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Respirable Dust Exposure Monitoring and PPE Compliance among Sanding and Spray-Painting Workers

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Structured Abstract

Background: Aviation maintenance activities such as sanding and spray painting are recognised as high-risk tasks due to their potential to generate airborne respirable dust, posing occupational health risks to workers. In composite aircraft component maintenance, exposure control depends not only on engineering measures but also on effective use of personal protective equipment (PPE). However, PPE compliance is often influenced by workers' perception of task-related risk rather than measured exposure alone. This study aimed to quantify respirable dust exposure during sanding and spray-painting operations and to examine PPE compliance in relation to task-specific exposure conditions and risk perception.

Methods: A cross-sectional study was conducted at Composites Technology Research Malaysia (CTRM) Aero Composites Sdn. Bhd., involving six workers representing two Similar Exposure Groups (SEG): sanding (n = 3) and spray-painting (n = 3). Respirable dust exposure was assessed using personal gravimetric air sampling in accordance with NIOSH NMAM 0600. Both full-shift 8-hour time-weighted average (TWA) sampling and 30-minute task-based sampling were performed to characterise average and short-term exposure levels. PPE compliance was evaluated through direct workplace observation using a structured ordinal scoring system reflecting the consistency and completeness of PPE use. A self-administered questionnaire was used to assess workers' perception of task-related risk and its influence on PPE compliance.

Results: Eight-hour TWA respirable dust concentrations among sanding workers ranged from 4.76 to 8.60 mg/m³, with all values exceeding the reference permissible exposure limit (PEL) of 3.0 mg/m³. In contrast, spray-painting workers recorded lower TWA concentrations ranging from 1.67 to 2.92 mg/m³, all below the reference limit. Task-based sampling revealed markedly elevated short-term respirable dust concentrations for both activities, with sanding ranging from 25.58 to 41.32 mg/m³ and spray painting from 23.61 to 31.48 mg/m³. Despite higher exposure levels, sanding workers demonstrated higher PPE compliance. Questionnaire findings indicated that sanding workers perceived their tasks as high risk, contributing to more consistent PPE use, whereas spray-painting workers perceived lower risk and exhibited reduced PPE compliance despite elevated short-term exposure.

Conclusion: Sanding operations were associated with higher average respirable dust exposure compared to spray-painting activities, although both tasks generated substantially elevated short-term concentrations during active work periods. Differences in PPE compliance were influenced more strongly by task-related risk perception than by exposure magnitude alone. These findings highlight the importance of integrating respirable dust monitoring with behavioural and perception-based assessments to strengthen exposure control strategies in aviation maintenance environments.

Keywords: Respirable dust, Occupational exposure, PPE compliance, Aviation maintenance, Exposure assessment

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