

RAILROAD LOCOMOTIVE WHOLE-BODY VIBRATION STUDY: VIBRATION, SHOCKS AND SEAT ERGONOMICS

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Introduction

North American railroad locomotive operators (engineers and conductors) are exposed to multi-axis vibration and shocks (1, 2). A recent epidemiological survey showed a prevalence of serious type of neck and lower back disorders nearly double that of a control group (3). Ergonomic working conditions are important co-factors in a vibration and shock exposure risk assessment (4, 5). The goal of this study is to illustrate typical work stations (cabs and seats) in US/Canadian type locomotives and assess shock related exposure risk by calculations of the new proposed shock risk indicators according to the new ISO 2631-5 (2004) (6).

Methods

Locomotive cab and seat inspections were conducted and operators' activities were assessed by a trained observer. Field measurements (n=50) were obtained during normal revue service following generally accepted guidelines (ISO 2631 (1)). A sub-sample of n=20 locomotives were selected for the calculation of proposed shock indicators (ISO 2631 (5)).

Results

There has been little change in basic locomotive cab and seat design in the U.S.. Two locomotive cab design concepts are used: the Association of American Railroad (AAR) Control Stand and in newer series wide-body locomotives the "Control Consol" (Figures 1-2), with varying seating conditions, but frequently subjecting the operator to an awkward body posture in addition to the vibration and shock exposure.

[Fig 1] Traditional cab and seat design ("American Standard Control Stand")

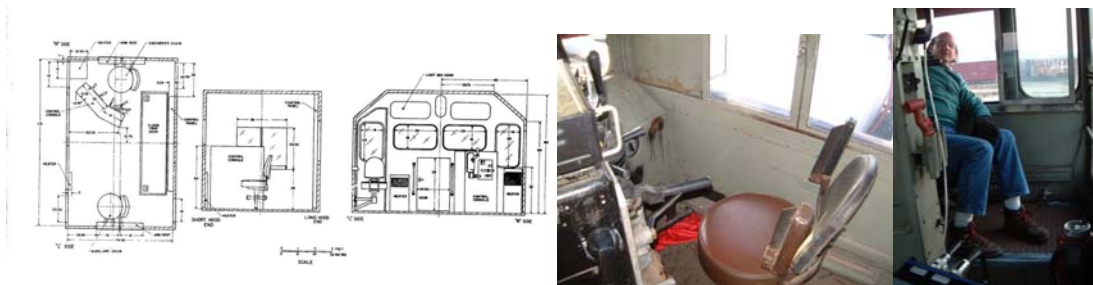
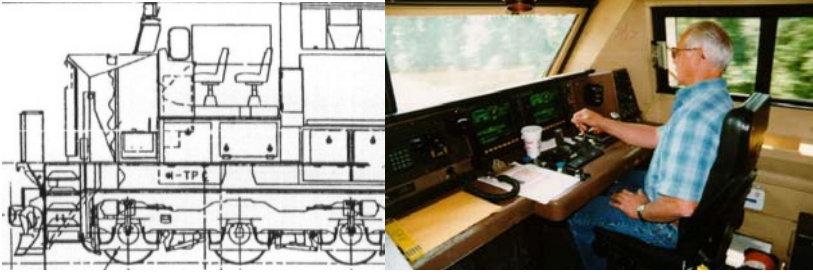


Fig 2) Modern "Control Consol" in "wide body" locomotive cab and seating



The results of the vibration and shock measurement of the basic x, y, z-axis ($a_{w\text{ rms}}$) and vector sum (a_v) ranges were 0.07- 0.19, 0.13-0.4, 0.14-0.5 and 0.27 – 0.65, respectively. The ranges of the “shock” indicators $MTVV/a_w$ and $VDV/(a_w \cdot T^{1/4})$ were (x,y,z): 3.2-7.6, 2.9- 9.4, 3.3-10 and 1.44-2.3, 1.37-1.71, 1.44-1.94 and exceeded in a number of cases the critical values given by ISO 2631 (1). The daily equivalent static compression dose S_{ed} range was 0.11 to 0.79, mean 0.32 and the R-factor range was 0.12 to 0.92, mean 34, suggesting possible conflicting shock exposure risk information.

Discussion

Different shock indicator values were computed based on both ISO standards. Although, the new ISO 2631-5 method for evaluation of vibration containing multiple shocks suggests in our calculations possibly a low exposure risk other data and experience suggest an underestimation error relying solely on this indicator. We propose considering a combined sum score, in an overall risk assessment, that includes ergonomic co-factors such as awkward body posture, cab and seat design, and other environmental factors.

References

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