

METHODS OF REDUCING THE EFFECTS OF NOISE AND VIBRATION ON POWER SAW OPERATORS

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ABSTRACT

Methods developed and implemented in the U.S.S.R. for reducing the effects of vibration and noise emanating from chain saws are discussed. These include modifications to the engine exhaust system, the cutting apparatus, and a combined system of antivibration isolation for chain saw handles. Exposure limits for chain saw operator are also discussed.

INTRODUCTION

Chain saws have been widely used in logging operations. Because of the efforts of scientists and manufacturers, the modern power chain saw has become a highly efficient and convenient tool for this job. However, a high level of vibration on the handles remains a significant disadvantage of this tool. Along with other types of logging equipment, it is responsible for occupational diseases of operators.

If drastic measures to eliminate the harmful effects of vibration are not taken in the near future, then the use of chain saws on logging operations will be considerably diminished. The ever-increasing introduction of other types of machines for felling, limbing, and bucking timber also contributes to the process of reducing the number of chain saws used in logging.

Two basic trends have reduced the impact of vibration on the body of the chain saw operator: decreasing the vibration level of the tool and reducing the operator's working time with the tool.

DECREASING THE VIBRATION LEVEL

The main trend is the development of devices that decrease the vibration level of the power tool itself. In our experience, the following methods are effective and may be recommended.

- placing damping devices in the form of rubber-type or spring-type insulators between the engine and the handles—the so-called external protection from vibration (EAV system);
- increasing the vibro-insulating weight of chain saw units and parts, such as handles, fuel tanks, lubricating oil, carburetor, etc.;
- using balanced engines with dynamic balancing

mechanisms (of the Lanchester-Tailor type)—the so-called internal protection from vibration;

- using vibration absorbing materials on the chain saw handles;
- diminishing the weight of reciprocating engine parts;
- carefully balancing rotating engine parts;
- improving the gearing of the sprocket so the saw chain will have a reduced pitch.

Naturally, an optimum result in reducing vibration on the handle can only be achieved by considering the system as a whole.

This report covers the basic work conducted in the U.S.S.R. in protecting chain sawyers from occupational vibration. Long-term studies have shown that the safety-hygienic level of vibration on the chain saw handles may be reached through a combined system of protection against vibration that includes external as well as internal protection techniques (CAV-system).

A number of chain saw prototypes have been developed and investigated. The results of the study involved:

- including tanks for fuel and lubricating oils for external protection from vibration,
- using metal spring-type vibro-insulators to avoid the influence of temperature, and
- placing the dynamic balancing mechanism (which should be placed in the crankcase) in a central position.

The Taiga 214 chain saw production model (having a combined system of protection from vibration [CAV-system]) can be compared with two other chain saws having approximately the same engine power and external protection from vibration (EAV-system) (Table 1).

Table 1. Specifications of three chain saws.

Indicators	Taiga	Husqvarna	Stihl
	214	263CD	041AVE
Displacement, cm ³	75	63	61
Maximum power, h.p.	3.7	3.8	3.8
Weight of assembled unit (less fuel and oil), kg	8.3	8.2	8.0

The efficiency of the Taiga 214's combined system of handle protection against vibration can be compared with the efficiency of chain saws having only external protection from vibration (Table 2). Measurements were carried out in the perpendicular direction to the longitudinal axis of the bar and parallel to its plane (Y axis) in accordance with the procedure approved by the Ad Hoc Chain Saw Group of the FAO/ECE/ILO.

Table 2. Combined versus external antivibration protection.

Measurement position	Antivibration protection system*	Mean values of oscillatory acceleration (m/s ²) in octave band frequencies (Hz)					
		31.5	63	125	250	500	1,000
<i>Idling</i>							
Front handle	CAV	0.95	5.33	0.95	0.95	0.95	1.5
	EAV	1.5-7.0	1.7-4.8	0.9-1.5	0.3-1.3	0.1-1.5	0.1-0.8
Rear handle	CAV	2.68	2.38	0.95	0.95	0.95	0.95
	EAV	8.0-25.0	4.5-25.0	0.6-1.5	0.1-1.7	0.1-1.9	0.1-0.6
<i>Full load (cutting)</i>							
Front handle	CAV	1.50	5.33	4.76	4.76	3.78	15.0
	EAV	0.7-2.0	2.0-7.0	15.0-40.0	4.0-16.0	1.5-8.0	1.5-5.0
Rear handle	CAV	2.68	5.33	3.0	3.0	1.89	4.24
	EAV	1.2-3.0	10.0-17.0	18.0-28.0	14.0-28.0	3.0-7.5	1.0-4.0
<i>Racing</i>							
Front handle	CAV	0.95	1.50	3.0	5.33	5.98	5.33
	EAV	0.3-1.5	1.0-2.4	5.0-48.0	17.0-35.0	2.0-24.0	1.9-17.0
Rear handle	CAV	1.19	1.69	3.37	1.89	3.0	7.54
	EAV	0.3-1.6	1.0-2.5	5.0-37.0	9.0-35.0	9.0-30.0	1.5-4.0
ISO Std. March 1975, less correction factors		2.72	5.36	10.71	21.25	42.5	85.0
U.S.S.R. Hygienic Standard (State Standard #17770-72)		6.92	9.89	14.12	19.77	27.9	39.5

*CAV corresponds to the Taiga 214 saw measurements; EAV corresponds to saw models with external antivibration protection only.

As may be seen from Table 2, the Taiga 214 chain saw meets U.S.S.R. hygienic standards and the proposed ISO standards. The disadvantages of introducing the balancing mechanism into the engine design appear to be:

- the saw is more complicated and expensive,
- the dependability is reduced to some extent as additional parts are introduced into the design,
- the power per liter of displacement is diminished by 10% to 15% because more of the fuel mixture is blown through the crankcase, and
- the weight of the saw is increased, though insignificantly.

REDUCING WORKING TIME

The other, more secondary, trend to protect the

operator from vibration impact is by reducing the working time with the running saw.

In accord with U.S.S.R. legislation, physiologically proven maximum working times for chain saw operators have been set (Table 3).

Table 3. Maximum allowable work time for chain sawyers in U.S.S.R.

Operation	Continuous work time (min)	Total work time/7-hr shift (min)
Felling	40	280
Limbing	20	240
Bucking of tree lengths and logs	20	250

The continuous period of work with the chain saw is determined by the capacity of the tank, which is limited for each chain saw model. Time for refueling the chain saw tank usually totals 4 to 8 minutes and represents a forced-work break.

It is to be noted that in the U.S.S.R. the chain saw operators not only conduct their specific work function but also perform other jobs unrelated to vibration. In this way, improved chain saw design combined with preventive measures to limit vibration exposure time provide a safer job situation for the chain saw operator during his working shift.

CONCLUSIONS

There are two main methods—technical and preventive—for reducing harmful effects of vibration and noise on the body of the power saw operator.

The main noise and vibration source in a saw is the engine exhaust system and the cutting apparatus.

For noise attenuation, it is desirable to use two-chamber mufflers with large volume; saw chains with a small pitch between the pivots; perfect tenacity of the chain and sprocket; and fine lubrication of the cutting apparatus.

The effect of using the so-called combined anti-vibration system on new models of power chain saws is positive. This system combines rubber and spring mounts between engine and handles of the saw for dynamic balancing directly in the engine.

Vibration levels measured on the handles of the Soviet chain saw Taiga 214 while cutting are no more than 7.50 m/s^2 at 125 Hz and 6.0 m/s^2 at 250 Hz.

In accord with special U.S.S.R. regulations, human exposure to noise and vibration should not exceed 320 minutes per shift in the process of felling timber; when debranching and bucking, the limit is 280 minutes. Maximum permissible period of uninterrupted work with a saw when felling is 40 minutes; when debranching and bucking, this is reduced to 20 minutes.

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Sponsored by
National Institute for Occupational Safety and Health
Cincinnati, Ohio, U.S.A.
October 1975

Editors:
D. E. WASSERMAN
W. TAYLOR

Manuscript Editor:
M. G. CURRY

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Center for Disease Control
National Institute for Occupational Safety and Health
Cincinnati, Ohio 45226
April 1977

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DHEW (NIOSH) Publication No. 77-170