This is a peer-reviewed, author's accepted manuscript of the following editorial: Moura, R., Beer, M., de Souza, G. F. M., & Patelli, E. (2022). Special section on decommissioning and life extension of complex industrial assets. *ASCE-ASME Journal of Risk and Uncertainty in Engineering Systems Part B - Mechanical Engineering*, *8*(4), [040301
]. https://doi.org/10.1115/1.4055799

Special Section on Decommissioning and Life Extension of Complex Industrial Assets

The final phase of the operational life of complex industrial systems leads to a very significant business decision: to engage in life extension, repurpose its use, or decommission the asset. Decommissioning is the ultimate stage of the lifecycle of an industrial system. It comprises the removal and disposal of equipment, structures and residues, environmental recovery and/or remediation, and postdisposal monitoring. Due to the timescale and complexity of the decommissioning activities, it involves many challenges in order to make safe and cost-effective decommissioning an achievable objective. According to the global research and consultancy Wood Mackenzie, decommissioning expenditures for offshore petroleum and natural gas facilities worldwide will exceed US$15 billion a year by 2030. Between 2021 and 2050, the total expenditure is expected to be around US$400 billion. Other complex industrial assets face similar challenges: nuclear-decommissioning expenditures were US$5.82 billion in 2019 and projections from Research & Markets indicate annual costs of US$9.43 billion by 2027. Life extension of engineering systems that have reached the end of their originally designed life has the potential to push back decommissioning costs. For instance, offshore platforms and nuclear facilities were often designed to operate for 20 to 40 years. However, their lifespan can be extended for another 20–30 years if adequate measures are taken. To sustain a safe extended operation, advanced reliability and integrity management techniques and an improved understanding of system behavior will be required. This Special Section focuses on how new structural health monitoring technologies, digital transformation, and improved goal-setting safety regulations can support economic decisions and engineering strategies to safely operate aging assets. To achieve the best outcomes, automation and conversion of manned into unmanned facilities, the usage of digital twins as an effective tool for asset management from the design to decommissioning, big data analytics, and machine learning and artificial intelligence should be considered to anticipate critical issues and manage risks. The introductory paper of this Special Section issue is a Technical Brief describing regulatory advancements that occurred in 2020 in the Brazilian decommissioning market. New provisions brought well-defined rules aimed at field life extension, decommissioning and unlocked the possibility of repurposing facilities for alternate applications (e.g., carbon capture and storage—CCS and offshore wind). According to Souza et al., the new regulations boosted the activity, and the technical brief indicates that 32 decommissioning programs were submitted to the regulator from May 2020 to November 2021, making the presented results of significant value to policymakers and the engineering community. The next paper presents a risk-based approach to identify hazards and control decommissioning risks of a vinyl chloride monomer (VCM) plant. To keep risks in the ALARP zone — as low as reasonably practicable — the authors propose the extension of the well-known and largely adopted industry Hazard and Operability Study (HAZOP) to a decommissioning HAZOP. This is an application paper, classified as an expert view, and the successful application of the adapted HAZOP technique ensured adequate risk control while reducing total decommissioning time (and cost), according to Raman and Medonos. The schematic diagram of the plant combined with some of the HAZOP node records show how the technique was applied in the case study, thus the work can assist practitioners in using a similar approach to evaluate risks before and during the decommissioning stage. The challenges to decommission nuclear submarines in a safe manner are tacked by Maia et al., which focus on the reactor disposal problem in their case study. A multicriteria decision-making approach (MCDM) is proposed to assist decision-makers to select a safe facility site to store the reactor, based on the application of the Analytic Hierarchy Process (AHP). In general, the evaluation of the candidate sites for the disposal of industrial residues is a topic of relevance. The flexibility of AHP, which may use both qualitative and quantitative data to feed weights, and the structured selection of factors to evaluate the six proposed sites offered a well-designed criterion for disposal site selection, which may be used for a wide range of applications. In the wake of the energy transition, Uggenti's et al. research paper is focused on investigating the technical requirements and feasibility of repurposing an ageing offshore oil and gas platform to produce renewable energy (i.e., photovoltaic). The generated electricity is expected to feed an offshore seawater reverse osmosis desalination plant installed in the former petroleum facility, to distribute fresh water to surrounding offshore oil and gas platforms. The proposed solution would decrease decommissioning costs and reduce the carbon intensity of nearby production platforms receiving water desalinized from a sustainable energy source. This is an innovative approach, and key concepts and critical aspects of the case study basic design were evaluated. The development of future requirements for the design philosophy of reused offshore facilities should take advantage of assumptions, basis of design, and engineering challenges presented in this case study. Hydropower plants are not dependent on large-scale burning of fossil fuels to generate electricity and thus are regarded as key elements of the energy transition. Melani et al. use different techniques of data and reliability analysis to develop a framework to support the decision-making process to extend the in-service time of equipment and systems of hydroelectric generation facilities. Life expectancy is estimated by examining the current health condition with Remaining Useful Life Analysis (RUL), Life Data Analysis (LDA), and by assessing the obsolescence of the system. Based on data from a real 200 MW power plant, possible scenarios are simulated to estimate failure probabilities and system reliability, in order to inform asset management decisions. Structural health monitoring is an essential element of asset lifecycle management, particularly when dealing with power generation plants. Banyay et al. combine neutron noise monitoring and mechanics-informed analysis to perform a remote condition assessment of nuclear reactor vessel internals, proposing a monitoring and diagnostic framework. Components are analyzed using computational structural mechanics models and machine learning methods to improve the interpretability of the neutron noise measurement results, anticipating the detection of degradation scenarios in the reactor structures. Life extension of concrete structures is the subject of the work presented by Dauji et al., which uses parametric (statistical probability distribution function) and nonparametric (balanced bootstrap) approaches to estimate concrete strength. The approach aims to obtain strength results from concrete structures with limited direct strength measurements. These contributions to science highlight the scientific interest and relevance of the decommissioning and life extension processes in complex industrial assets. Important topics such as factors influencing decision-making to decommission or extend the life of industrial facilities, the usage of computational strategies to predict service life, regulatory approaches, and reliability analysis of ageing assets were covered. Consequently, a well-balanced Special Section issue, ranging from decommissioning and disposal to life extension and repurposing is now available. The process of developing this Special Section issue was particularly enjoyable, due to the hard work of the brilliant authors, the high standards of the reviewers, and the quality of the manuscripts submitted. We hope the scientific works hereby presented will contribute to future developments.