The Noise Exposure of Snow Removal Workers Measured According to OSHA and ISO

ÉTUDES ET RECHERCHES

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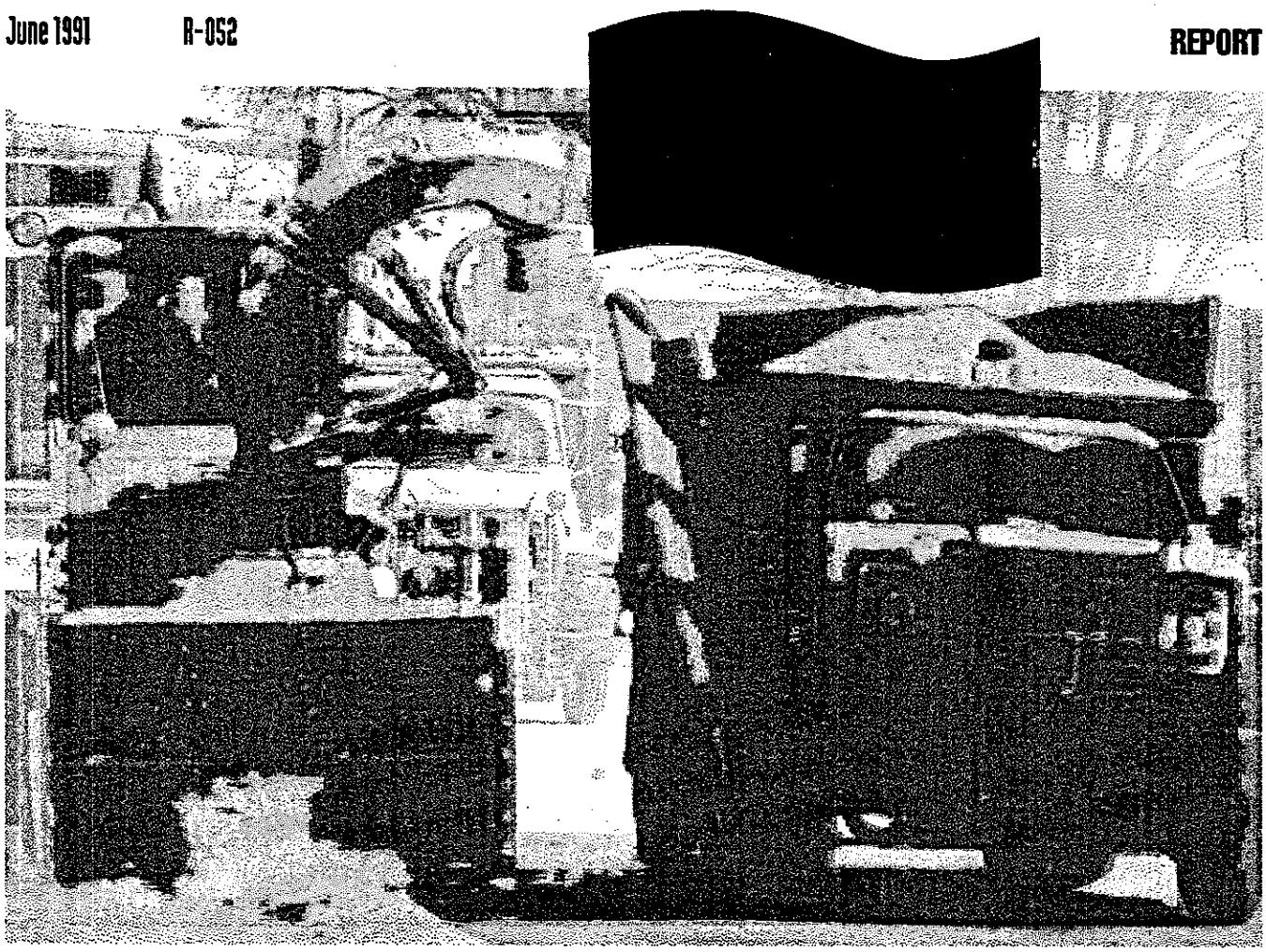

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REPORT

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Health Problems:
Deafness

Group of workers involved:
Workers in snow removal services

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1.0 INTRODUCTION

Most large Canadian cities with major snowfalls require teams of workers for clearing snow and loading it onto trucks. These operations, which involve powerful motorized vehicles, expose many workers to high levels of noise.

Few evaluation measures are reported in the scientific literature covering these specialized operations. In fact, the driving of heavy trucks has been evaluated in studies carried out in West Germany by Enz and Deserno[1], in France by Bruyère and Malherbe[2,3], and in the United States by Hessel, Heck and McJilton[4].

The purpose of this study is to determine the noise exposure of workers assigned to snow removal. This is done by using histogram dosimeters which are worn by the workers for the total exposure period which is evaluated in relation to the standard in force in Quebec (OSHA standard)[5]. Furthermore, in order to evaluate the impact of a change in measurement standards, simultaneous dosimetry carried out according to OSHA and ISO 1999[6] parameters allows the difference in exposure dose to be determined in relation to the two measurement principles.

The dosimetric results are grouped by type of operation for comparison purposes. They are also classified and compared in order to verify the effect of the two measurement principles on the workers' exposure doses.

1.1 Summary of the snow clearing and loading operations

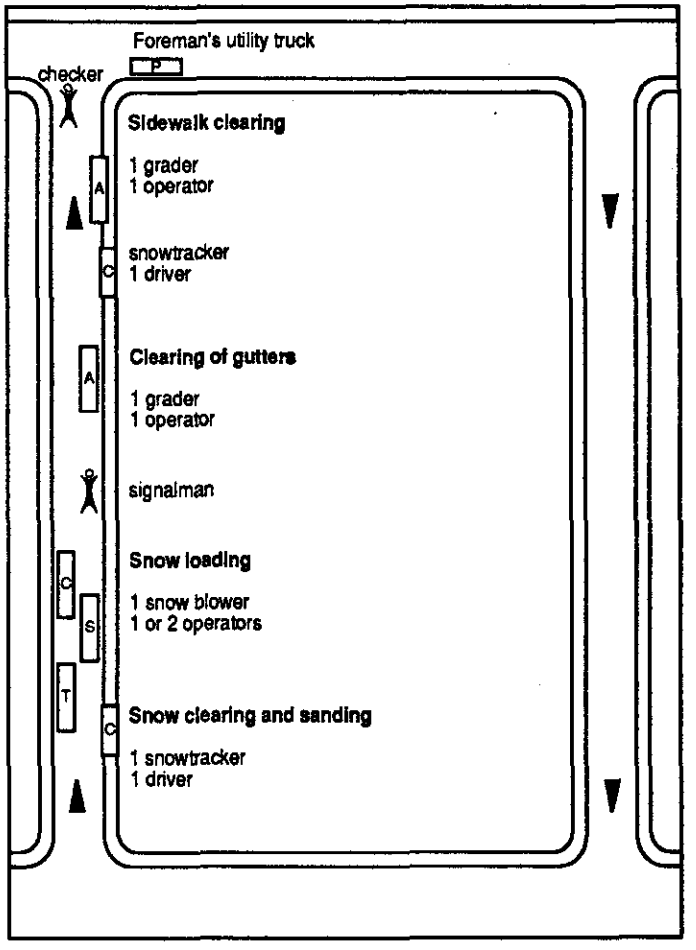
Snow clearing and snow removal operations in the Montreal metropolitan area involve more than 500 workers who perform the following functions: grader operator, snowblower operator, snowtracker driver, truck driver, loader driver, and signalman (loading-operation utility man).

At the start of a snowfall, abrasive is spread, and when accumulations of snow exceed two centimeters, snowtrackers, snowplows, and graders begin operating.

At the end of a snowfall, snow loading operations involve snowclearing trucks, snowtrackers, snowplows, loading trucks, graders, snowblowers, and loaders. The progression of vehicles during snow loading is illustrated in Figure 1. Loaders are used to clear intersections and to move the snow on unloading sites.

Figure 1

Snow loading operations



2.0 METHODOLOGY OF INTERVENTION

The dosimetric measurements were carried out using Dupont MK3 dosimeters. The dosimeters were worn by the workers throughout the working period, in other words, for 12 hours. Approximately 40% of all the dosimeters were adjusted according to OSHA measurement parameters, and approximately 60% according to ISO-1999 parameters. To improve the statistical treatment, the measurements were separated into two equal segments of approximately 6 hours each, as presented in the Canadian CSA standard[6].

All references appear at the end of the document.

In order to compare the exposure doses on the basis of the two measurement methods, more than 40% of the measurements were performed simultaneously with two dosimeters. The two instruments were worn for the entire work period by the workers involved. The dosimeter microphones were held approximately one-quarter inch apart by a plastic attachment device.

2.1 Measurement principles

In order to verify the importance of the measurement parameters, the MK3 dosimeters were adjusted according to the OSHA parameters (to check compliance with the Quebec standard) and according to those of ISO-1999. The summary of the characteristics of each measurement principle is presented in Table 1.

The doubling rate is the increase in decibels (dB) necessary to double the noise exposure dose for a given period, whereas the integration threshold is the level in decibels below which the instrument does not account for the noises in calculating the total dose.

2.2 Instrumentation used

The dosimeters used for these interventions are Dupont model MK3 histogram dosimeters. These instruments are capable of measuring equivalent sound levels 16 times per second and of retaining in memory an equivalent level for each minute over the total duration of a work shift (maximum 24 hours). The data thus collected are extracted using an interface, an IBM-PC dosimeter, Dupont model CI-1, and processed using a program developed by the IRSST[7].

2.3 Selection of workers

The workers for each type of operation (6 separate operations) were selected by taking as reference the criteria supplied in CSA standard Z107, 56-M86 "Méthode de mesure de l'exposition au bruit en milieu de travail" (Procedures for the Measurement of Occupational Noise Exposure) (draft standard at that time which has since been adopted). A sufficient number of measurements were performed in most cases for each of the tasks, to comply with the minimum acceptable standard deviation criteria for each series. Since the measurements were of a 12-hour duration, we separated the dosimetric measurements into two equal periods and treated them as different measurements for one worker. The effect of the compression of the 12-hour cumulative dose into 8 hours (100% dose for 12 hours gives 150% in 8 hours) is to increase the Leq by 1.76 dB when the measurement is made according to ISO.

The vehicles where chosen from the equipment fleet in such a way as to consider all possible classes, taking into account the types and ages of the machines.

Table 1

Characteristics of Noise Measurement Instruments

ISO 1999		QUEBEC STANDARD (OSHA)	
CALCULATION PARAMETERS USED		CALCULATION PARAMETERS USED	
Integration treshold:	80 dB(A)	Integration treshold:	5 dB(A)
Doubling rate:	Q = 3 dB	Doubling rate:	Q = 5 dB
Mode of integration:	not applicable	Mode of integration:	slow
Criterion level:	90 dB(A)	Criterion level:	90 dB(A)
INSTRUMENT SPECIFICATIONS		INSTRUMENT SPECIFICATIONS	
Class:	2A	Class:	2A
Crest factor:	>30 dB	Crest factor:	>30 dB
Impulse range:	53 dB	Impulse range:	53 dB
Measurment range:	80 to 141 dB (A)	Measurment range:	80 to 141 dB (A)
CALCULATION OF EQUIVALENT LEVEL		CALCULATION OF EQUIVALENT LEVEL	
$Leq\ (ISO) = 10 \log \left[\frac{1}{T_0}\int^{T_0} 10^{\frac{L(t)}{10}} dt\right]$		$Leq\ (OSHA) = 16.6 \log \left[\frac{1}{T_0}\int^{T_0} 10^{\frac{L(t)}{16.6}} dt\right]$	

3.0 RESULTS

The measurements characterizing worker exposure in relation to the standard in force in Quebec constitute the first part of the results. Their purpose is to verify whether these workers are overexposed.

The comparison of the measurements carried out according to the different instrumental criteria is then presented. This comparison is carried out mainly to evaluate the extent of the differences resulting from the use of the different measurement parameters, set by OSHA and ISO respectively.

3.1 Exposure levels of workers performing snow removal

The noise doses calculated for each portion (half) of the total 12-hour work period were collected for similar operations. This was done in order to determine the average exposure of workers for each of the functions established during the selection of workstations to be evaluated. All of the measurements that were done on five occasions during the winter of 1985 are presented in Table 2.

Table 2

Measurement of the Average Noise Exposure Doses of Workers Performing Snow Removal

Functions evaluated	Average Leq (OSHA)	Standard Deviation	Number of measurements
Drivers of snowtrackers (old models)	94.7	±0.9	2
Drivers of snowtrackers (recent models)	88.9	±2.2	6
Operators of snowblowers (old models)	93.8	±0.6	6
Operators of snowblowers (recent models)	90.0	±1.5	4
Drivers of loaders	89.0	±1.9	10
Operators of graders	83.5	±2.9	10
Truck drivers*	78.0	±6.5	4
Signalmen*	78.7	±5.4	4

* Note: Too large a variation in the work carried out or in the equipment used, results in a significant increase in the standard deviation of these measurements.

3.2 Comparison of the noise doses measured according to OSHA and ISO

The measurements were carried out using two dosimeters worn by one worker during the entire work period. The microphones were held together by a small plastic device attached to the worker's shirt collar. These comparative tests are particularly interesting within the framework of a current process to review measurement criteria and standards in Canada. As in the previous protocol, the 12-hour dosimetric measurements were divided into two separate measurements for statistical treatment purposes.

Since the measurement devices meet the instrument criteria specific to standard IEC 651, we believe that the measurements according to ISO and OSHA are precise to approximately 2 dB.

The table of comparative measurements (Table 3) allows us to state that, in general, the use of OSHA measurement parameters underestimates the noise doses for levels around 90 dB(A) by approximately 1.5 dB(A), as compared to the ISO standard. For measurements at lower levels in the order of 85 dB(A), the underestimation was around 3 or 4 dB(A). The integration threshold set at 85 dB(A) for OSHA has a greater effect on dose recording than the threshold of 80 dB(A) used for measurement according to ISO.

In order to provide indicative and comparative OSHA and ISO information on the noise levels encountered during continuous operations of snow removal equipment, Table 4 presents the equivalent levels for one-hour measurement periods. This table allows us to evaluate the exposure levels arbitrarily, if the work was performed continuously without break or waiting. One notes that snowblowing operations and snow clearing operations with the snowtrackers (old models) are by far the noisiest operations, as presented in Table 5.

Table 3

Comparative Doses Evaluated According to ISO and OSHA

Functions evaluated		Leq ISO-1999 (8 hours)	Leq OSHA (Québec regulation 8 hours)
Drivers of snowtrackers (old models)	(2)	96.4	94.7
Drivers of snowtrackers (recent models)	(6)	91.0	88.9
Operators of snowblowers (old models)	(6)	93.8	93.8
Operators of snowblowers (recent models)	(4)	91.1	90.0
Drivers of loaders	(10)	91.8	89.0
Operators of graders	(10)	86.9	83.5
Truck drivers*	(4)	84.5	78.0
Signalmen*	(4)	86.9	78.7

* Note: Too large a variation in the work carried out or in the equipment used, results in a significant increase in the standard deviation of these measurements.

Table 4

Equivalent Noise Levels Measured for Continuous Activity Periods of One Hour (Indicative Measurements)

Functions evaluated	Leq (1 hour) OSHA	Leq (1 hour) ISO
Drivers of snowtrackers (old models)	95.5 ± 0.8	94.0 ± 4.6
Drivers of snowtrackers (recent models)	90.7 ± 2.2	89.8 ± 2.3
Operators of snowblowers (old models)	92.9 ± 1.7	94.8 ± 0.9
Operators of snowblowers (recent models)	89.3 ± 2.2	90.1 ± 1.8
Drivers of loaders	90.3 ± 3.0	91.3 ± 2.6
Operators of graders	83.9 ± 4.6	87.3 ± 3.4
Truck drivers*	83.7 ± 7.1	83.7 ± 2.5

Note: Signalmen are not included since they are not assigned to a specific vehicle.

Table 5

COMPARATIVE MEASUREMENTS OF TIME DISTRIBUTIONS IN PERCENTAGE AT A GIVEN LEVEL, ACCORDING TO THE OSHA AND ISO MEASUREMENT CRITERIA

Functions	Equivalent Level	80 dB(A) %	85 dB(A) %	90 dB(A) %	95 dB(A) %	100 dB(A) %
Drivers of snowtrackers (old models)	OSHA ISO	65.4 72.6	59.1 59.6	49.5 40.3	21.1 17.1	1.1 2.8
Drivers of snowtrackers (recent models)	OSHA ISO	48.1 62.7	43.0 50.0	26.7 28.4	3.3 3.1	0.4 0.1
Operators of snowblowers (old models)	OSHA ISO	58.8 71.6	52.0 60.8	41.4 45.9	25.6 23.6	0.5 1.4
Operators of snowblowers (recent models)	OSHA ISO	63.3 79.5	53.7 65.7	20.0 26.7	1.4 2.2	0.0 0.3
Drivers of loaders	OSHA ISO	59.8 70.6	49.8 60.3	21.8 30.2	3.7 6.3	0.5 0.7
Operators of graders	OSHA ISO	36.8 62.3	22.6 37.5	4.4 9.7	1.1 1.4	0.2 0.1
Truck drivers	OSHA ISO	26.1 37.1	18.3 15.1	10.2 4.3	5.0 0.7	1.3 0.1
Signalmen	OSHA ISO	20.0 36.9	9.0 17.8	3.2 6.6	0.6 1.7	0.0 0.2

4.0 DISCUSSION

4.1 Exposure of workers performing snow removal

Workers doing snow removal and snow loading are exposed to very high instantaneous noise levels. In fact, an examination of histograms of equivalent levels (1 minute) as a function of time very often shows results above 95 dB(A). However, the effect of the variable and intermittent character of these exposures is to reduce the equivalent levels for eight hours to almost 90 dB(A) for drivers of snowtrackers (recent models), operators of snowblowers (recent models), and drivers of loaders. One also notes higher exposures of 94 to 95 dB(A) for drivers of snowtrackers (old models) and operators of snowblowers (old models). This situation can be explained in part by the inadequate soundproofing of these vehicles' cabins and also by the poor condition of the exhaust systems. Major differences in the design of the new models have definitely contributed to reducing the levels of noise emitted by the latter.

The use of a personal radio also contributed in a few cases to increasing the exposure dose[3]. A recently published[9] study shows a 1.9 dB(A) increase in the dose, which can result in a permanent loss of 4 dB(A) after 20 years of exposure in the most sensitive workers. By examining worker exposure profiles in greater detail, one can observe that the operation of vehicles with the windows open increases the exposure by at least 3 dB(A). An American study shows that for light trucks travelling at high speed, the difference in exposure can reach 20 dB(A)[10].

4.2 Comparative measurements according to OSHA and ISO

Table 3, for doses reported for an 8-hour period, shows that there are variations in the order of 1.5 dB(A) for the five functions with higher risk potential (snowtracker, snowblower, and loader). However, for the other functions with lower exposure, the differences are 3 to 8 decibels lower for measurements according to OSHA as compared to doses measured according to ISO.

For short continuous operating periods (one hour), the measurements according to the OSHA and ISO standards are practically the same for drivers of old model and recent model snowtrackers, for operators of old and recent model snowblowers, and for drivers of loaders. It seems that the difference between the ISO and OSHA integrations is accentuated in the case of intermittent noise, particularly due to its different integration threshold.

For grader operators, the observed difference is greater than 3 dB(A) and may be attributable to the respective OSHA and ISO integration thresholds set at 85 and 80 dB(A).

5.0 CONCLUSION

Snow removal operations expose workers performing the tasks of snowtracker driver and snowblower operator to high noise levels.

To reduce the workers' levels of exposure, strict policies for the replacement of old noisy equipment could be applied by implementing stringent specifications regarding equipment purchase. Continuous maintenance of the vehicles' mechanical components and exhaust systems would definitely contribute to a decrease in the noise emitted during snow clearing and loading operations.

The effect of the OSHA measurement method is, in most cases, an underestimation of the noise dose. Over the short term, this measurement method should be replaced by the ISO method which takes into account the total real energy perceived by the ear, and consequently is more appropriate for evaluating the extent of the hearing impairment of workers exposed to noise.

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