: none">? Good Practice #1: Address EOCs in Future HRAs/PRA (Recommendation).? Good Practice #2: As a Minimum, Search for Conditions that May Make EOCs More Likely. Even if the recommended first good practice above is not performed, the use of risk in any issue assessment should at least ensure that conditions that promote likely EOCs do not exist.
IAEA-TECDOC-1804[12]	<ul style="list-style-type: none">? Post-initiator HFEs: Significant errors of commission, i.e. actions that lead to additional functional unavailabilities, or inappropriately initiate system are identified.
UK ONR technical assessment guide (TAG) on HRA [10]	<ul style="list-style-type: none">? The dutyholder has identified pre-accident human errors (including maintenance, testing and calibration activities, plant alignment activities), direct initiating event human errors, human errors during the course of fault sequences and post-accident human errors (omissions, detection, diagnostic and decision errors, commission errors etc. and common cause human failures).? The dutyholder has considered plausible deviations from normal plant conditions or fault sequences that might cause additional human errors leading to exacerbated or additional fault sequences.? Occasions for misdiagnosis of the situation by the operators have been analyzed systematically. HFEs resulting from identified credible misdiagnosis have been modelled correctly ...

Reviewed EOC related HRA methods and studies

- A Technique For Human Event Analysis (ATHEANA), NRC
 - An approach for identifying and defining HFEs (especially for EOCs), an HRA quantification method, and a knowledge-base (including analyzed events and psychological literature)
 - Focuses on the error-forcing context
 - Recently included as one of the detailed HRA method for Fire HRA modeling (NUREG-1921)
- The Commission Errors Search and Assessment (CESA) method
 - CESA was developed at PSI for the identification of EOCs and the analysis of their significance (from around 1999).
 - PSI has performed three plant (1 PWR and 2 BWR plants for level 1 full power PSA) Pilot studies to identify potential EOC scenarios and assess their risk-significance.
- UK EDF Energy efforts in EOC (by Martin Reid, etc.)
 - EOC at Decision Points

International Survey on EOC - Summary

- Respondents
 - In total 18 replies from 12 different countries within:
 - Europe: 10
 - Asia: 5
 - Africa: 1
 - US: 2

Organisation	Country
Tractebel-Bel V	Belgium
CGN SNPI	China
CNPE	China
SNERDI	China
Fortum	Finland
TVO	Finland
IRSN	France
NEL	Japan
NECSA	South Africa
KAERI	South Korea
FKA	Sweden
RAB	Sweden
OKG	Sweden
Risk Pilot	Sweden / Finland
EDF Energy	UK
Jensen Hughes	US
Callaway	US
Relko	Slovakia

1c) Is EOC considered in your PSA?

- For the Category C EOCs, the following findings can be derived from the survey:
 - 4 organizations (24% of 17 total repliers) have explicitly considered Category C EOCs and the impacts in PSA
 - 7 organizations (41% of 17 total repliers) have considered Category C EOCs in their HRA method quantification. However it is not clear if the impact of EOC is considered (leading to exacerbated or additional fault sequences)
 - 6 organizations (35% of 17 total repliers) clearly stated that Category C EOCs are not considered

There is a large difference in terms of if EOCs are considered to be taken into account or not and in that case how!

2a) What types of EOCs have you modelled in your HRA?

- Reflections:
 - No explicit discussion (or analysis) of EOCs, but many Cat A and B events can be seen as EOCs
 - Some respondents say that taking EOC into account for Cat C events is a future activity
 - Probabilities for Cat C events are rough estimations (conservative), EOC is not considered explicitly though
 - Several point that Cat B events can be seen as EOCs, e.g. LOCA during shutdown/outage

HFE Category	EOC Considered in 17 total repliers
A	53%
B	38%
C	56%

2d) How important is the EOC in your PSA model?

Important	Not important	Not available, not sure or it depends
41% (7 repliers)	24% (4 repliers)	35% (6 repliers)

Whether EOCs are important or not seems to differ a lot!

NPSAG EOC Phase 1 – Conclusions

- It is a desire for many PSA and HRA analysts to improve EOC analysis to have a better understanding of the plant risk.
- It is not yet known how significant it is that most methods do not explicitly search for and evaluate EOCs, particularly with respect to EOCs occurring as a result of misdiagnosis

NPSAG EOC Phase 1 – Recommendations

- A minimal guidance on EOCs in the good practices should be considered
 - The EOC impacts are the focus of the EOC issue that is currently missing in PSA study.
 - Usually the interested EOC is closely related to the decision errors which lead to worsening the accident progression or cause an initiating event.

NPSAG EOC Phase 1 – Recommendations

- **Recommendations on EOC Identification:**
 - An effective process for identification of the important EOCs should be developed. EOC types of opportunities can be huge in a complex system like a NPP and can be related to all three categories of human actions, i.e. Category A, B and C. It is essential to develop an effective identification/screening process to focus resources in the most important EOCs and their effects.
 - The experiences gained in the existing efforts, e.g. PSI CESA applications, ATHEANA applications and UK EDF Energy studies, are already quite good to formulate a good process. The identified important EOCs from these studies could be good start points to form the list of EOCs.
 - Also as suggested by the survey feedback from e.g. Tractebel and Bel V (Belgium), each important equipment can be checked to see if an EOC should be considered.
 - An international database for the important EOC actions and relevant scenarios could also form a good basis for future new studies.

NPSAG EOC Phase 1 – Recommendations

- **Recommendations on EOC Modelling:**
 - It may be more appropriate to create new events and alter the logic model when we model EOC HFEs. Usually, it will take very different contexts to lead to an EOC than to an EOO, and therefore the dependencies on events downstream in the PRA logic model could be different.
 - Such considerations are relevant to later events in trees and for the cutset or sequence recovery analysis. When the EOC impact is considered, the logic model is most likely to be altered.
 - In case the above discussed dependency issue and logic issue are not relevant, we can add EOC HEP contribution to the original modelled HFE, which means the HEP for the HFE is made up of EOC contributions and EOO contributions

NPSAG EOC Phase 1 – Recommendations

- Recommendations on EOC Quantification:
 - Just like different HRA methods are used in different plants, it is expected that EOC quantification will be performed using different HRA methods in different plants. It is good to keep some consistence in one PSA model. It is also recommended that the experiences learned from ATHEANA and CESA quantification could be incorporated in the HRA quantification improvement.
 - Expert judgement would very likely play more important roles in EOC quantification. Thus documentation is very important.
 - In the future, EOC error modes and specific HEP data for the new digitalized plant can be collected

NPSAG EOC Phase 1 – Recommendations

- **Recommendations on EOC Preventions/mitigations:** When the EOC prone conditions are identified, it is recommended to:
 - Improve the plant information/operating crew interface to make sure clear and adequate information is present
 - Improve the procedure and operator training so that both of them cover the actual plant situation very well.
 - From the PSI pilot study experiences, the potential safety improvements are mainly in procedures.

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