

**WHOLE-BODY VIBRATION (WBV) EXPOSURE:
AN INVESTIGATION OF DRIVING METHOD EFFECT DURING RAILROAD
FREIGHT CAR INSPECTION**

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ABSTRACT

Three railroad carman inspector vehicles were assessed in terms of WBV at the seat pan during simulated conditions. Two driving methods were also assessed: driving at the "maximum train yard speed" of 15 miles per hour and "driving for conditions," or prudent driving at or below 15 miles per hour. A Ford F-350, a Ford F-150, and a Honda Recon ATV were evaluated in this study. Basic vibration, vibration dose value, and daily equivalent static compression dose were measured and assessed for each of the vehicles and driving methods per ISO 2631 Parts 1 and 5. Driving at maximum train yard speed, rather than driving for conditions, resulted in higher exposures for all three WBV measures and vehicles. Driving for conditions is one method to improve safety in terms of keeping WBV exposure safe.

Keywords: whole-body vibration, railroad, carman

**EXPOSITION AUX VIBRATIONS TRANSMISES À L'ENSEMBLE DU CORPS :
UNE ÉTUDE SUR LES EFFETS DES MÉTHODES DE CONDUITE AU COURS DE L'INSPECTION DE
WAGONS DE MARCHANDISES**

Trois locomotives d'inspection avec conducteur ont été évaluées par rapport aux vibrations transmises à l'ensemble du corps sur le siège dans des conditions simulées. Deux méthodes de conduite ont également été évaluées : la conduite à la « vitesse maximale du train en gare », soit 24 kilomètres par heure, et la « conduite en fonction des conditions », ou conduite prudente, à un maximum de 24 kilomètres par heure. Dans le cadre de cette étude, un Ford F-350, un Ford F-150 et un Honda Recon VTT ont été évalués. La vibration de base, la valeur de la dose de vibration et la dose quotidienne équivalente de compression statique ont été mesurées et évaluées pour chacun des véhicules et chacune des méthodes de conduite, et ce, selon la norme ISO 2631, parties 1 et 5. Le fait de conduire à la vitesse maximale du train en gare, plutôt qu'en fonction des conditions, a donné lieu à des expositions plus élevées concernant les vibrations transmises à l'ensemble du corps pour les trois mesures et les trois véhicules. Le fait de conduire en fonction des conditions représente une méthode permettant l'amélioration de la sécurité pour l'exposition sécuritaire aux vibrations transmises à l'ensemble du corps.

Mots clés : vibrations transmises à l'ensemble du corps, chemin de fer, wagonnier

INTRODUCTION

Whole-body vibration assessment at the seat pan has been performed for a variety of railroad job and task exposures, including the locomotive cab under various conditions (Cooperrider and Gordon, 2008; Johanning, 2006; Larson et al. 2006; Weames et al. 2014; Page et al. 2010). In addition to the locomotive cab, various maintenance-of-way (track repair) machines have been assessed (Johanning, 2010). Weames et al. (2012) assessed WBV exposure, overall, for freight car inspection performed in train yards. This task is commonly performed using a pickup truck, an ATV (straddle seat), or a “mule” (bench seat). The individual performing the task is called a carman inspector or car inspector in railroad terminology. The car inspector proceeds from freight car to freight car, in a pickup truck, ATV, or mule, looking at various freight car components to ensure the operability and safety of those components. An example of the components inspected include the break shoes. In this portion of the car inspector's job, the pickup truck, ATV, or mule is typically driven at low speeds—walking speed or slightly faster by the car inspector. In some instances, the car inspector may travel in a pickup truck, ATV, or mule, relatively long distances throughout the train yard to get to the train in need of having its freight cars inspected. In this component of the task, the car inspector operates under train yard speed restrictions for such vehicles, commonly 10 to 15 MPH.

The focus of our research is traveling by pickup truck, ATV, or mule throughout the train yard before and after freight train inspections, but not the low-speed inspection task itself. Further, within the travel component of the car inspector's job, the method by which the car inspector drives the pickup truck, ATV or mule was assessed.

METHODS

Three different freight car inspection vehicles were tested under two driving methods. The vehicles tested included a 2015 Ford F-350, a 2014 Ford F-150, and a 2014 Honda Recon ATV. No “mules” were tested in this specific research project. The two driving methods included driving at the posted train yard speed limit of 15 MPH and “driving for conditions” at speeds as conditions warranted (15 MPH or less). The test time averaged 9 min. 40 sec. while driving 15 MPH and 14 min. 7 sec. while driving for conditions. WBV measurements followed ISO 2631-1 and 2631-5 protocols (ISO, 1997; ISO, 2004). Testing was conducted over a 2.3-mile circuit at an exemplar train yard in Jackson, Michigan. At the time of testing, the train yard driving surfaces had not been recently graded or maintained.

RESULTS

Table 1 below shows the WBV measures for each of the tested conditions. Each condition was assessed twice. A two-by-three ANOVA model was used to determine significance. Vehicle and driver method effects were both statistically significant at an alpha of 0.05 for all but two WBV measures—RMSy (2hr) and VDVy (2hr).

Table 1: Average (across trials) WBV Data for Each Test Condition.

Vehicle	Driving Method	RMSx (2 hr)	RMSy (2 hr)	RMSz (2 hr)	VDVx (2 hr)	VDVy (2 hr)	VDVz (2 hr)	Sed (2 hr)
F-350	For Conditions	0.408	0.742	0.887	5.589	10.379	11.812	0.543
F-350	15 MPH	0.608	0.941	1.174	9.210	13.113	17.024	0.917
F-150	For Conditions	0.386	0.678	0.717	5.385	9.506	9.481	0.408
F-150	15 MPH	0.436	0.681	0.909	6.251	9.615	12.078	0.536
ATV	For Conditions	0.472	0.601	0.648	6.770	8.088	8.281	0.311
ATV	15 MPH	1.424	0.899	0.792	23.977	13.072	11.234	0.436

DISCUSSION

The results show the effect of vehicle and operator driving method for this portion of the car inspector's duties—driving to and from trains. Importantly, regardless of the vehicle used by the car inspector, WBV exposures can

be minimized by driving with prudence. The 2-hour analysis provides a worst-case-scenario in terms of exposure, whereby the drive time to and from trains has been found to be much lower. The above data does not estimate overall exposure for the work shift.

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