

Spotlight: Northeastern University researchers find that heavy surface mine equipment operators are likely to exceed ISO daily vibration limits when operating equipment for a full (8-hr shift).

Alpha Foundation Grant AFC113-14: Whole Body Vibration Exposure and Injury Prevention of Heavy Equipment Operators in Open Pit Coal Mines

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Exposure to musculoskeletal injuries is a concern for operators of large-scale vehicles and equipment, especially in rough terrain conditions, such as that in surface mining operations. The International Organization for Standardization (ISO) establishes recommended vibration action limits necessary to avoid risk of developing Musculoskeletal Disorders (MSDs). Action limits are developed for various vibration exposure metrics. The three measured examined in this study are:

- $A(8) = 0.5 \text{ m/s}^2$ for the daily time-weighted average vibration
- $(VDV(8)) = 9.1 \text{ m/s}^{1.75}$ for the daily Vibration Dose Value, which is a time-weighted measure more sensitive to cumulative and impulsive vibration exposure.
- $Sed(8) = 5 \text{ MPa}$ - daily static compressive dose a raw continuous measure designed to better characterize and capture impulsive exposures.

Full-shift, 6 to 12-hour, continuous whole body vibration measurements were collected from 11 of the most representative types of the mine’s fleet vehicles in terms of hours of operation and number of vehicles. The results of the study as shown in the table indicate that most vehicles would be restricted to considerably less than a full shift and often less than 4 hours per day for time weighted exposures and less than 2 hours for impulsive focused exposures.

- The impulsive exposure parameters daily Vibration Dose Value ($VDV(8)$) and daily static compressive dose ($Sed(8)$) were above action limits and reduced heavy equipment vehicles operation times (time exposed before reaching the action limit) by one-half to two-thirds relative to daily time-weighted average vibration $A(8)$ exposures.
- Exposures were similar in multiple axes, not just in the traditional vertical direction.
- The direction (axis) with the highest amplitude of vibration exposure varied across the different heavy equipment vehicles, which is most likely related to the different tasks the vehicles complete within the mine.

Equipment	Σxyz		
	0.5 m/s^2	9.1 $\text{m/s}^{1.75}$	0.5 MPa
	$A(8)$	$VDV(8)$	$Sed(8)$
Hydraulic Shovel	6.4	2.6	4.2
Electric Shovel	8.9	4.8	40.6
Bull Dozer	2.4	0.7	1.9
Front Loader	2.6	0.8	1.9
Wheel Dozer	1.7	0.2	0.4
Grader	2.9	0.6	0.2
Scraper	1.7	0.4	0.4
240 Ton Truck	4.9	1.5	0.6
Water Truck	3.9	1.3	0.3
320 Ton Truck	4.0	1.1	0.8
190 Ton Truck	4.1	1.9	6.5
Medium time in hours equipment could be operated until reaching ISO daily action limit for vector sum of all three axes of motion (x, y, and z).			