

Maintenance-Aware Risk Curves: Correcting Degradation Models with Intervention Effectiveness

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Abstract-

In predictive maintenance frameworks, risk curves are used as interpretable, real-time indicators of equipment degradation. However, existing approaches generally assume a monotonically increasing trend and neglect the corrective effect of maintenance, resulting in unrealistic or overly conservative risk estimations. This paper addresses this limitation by introducing a novel method that dynamically corrects risk curves through a quantitative measure of maintenance effectiveness. The method adjusts the evolution of risk to reflect the actual impact of preventive and corrective interventions, providing a more realistic and traceable representation of asset condition. The approach is validated with case studies on critical feedwater pumps in a combined-cycle power plant. First, individual maintenance actions are analyzed for a single failure mode to assess their direct effectiveness. Second, the cross-mode impact of a corrective intervention is evaluated, revealing both direct and indirect effects. Third, corrected risk curves are compared across two redundant pumps to benchmark maintenance performance, showing similar behavior until 2023, after which one unit accumulated uncontrolled risk while the other remained stable near zero, reflected in their overall performance indicators (0.67 vs. 0.88). These findings demonstrate that maintenance-corrected risk curves enhance diagnostic accuracy, enable benchmarking between comparable assets, and provide a missing piece for the development of realistic, risk-informed predictive maintenance strategies.

Index Terms- risk curves; predictive maintenance (PdM); maintenance effectiveness; Condition-Based Monitoring (CBM); Prognosis and Health Management (PHM); power plant pumps; reliability engineering

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