

Analysis of Claims in Nuclear Power Plant Projects: The Role of Regulatory Bodies and Safety Compliance

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Abstract

Nuclear power plant construction projects are characterized by their mega-scale, long durations, and extremely high-risk nature, necessitating stringent safety regulations and oversight by regulatory authorities. This paper examines the key causes of claims in First-of-a-Kind (FOAK) nuclear projects, focusing particularly on the influence of regulatory interventions and safety compliance on claim occurrences. Using case studies of Olkiluoto 3 (Finland), Vogtle Units 3&4 (USA), and Barakah (UAE), we analyze how regulatory approval processes, design immaturity, quality assurance, and supply chain issues contribute to delays and cost overruns that trigger claims.

1. Introduction

Nuclear power plant (NPP) projects involve extensive financial and technical commitments, typically spanning eight to twelve years and requiring billions of dollars in investment. These projects are inherently high risk due to the radioactive materials involved and the potentially catastrophic social and economic consequences of failures. The sector demands adherence to strict safety and technical standards enforced through rigorous regulatory control that requires multiple pre-approval stages. Delays in regulatory approvals directly impact project schedules and costs, leading to disputes and claims.

2. Background and Literature Review

Prior research on claims in NPP construction projects has concentrated mainly on technical and managerial issues such as design changes, procurement delays, and work interference. However, the specific role of regulatory authorities as direct drivers of claims remains underexplored. Following the Fukushima accident, global nuclear safety regulations have tightened substantially, increasing the complexity of approval processes and introducing additional safety requirements. These changes have heightened the frequency and severity of regulatory-induced delays and redesigns, exacerbating uncertainty in project execution and increasing the probability of claims.

3. Characteristics of Claims in Nuclear Power Plant Projects

Claims in nuclear EPC projects emerge from a complex interplay of factors, including regulatory interventions, contract interpretation disputes, and construction execution issues. Unlike general construction projects where claims typically involve straightforward contractor-client disputes, NPP projects often involve multi-party disputes encompassing regulators, contractors, and suppliers. Such disputes tend to have unclear accountability due to the cascading effects of delays and redesigns triggered by regulatory requirements and compliance issues. These factors critically affect the credibility of the nuclear industry and the export potential of nuclear technology.

4. Regulatory Impact on FOAK Nuclear Projects

FOAK projects face distinct challenges due to immature designs subject to frequent revisions, incomplete safety analyses, and inexperience among suppliers and regulators with novel equipment and systems. Regulatory authorities impose stringent safety proofs and rigorous certification processes that increase the likelihood of approval delays, quality assurance failures, and supply chain disruptions. The regulatory interface with contractors and vendors is often hindered by unfamiliarity and lack of coordination, prolonging review cycles and amplifying project risks.

5. Case Studies: Olkiluoto 3, Vogtle Units 3&4, and Barakah

The Olkiluoto 3 project in Finland, the world's first European Pressurized Reactor (EPR), experienced a 14-year schedule delay and cost escalation from €3.2 billion to over €11 billion. Major issues included repeated design changes, failure of I&C component certification, and delivery delays, resulting in protracted arbitration. The Vogtle 3&4 project, deploying the first AP1000 reactors in the US, has similarly faced 6 to 8 years of delay and cost growth from \$14 billion to \$35 billion, due to design modifications, modular fabrication mismatches, and quality problems resulting in testing delays and requisite rework. The Barakah project in the

UAE, also a FOAK, has seen comparatively minor regulatory delays and design changes, leading to better project stability.

REFERENCES

6. Regulatory Approaches and Contractual Framework

Distinct regulatory styles shaped the claim profiles of Olkiluoto 3 and Vogtle 3&4. Finland's STUK regulator employs a conservative, real-time on-site approval system requiring pre-approval for every drawing and material, which resulted in incremental stop-work orders and rework. Conversely, the US NRC follows a document-based, certification-driven procedure focusing on repeated safety evaluations of design changes, which contributed to schedule slippage and financial distress for contractors. Contract models also varied, with Olkiluoto adhering to fixed-price turnkey EPC contracts bearing most risks on the contractor, while Vogtle shifted risk obligations toward the owner post-bankruptcy, highlighting the critical impact of regulatory and contractual interaction on claims.

7. Discussion

The findings underline that regulatory intervention shapes the pathways and severity of claims in FOAK nuclear projects through approval delays, design hold-ups, and quality oversight failures. Immature designs, insufficient coordination between regulators and suppliers, and complex safety requirements generate cascading effects that escalate into multi-party disputes. Real-time verification demands impose intensive burdens on contractors but may facilitate early issue detection, whereas procedural certification processes can accumulate delays with significant financial impacts. Understanding these dynamics is essential for managing regulatory risks and improving project outcomes in future nuclear construction endeavors.

8. Conclusion

This study demonstrates that regulatory bodies and safety compliance critically influence claim occurrences in FOAK nuclear power plant projects. The interplay of design immaturity, approval delays, quality assurance failures, and supply chain instability elevates project risks and claim potential. Enhanced coordination between regulators and contractors, process optimization for approvals, design improvement at project inception, and diversified supply chains are recommended to mitigate claims and improve viability in future nuclear projects.

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