



Technology News

From the Bureau of Mines, United States Department of the Interior



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No. 419, May 1993

Vibration Testing of Off-Road Vehicle Seats

Objective

Perform laboratory tests to measure the vibration attenuation characteristics of off-road vehicle operator seats for various types of seat suspensions, cushions, and seat adjustment settings.

Background

A study was conducted by the U.S. Bureau of Mines to determine the probability of whole-body vibration (WBV) exposure for a large class of off-road machinery operating in surface coal mines. The study determined that more than 40 pct of off-road equipment operators were exposed to WBV exceeding the standard fatigue-decreased-proficiency (FDP) level defined by the International Standards Organization in its guideline ISO standard 2631. The tire-terrain interaction of a moving vehicle generates vibrations that are transmitted through the vehicle suspension, cab mounting, and seat. The final point of transmission of vehicle vibration to the operator is through the seat. A seat that provides good vibration isolation and allows good vehicle control is of prime importance to operator safety and health.

Approach

The Bureau conducted vibration tests of four off-road vehicle seats. The study determined the optimal adjustment settings (air pressure, preload setting, etc.) for each seat tested. Two seats employed mechanical suspensions and two seats employed air spring suspensions. The seats

were tested using a 22241-N (5,000-pound-force) electrodynamic shaker. The seats were subjected to a swept sine acceleration input. The frequency range tested for the seats was from 0.7 to 10 hertz. Laboratory tests were constructed to simulate the mining vibration environment within the limitations of the test equipment. The seats were tested at maximum vibration levels that never exceeded the 4-hour, FDP exposure time defined in ISO 2631. Mechanical suspension seats were tested with varying seat cushion densities and preload-to-mass ratios (preload settings). Air suspension seats were tested with varying seat cushion densities and air pressure levels.

Results

Reported results were transmissibility and the root mean square of the peak accelerations of the seat, with the transmissibility being the ratio of vibrations at the seat cushion to cab floor. Air suspension seats pressurized greater than 552 kilopascal (80 pounds per square inch) provided vibration attenuation over the frequency range tested (0.7 to 10 hertz). Air pressures below 552 kilopascal produced two large transmissibility peaks.

The seats employing mechanical suspensions had larger transmissibilities than air suspension seats. In addition, if the mechanical seats' preload adjustment was set greater than the operator's weight, increased vibration transmissibility resulted.

The effect of seat cushion density was that greater density cushion material resulted in lower transmissibility peaks but poorer frequency attenuation ability, while lower density material produced greater transmissibility peaks but better frequency attenuation.

For More Information

For a free single copy of Report of Investigation (RI) 9454 write to the Bureau's Publication Distribution Section, Building 149, P.O. Box 18070, Cochrans Mill Road, Pittsburgh, PA 15236-0070. Additional information may be obtained by contacting:

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