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Review of Reliability-Centered Maintenance Approaches for Maximizing Mechanical Equipment Lifespan

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Abstract: *Mechanical equipment it is normal for the functional effectiveness of key components to determine the operational reliability of large mechanical equipment. Fixing mechanical equipment quickly before it breaks down is important to make sure it works well. This paper is a critical discussion of the reliable maintenance and care of mechanical systems to achieve the fullest life of equipment and efficiency. It discusses the shift in the past from reactive and preventative maintenance to smart, data-driven, predictive and reliability-focused operations that Industry 4.0 technologies provide. The principles of reliability optimization design are discussed, which focus on combining the methods of probabilistic approach and dependability on a system level. Performance comparison is drawn between various maintenance strategies, and common mechanical failures of rotating machines, including bearing, gearbox, and misalignment faults, are discussed in terms of causes and consequences. Also, the paper addresses predictive maintenance and the significance of the Internet of Things-based sensor technologies in real-time condition monitoring as part of lifecycle management. The literature review has indicated new trends related to machine learning, deep reinforcement learning, and predictive maintenance optimization models. The paper ends with defining strategic research gaps and showing the necessity of a single, AI- and IoT-based maintenance system that allow making the industry more reliable, cost-effective, and sustainable.*

Keywords: Mechanical System Reliability, Predictive Maintenance, Lifecycle Management, IoT Sensors, Equipment Lifespan, Fault Diagnosis

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