

Human reliability analysis: a review of the methods used at nuclear industry

L. N., Oliveira¹, I. J. A. L., Santos², P. V. R.,
Carvalho²
e-mail: lecionoliveira@gmail.com,
luquetti@ien.gov.br, paulov@ien.gov.br

¹ Eletronuclear

² SEESC, IEN

Keywords: human reliability, nuclear industry, human error.

As modern industrial systems have become larger and more complex, the prevention of accidents is highly emphasized, and the interest in the predictive error analysis, specifically Human Reliability Analysis (HRA), has increased [1]. The HRA in the context of a Probabilistic Safety Assessment (PSA) is an attempt to model human interactions and predict the impact of such interactions on the system's safety and reliability. When it comes to complex systems such as Nuclear Power Plants (NPPs) that involve a large number of human interactions in every phase of the plant operations, the HRA becomes an extremely important element of PSA for a realistic assessment of plant safety [2]. This study reviews the status of researches on the reliability analysis methods at nuclear industry and its evolution along the years. Human reliability analysis (HRA) is one of the elements used in Probabilistic Safety Analysis (PSA) and is performed as part of PSAs to quantify the likelihood that people will fail to take action, such as errors of omission and errors of commission. An electronic search on CAPES Portal of Journals (a bibliographic database) was performed. This literature review covers original papers published since the first generation of HRA methods until the ones published on March 2017. A total of 94 papers were retrieved by the initial search and 13 were selected to be fully reviewed and for data extraction after the application of inclusion and exclusion criteria, quality and suitability evaluation according to applicability at nuclear industry. Table 1 and table 2 present the results of paper selection steps and the distribution of the papers across the various databases and journals. This literature review deals with HRA, the importance of model human interactions and

predict the impact of such interactions in the context of a PSA. These are reasons to HRA practitioners have tried to evaluate HEPs for many decades. Results point out that the methods from first generation are more used in practice than methods from second generation. This occurs

because it is more concentrated to calculate the probability of success or failure in the execution phase of human interaction, or human action, what make them useful for quantitative risk assessment to PSA [3].

Table 1 - Search results by Journal

Database	Journal	Selected after title and abstract reading, n	Selected after full reading, n	Percentage of selected papers by Journal from the Total(94), %
Elsevier	Annals of Nuclear Energy	6	2	2,1
Elsevier	Applied Ergonomics	1	1	1,1
SpringerLink	Cognition, Technology & Work	1	1	1,1
Elsevier	Fuzzy Sets and Systems	1	0	0,0
Wiley Online Library	Human Factors and Ergonomics in Manufacturing	2	0	0,0
IEEE Xplore	IEEE Transactions on Nuclear Science	1	1	1,1
Computers & Applied Sciences Complete	International Journal of Performability Engineering	1	0	0,0
Elsevier	Journal of Loss Prevention in the Process Industries	2	1	1,1
Elsevier	Nuclear Engineering and Technology	2	1	1,1

Table 2 - Continuation of Summary of search results

Elsevier	Reliability Engineering & Systems Safety	20	4	4,3
Wiley Online Library	Risk Analysis	3	2	2,1
Elsevier	Safety Science	3	0	0,0
Directory of Open Access Journals (DOAJ)	Science and Technology of Nuclear Installations	1	0	0,0
Emerald Insight (Emerald)	The International Journal of Quality & Reliability Management	1	0	0,0
Total		45	13	13,8

References

- [1] JUNG, W. D.; YOON, W. C.; KIM, J. W. Structured information analysis for human reliability analysis of emergency tasks in nuclear power plants. **Reliability Engineering & System Safety**, Amsterdam, v. 71, n. 1, p. 21–32, 2001.
- [2] MOIENI, P.; SPURGIN, A. J.; SINGH, A. Advances in human reliability analysis methodology. Part I: frameworks, models and data. **Reliability Engineering & System Safety**, Amsterdam, v. 44, n. 1, p. 27–55, 1994.
- [3] OLIVEIRA, L. N.; SANTOS, I. J. A. L.; CARVALHO, P. V. R. A review of the evolution of human reliability analysis methods at nuclear industry. In: INTERNATIONAL NUCLEAR ATLANTIC CONFERENCE, - ENFIR - Meeting on Nuclear Reactor Physics and Thermal Hydraulics, 10., 2017, Belo Horizonte. **Anais...** Rio de Janeiro: ABEN, 2017. Não paginado.