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SOUND LEVELS ON MANITOBA FARMS AND REDUCTION OF WINDROWER NOISE

by

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ABSTRACT

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More than three hundred tests were made to determine typical sound levels of many types of farm machinery used by farm workers in Manitoba. Sound pressure levels were measured at the operator's ear with portable measuring and recording equipment. Only twenty percent of the tractors tested produced sound levels of less than 90 dBA at high idle when loaded. The sound level at the operator's ear for eight forage choppers ranged from 95 to 109 dBA. Most self-propelled swathers, power-take-off combines, grinder-mixers, forage blowers, balers, vegetable harvesters, grain dryers and even small riding garden tractors produced sound levels in excess of 90 dBA. Very few farm machines had sound levels of 90 dBA or less and therefore a risk of hearing impairment is possible for operators exposed to eight or more hours per day on a continuous basis.

Tests were performed on a water cooled self-propelled windrower to determine its dominant noise sources. Various

engine, exhaust, and hydrostatic transmission treatments were tried to reduce the sound level at the operator's ear. The exhaust and transmission treatments were very beneficial.

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Collecting data for the rural Manitoba noise survey was an enormous task. The co-operation and patience shown by the participating Manitoba farmers during busy seasons of the year was greatly appreciated.

Thanks are due to the Department of Agricultural Engineering, University of Manitoba, for provision of funds and research facilities for this project. I would like to acknowledge the assistance of staff and graduate students of the Agricultural Engineering Department during the noise reduction portion of this study.

I would also like to thank Versatile Manufacturing Limited of Winnipeg, Manitoba for their full co-operation and the use of an SP400 swather, without which the noise reduction portion of this study could not have been done.

Last of all I thank my wife, Lynne, who successfully accomplished such a tiring job of typing and arranging the manuscript.

This thesis is dedicated to the farmers of Manitoba who are concerned about their own health and that of others who have chosen the same vocation.

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CHAPTER 1

INTRODUCTION

1.1 Definitions

Noise is a disturbance in a communications system that interferes with or prevents reception of desired information. Acoustical noise has been described as "sound without value" or "unwanted sound". Sound in this study refers to the propagation of periodic pressure disturbances in air which reach the human ear.

The Sound Pressure Level, in decibels, of a sound, is twenty times the logarithm to the base ten of the ratio of the air pressure of the sound to a reference pressure. The reference pressure employed throughout this study is 0.0002 microbar (dyne/cm^2). The reference pressure of 0.0002 microbar is approximately the threshold of human normal hearing at 1000 Hz, and is zero decibels on the sound pressure level scale.

The Sound Level, in decibels, is a sound pressure level (re 0.0002 dyne/cm^2) which has been weighted according to the latest revision of the American Standards Association's standard on sound level meters.

1.2 Objectives

Several studies have been done which indicate that

farm tractors have high sound levels. There is little documentation of sound levels produced by other types of equipment that farmers use in their work. One objective of this study was to determine typical sound levels to which farmers in Manitoba were being exposed on several types of machines.

A second objective was to create an awareness among Manitoba farmers of risk of hearing damage due to excessive exposure to high sound levels. This was done by giving each operator a card indicating the sound level of his machine and a chart indicating recommended daily exposure times for various sound levels.

Several studies have been made which identify typical noise sources and offer some methods of reducing farm tractor noise. A third objective was to perform some of these reduction methods on a typical farm machine other than a tractor.

CHAPTER 2

REVIEW OF LITERATURE

2.1 Previous Agricultural Noise Surveys

Several surveys have been done which indicate that farm tractors have high sound levels. High sound levels were found in all tractor power classes as can be seen below. Another interesting observation is that there is little documentation of either high or low sound levels of farm machinery other than tractors.

Lierle and Reger (1958) measured sound levels on eleven tractors ranging in size from 35 to 60 hp. During field operations they found a range of sound levels from 95 to 107 dBC with an average of 101 dBC. Load and field conditions were not specified.

Weston (1963) showed that farm tractor noise levels ranged from 92 to 114 dBA.

Huang and Suggs (1968) tested four late model gasoline tractors ranging from 25 to 64 hp. They found that the tractor noise at full power-take-off load was generally in the range of 101 to 109 dBA at the operator's ear. The noise was predominantly of low and medium frequency when the tractors were equipped with conventional mufflers.

Matthews (1968) showed that the mean sound level of twelve wheel tractors was 91.2 dBA with a maximum value

of 102 dBA and a minimum value of 84 dBA. The tractors ranged from 40 to 65 rated hp with a mean value of 50.4 hp. Matthews also found that thirty wheel tractors ranging from 35 to 100 rated hp had sound levels ranging from 74 to 96 dBA. The tractors had an average power of 51.8 hp and a mean sound level of 86.6 dBA. Eleven other tractors had an average sound level of 87.4 dBA for field operations of drilling and rolling. The minimum sound level was 80 dBA and the maximum was 95 dBA. The rated power of the tractors varied between 50 and 60 hp with the mean being 53.2 hp. The mean sound level of nineteen combine harvesters was 89.7 dBA with readings varying from 86 to 98 dBA.

Jones and Oser (1968) reported on tests conducted on fifty-five tractors at the University of Nebraska Tractor Test Laboratory. They reported an average sound level of 103.5 dBC for tractors averaging 48.85 hp with readings as high as 113 dBC. Other agricultural machines were also tested yielding sound levels from 90 dBC for a grain roller mill to 110 dBC for a two-row mounted corn picker.

Simpson and DeShayes (1969) reported on a three year study conducted at the University of Nebraska Field Laboratory at Mead, Nebraska. They found a general decrease in hearing acuity for 146 farm workers. Tractor operators

who wore ear plugs during this study were found to have 20 dB better acuity at 4000 Hz than workers not wearing ear protection. They found an average sound level of 104.8 dBC for 55 tractors averaging 48.85 hp.

In 1970, sound pressure levels became another parameter to be included in the tractor test performed at the University of Nebraska. Twenty-nine tractors ranging from 31 to 135 pto hp had an average sound level of 95 dBA at the operator's ear. The average rated horsepower of the tractors was 82.5 hp and the sound levels varied from 89.5 to 100 dBA. In 1971, twenty-seven tractors were tested at Nebraska. Their mean rated power was 110.8 hp and the average sound level was 91.4 dBA. Power-take-off horsepower ranged between 19 and 225 hp and sound levels ranged between 84.5 and 99 dBA. For twenty-three tests in 1972 the average horsepower was 96.0 hp with a minimum of 22.0 hp and a maximum of 176.0 hp. The average sound level was 91.1 dBA with a minimum of 82 dBA and a maximum of 101.5 dBA.

Matthews and Talamo (1971) summarized octave band pressure levels for twelve tractors in a power range from 45 to 100 hp. The octave spectra demonstrated the dominance of the 125 Hz component close to the engine firing frequency, particularly when the engine was loaded. When loaded at 85 percent maximum power and travelling at

7 km/h a maximum sound level of 100.5 dBA was noted. The mean value was 97 dBA and the minimum value was 93.5 dBA. At maximum speed with a light load, a maximum sound level of 98 dBA was noted. The mean value was 94.5 dBA and the minimum value was 90 dBA. A summary of fifty-two National Institute of Agricultural Engineering tests from 1963 to 1969 showed that the sound level at the operator position was increased when a cab was fitted to the tractor in fifty-one of the cases. The increase occurred mainly in the 250 to 4000 Hz range.

Splinter, Mumgaard, Steinbruegge, and Larsen (1972) reported on sixty-seven tractors tested at the University of Nebraska. It was noted that not one of the first twenty-six tractors tested had readings below 90 dBA at 100 percent pull and yet only nine of the last twenty-six tractors tested were above 90 dBA. Four of these were 85.5 dBA or below. They found there was essentially no difference in sound level for tractors operated at 100 percent or 75 percent load, full throttle. There was only a 0.7 dBA decrease at 50 percent load, full throttle. Fifty-six of the tractors were operated at 50 percent load at a reduced engine speed in a higher gear. The sound level at the operator's station decreased from 92.4 to 89.9 dBA in this case.

Combining the above Nebraska tests for 1970, 1971

and 1972 gives information at rated load for a total of seventy-nine tractors ranging in size from 19 to 225 pto hp at rated engine speed. Sound levels measured at the operator's ear when the tractors were under maximum load and at rated engine speed ranged from 82 to 101.5 dBA. The mean power of the tractors was 96.1 hp.

2.2 Previous Noise Reduction Projects

Most vehicle noise reduction is done by the use of one or more of three techniques. These have been called "cut and try", "quiet vehicle" and "attenuation factor" techniques. Examples of the use of these techniques are given below. The merits of each method are also summarized.

Giovanetto and Kacynski (1972) reported on a "cut and try" or "hedge clipping" method used to quiet the cab of a WABCO model 444 motor grader from 96 dBA to 86 dBA with doors and windshield open. A complete sound survey was taken to determine a normal and a worst case condition. It was decided that the cab noise with the grader stationary and the engine at full speed was typical of the noise produced during normal operation.

Suspected noise sources were treated one at a time. The replacement of the single standard muffler with two special mufflers reduced the sound level by 1.5 dBA. Enclosing and sealing the engine compartment, and plugging