We are IntechOpen, the world's leading publisher of Open Access books Built by scientists, for scientists

6,300

Open access books available

172,000

International authors and editors

190M

Downloads

Our authors are among the

154

Countries delivered to

TOP 1%

most cited scientists

12.2%

Contributors from top 500 universities

WEB OF SCIENCE™

Selection of our books indexed in the Book Citation Index
in Web of Science™ Core Collection (BKCI)

Interested in publishing with us?
Contact book.department@intechopen.com

Numbers displayed above are based on latest data collected.
For more information visit www.intechopen.com

Introductory Chapter: An Overview of Reliability and Risk Analysis

Muhammad Zubair and Eslam Ahmed

1. Introduction

Reliability improvement can be acquired through such measures as testing, periodic examinations, support, and quality assurance for exercises influencing the quality of a nuclear power plant. Reliability engineering can add to these actions through proceeded with assessment of the viability with which assets are applied to accomplish expressed destinations and exhibit of how they can prompt the advancement of operation and maintenance. In this way, it has been shown that by utilizing disappointment and fix information, one can infer, by use of reliability examination methods, an ideal occasional testing or assessment recurrence, maintenance system, and operation practices. For more extensive use of the methods of reliability engineering in functional plant operation and maintenance, the primary prevention is the truth that these strategies are very novel to the reasonable specialist. Likewise, practical engineers are to some degree less slanted to see the value in the immediate benefits of this methodology in light of the fact that the reliability examiners are sometimes not ready to exhibit that the real presence of the investigation helps design, maintenance, and operational engineers to settle on reasonable choices [1].

2. Quality assurance and quality control

The more modern advancements become, the more significant are quality and reliability perspectives for ensuring the properties and operational attributes of the innovation. This is especially valid for enterprises such as nuclear energy, which are conceivably hazardous for individuals and the environment because of the utilization of radioactive materials and highly concentrated energy density. At the point when applied to nuclear fuel designing, quality assurance and quality control (QA/QC) and reliability necessities are totally interconnected. Notwithstanding, the terms are ideally utilized independently by fuel makers (weight on 'quality') and fuel operators (weight on 'reliability'). The QA/QC techniques and guidelines are a piece of the generally integrated management system (IMS) for an association.

Nuclear power has a place with a profoundly cutthroat power industry that aims for better business nuclear power plant execution inside characterized safety edges. Nuclear power improvement mirrors the advancing trade-off between techno-economic motivations and safety prerequisites. Henceforth, both specialized and safety viewpoints are to be viewed along with administrative methodologies focused on practical, commonsense execution of these substitute inspirations.

A nuclear reactor is by and large described by testing operational conditions, with the most extreme conditions in the reactor core, where high temperatures, corrosive media, and mechanical stresses are joined with concentrated radiation load on fuel elements, fuel assemblies, and reactor internals. These operational angles can prompt the corruption of material properties and eventually to failures of fuel and other reactor internals. The expense of such failures is high, and their outcomes can be amazingly extreme. Hence, careful consideration is given to the appropriate determination, improvement, design, assembling, testing, and operation of fuels and in-core components of nuclear reactors.

While different specialized, safety, and managerial aspects of fuel designing and execution are inspected in various publications, there is a lack of comprehensive direction over the scope of interconnected issues of fuel quality and reliability [2].

3. Risk management

In the current worldwide energy environment, nuclear power plant (NPP) supervisors need to think about numerous hazard components notwithstanding the nuclear safety-related risk. To remain cutthroat in current energy markets, NPP administrators should coordinate management of creation, safety-related, and economic risks compellingly. This risk management (RM) approach produces benefits that incorporate the following: Clearer rules for decision making. Utilizing ventures previously made in probabilistic safety analysis (PSA) programs by applying these examinations to different zones and settings. Cost consciousness and advancement in accomplishing nuclear safety and creation objectives. Correspondence improvement more successful inner correspondence among all levels of the NPP working association, and more clear correspondence between the association and its partners. Focus on safety, guaranteeing an incorporated spotlight on safety, production, and financial aspects during seasons of progress in the energy environment.

Throughout the most recent decade, in the various Member States, there has been a move from nationalized responsibility for utilities inside economies outfitted towards complete and stable business to privatized, serious business sectors with strain to diminish costs, staff numbers, and the designing responsibility. The emphasis presently is on gathering the objectives set by investors instead of governments. Some Member States have not seen such stamped changes, be that as it may, these shifts are characteristic of the bearing of the world's energy markets.

To get by in this new de-regulated and cutthroat environment, NPPs need to protect and keep up safety and focus on market costs, market interest, and execution. Plainly, deregulation builds hazards yet additionally produces openings for more substantial benefits. It is in this setting that NPP operators need to think about all parts of hazard and concoct an ideal arrangement that doesn't bargain safety and execution.

One of the significant advantages of a coordinated risk management approach is that safety, operational, and financial execution (and risks) are frequently connected. NPPs with outstanding safety records will, in general, show solid economic execution, and the other way around [3].

The objective of an integrated risk management approach is to fuse into the association's management framework a structure for a methodical investigation that shows identification and the executives of hazard in a portfolio setting. This incorporated (or portfolio) way to deal with hazard investigation can assist the association with deciding the right blend of preventive measures, transfer of risk to other gatherings, and maintenance of hazard by the association. The advantages will accumulate to the partners, including business or government proprietors and society [4].

Critical infrastructure systems (CISs), for example, nuclear power plants (NPPs) and help organizations, are the foundation of the cultured countries; they give the fundamental energy assets to networks. Notwithstanding, these CISs are frequently inclined to more than a solitary risk. Given the characteristic relationship of natural hazards or unintentionally, CISs can all the while being exposed to multi-hazards, which are simultaneous and progressive events of more than one risk. Multi hazards can additionally build the catastrophe hazard of CISs; be that as it may, contrasted and single hazard risk assessment, multi-hazard risk evaluation is generally new in many exploration spaces [5]. As of late, in any case, a notable multi-hazard occasion, the core damage accident of the Fukushima-Daiichi NPP in March 2011, drove the importance of doing essential multi-hazard risk evaluation. Under these conditions, the endeavors to comprehend and evaluate the multi-hazard chances have expanded in different exploration fields, including geophysics, sociology, underlying designing, reliability engineering, and nuclear safety engineering.

Especially in the scope of nuclear safety designing, the multi-hazard risk should be counted during NPP safety assessment. Albeit the multi-hazard force and its impact can generally be inconsequential under a specific return period chosen by the current design standard, the absolute multi-hazard risk, convolution of yearly event probability, and the result can be non-insignificant in the hazard assessment phase. In contrast to the planning stage, the risk assessment technique incorporates the disproportional results, which are expected under a multi-hazard force that is past the design criteria. The International Atomic Energy Agency (IAEA) distributed a progression of reports (2011, 2017, and 2018) on probabilistic safety assessment (PSA) for NPP multi-hazards. Site-explicit outer risks, external hazard combinations, just as critical structures, systems, and components (SSCs) exposed to multi-hazards, were examined in these reports.

4. Regulatory authorities

Notwithstanding IAEA, the U.S. Department of Energy (USDOE) likewise featured the significance of multi-hazard evaluation for NPP facilities [6, 7]. The progressing venture of the Korea Atomic Energy Research Institute (KAERI), called the “Development of multi natural hazard risk assessment,” likewise upholds various multi-hazard research themes, including different multi-hazard combinations (e.g., earthquake mainshock-aftershock, typhoon-earthquake, earthquake-landslide, and earthquake-tsunami) to work with the multi-hazard risk measurement for NPPs [8–10]. In any case, despite the arising need for multi-hazard investigation for NPP systems, the overall strategy is not broadly examined. Contrasted and single hazard risk evaluation, multi-hazard hazard assessment is generally new in the field, and the essential phrasings actually should be characterized.

Accordingly, we expected to survey cutting-edge research in multi-hazard investigation past nuclear safety engineering (e.g., geophysics, structural engineering, reliability engineering) and examine the advancement and difficulties in its application to NPP systems. The fundamental conversation subjects of this investigation are fourfold: order of multi-hazard interaction; the best multi-hazard examination for each multi-hazard combination; the advancement, potential, and difficulties in the use of the momentum multi-hazard examination strategies to NPP constructions and systems; and the flow research holes in the multi-hazard riskevaluation system. Mainly, writing on the state of the craftsmanship, the multi-hazard investigation is discussed as far as risk, delicacy, and hazard examination level. For quantitative evaluation of the multi-hazard risk, both hazard and delicacy models ought to be

created, where the delicacy model is the restrictive prospect of a predetermined damage state (e.g., moderate, extensive, or total failure) for a given risk force (e.g., peak ground acceleration, wind speed) [11]. The current advancement phase of the hazard and fragility examination straightforwardly influences the last multi-hazard risk, but it does not really ensure the accessibility of the multi-hazard risk assessment.

In utilizing hazard-educated methodologies for guaranteeing safety regarding working nuclear power plant (NPPs), hazard significance measures got from probabilistic risk assessments (PRAs) of the plants are essential components of thought much of the time. Getting these actions in suitable structures is helpful for leaders and can work with the utilization of hazard data.

In this monograph, the emphasis is on hazard significance as evaluated by the PRA models of NPPs created as per current guidelines and devices. The idea of hazard significance measure in PRA is, in numerous applications, identified with a solitary “basic event” and this is the thing that is generally determined by the PRA devices (albeit some of them, like RiskSpectrum, incorporate certain high-level choices, as examined later). Then again, what is of interest in useful applications is the hazard significance of specific segments like pump or valve, which is in current PRA models ordinarily addressed by different essential occasions where every primary event is identified with explicit failure mod or reason for inaccessibility [12] A similar failure mode may, because of various limit conditions, be introduced by various basic events in various accident arrangements. To convolute the things further, failure modes might be shared by different segments; for example, agent basic event might be an individual from some common cause failure (CCF) group. To plan the significance of specific basic events into the significance of part, some PRA applications, talked about underneath, set up a set of rules to be utilized for the reason. This cycle is relatively convoluted, is dependent upon interpretation, and now and again requires extra assessments. Accessibility of measures that can be straightforwardly associated with a segment of a safety system, “component level” significance measures, can work on the utilization of these actions in numerous applications [13].

Author details

Muhammad Zubair* and Eslam Ahmed
Department of Mechanical and Nuclear Engineering, University of Sharjah,
Sharjah, UAE

*Address all correspondence to: mzubair@sharjah.ac.ae

IntechOpen

© 2021 The Author(s). Licensee IntechOpen. This chapter is distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/3.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

References

- [1] IAEA. Reliability of Nuclear Power Plants. International symposium on reliability of nuclear power plants. (1975).
- [2] IAEA. Quality and reliability aspects in nuclear power reactor fuel engineering. IAEA nuclear energy series. (2015). No. NF-G-2.1.
- [3] Zubair, M. Ishag, A. Sensitivity analysis of APR-1400's Reactor Protection System by using RiskSpectrum PSA. Nuclear Engineering and Design, Volume 339, pp 225-234, 2018.
- [4] IAEA. Risk management: A tool for improving nuclear power plant performance. IAEA nuclear energy series. (2001). IAEA-TECDOC-1209.
- [5] Komendantova, N., Mrzyglocki, R., Mignan, A., Khazai, B., Wenzel, F., Patt, A., & Fleming, K. Multi-hazard and multi-risk decision-support tools as a part of participatory risk governance: Feedback from civil protection stakeholders. International Journal of Disaster Risk Reduction. (2014), 8, 50-67.
- [6] Coleman, J. L., Bolisetti, C., Veeraraghavan, S., Parisi, C., Prescott, S. R., & Gupta, A. Multi-hazard advanced seismic probabilistic risk assessment tools and applications. (2016a).
- [7] Coleman, J. L., Smith, C. L., Burns, D., & Kammerer, A. Development Plan for the External Hazards Experimental Group Report. (2016b).
- [8] Hur, J., Shafieezadeh, A. Multi-hazard probabilistic risk analysis of off-site overhead transmission systems. (2019).
- [9] Kim, JH., Kim, MK., Choi, IK. Preliminary Study on the Quantification of Component Level Failure Frequency by Multi-Hazard. (2019).
- [10] Mun, CU. Bayesian Network for Structures Subjected to Sequence of Main and Aftershocks. Seoul National University. (2019).
- [11] Gidaris, I., Padgett, J. E., Barbosa, A. R., Chen, S., Cox, D., Webb, B., & Cerato, A. Multiple-hazard fragility and restoration models of highway bridges for regional risk and resilience assessment in the United States: state-of-the-art review. Journal of Structural Engineering. (2017). 143(3).
- [12] Zubair M, Zhang Z. Reliability Data Update Method (RDUM) based on living PSA for emergency diesel generator of Daya Bay nuclear power plant. Safety Science, Volume 59, PP 72-77, 2013.
- [13] Vrbancic, I., Samanta, P. Risk Importance Measures in the Design and Operation of Nuclear Power Plants. Brookhaven National Laboratory. (2017).