A COMPUTER PROGRAM FOR THE CALCULATIONS
IN THE CSA STANDARD Z107.56
"PROCEDURES FOR THE MEASUREMENT OF OCCUPATIONAL NOISE EXPOSURE"

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ABSTRACT

The CSA Standard Z107.56 "Procedures for the Measurements of Occupational Noise Exposure" comprises a main body and four Appendices. Appendix B deals with the measurement of noise exposure of groups of workers using statistical sampling methods. Some rather complicated mathematical treatments of the data are required. These calculations can be performed very easily using the computer program described in this paper. The program is menu driven and user friendly. It has been offered to CSA for distribution.

SOMMAIRE

Le Standard de la CSA Z107.56 "Methodes de Mesures de l'exposition au bruit en milieux de travail" comprend une section principale et quatre appendices. L'appendice B traite des mesures du bruit pour les groupes exposes par l'utilisation d'une methode d'echantillonage statistique. Ell exige des calculs mathematiques assez compliques. Ces calculs peuvent etre executes tres facilement par l'utilisation d'un programme sur ordinateur decrit dans cette communication. Le programme est dirige par menu et est facile d'utilisation. Il a ete offert a la CSA pour distribution.

1.0 INTRODUCTION

The CSA Standard Z107.56[1] was published in 1986. It is the first Standard published worldwide (as far as the authors know) that deals with the issue of noise exposure measurements. Because of this fact and because of its wide field of application, this is one of the most popular standards published by the Canadian Standard Association.

The Standard comprises one main body and four Appendices that address such issues as employee's involvement, calculation of different noise exposure indices and procedures for the use of the L_{OSHA} (the Standard is written in terms of $L_{eq,T}$).

Appendix B of the Standard deals specifically with the measurement of noise exposure of groups of workers. This is a very important subject for large industries, where it is

very expensive to measure the exposure of every one of the exposed subjects. Instead, a statistical method is used where a sample is tested and the results are extrapolated over the whole population.

The starting point for the mathematical treatment of the data is the fact that the noise exposure data are normally distributed[2]. The Standard defines a Group as workers that are expected to have a similar noise exposure because of performing similar activities or being exposed to similar noise (e.g., in a large reverberant shop, almost every worker may have the same exposure, although several activities may be performed).

The objective of the measurement is to obtain the mean noise exposure level of the Group at the 95% confidence level, (L_{Trade}) and its Standard Deviation. With those data, a risk assessment can be performed by calculating the percentage of employees within the particular Group who have noise exposure levels exceeding a given criterion level (e.g., 85 dBA).

The procedure for the assessment is as follows:

1. The sample size is calculated to be statistically significant. This is done by either using existing tables[3] or, if the standard deviation of the population is known from previous measurements, by following a specific procedure outlined in the Standard.

2. The sample is surveyed for several days (generally one week). For each day the daily noise exposure level ($L_{eq,}$) of each worker is calculated (using the elapsed time of the measurement and the dose) or read on the instrument (if it is a direct reading dosimeter).

3. The weekly noise exposure of each worker ($L_{eq,}$) is calculated as the log sum of $L_{eq,8,i}$.

4. The mean noise exposure of the whole trade (L_{Trade}) is obtained as the arithmetic mean of the $L_{eq,}$,$_i$ from all workers within the sample. A subsequent calculation is used to obtain the upper 95% confidence limit for the L_{Trade}.

5. The percent of workers with noise exposure higher than a given level (e.g., 85 dBA) is calculated to assess the risk of the Group, also at the upper 95% confidence limit.

The above described mathematical treatment of data involves a substantial amount of calculation. Although these calculations are not complicated, they are tedious, time consuming and prone to errors.

This is why the computer program was developed. The requirements were that the program should be menu-driven and user friendly.

2.0 THE COMPUTER PROGRAM

This program was written in Microsoft QuickBASIC 3.0 on an IBM XT running IBM DOS 3.20. Required hardware is an IBM PC/XT/AT or compatible with 256K RAM and a single 360K floppy disk drive.

2.1 Calculations Included

The program performs several calculations on noise dosimetry data, as follows:

a) A single worker's $L_{eq,T}$,

b) A single worker's $L_{eq,4\circ}$,

c) L_{Trade} for a number of workers,

d) Upper Confidence Limit of the L_{Trade},

e) Standard deviation of $L_{eq,4\circ}$'s for a number of workers,

f) Percentage of the population with noise exposure above 85 dBA,

g) Upper Confidence Limit of the above,

h) The median $L_{eq,4\circ}$,

i) The modal $L_{eq,4\circ}$, and

j) The skew of the samples.

All statistics are calculated at the 95% significance level.

Data may be entered as:

a) Dose (in percent) and start and stop times,

b) Dose (in percent) and elapsed time only,

c) $L_{eq,\cdot}$, or

d) $L_{eq,\cdot\cdot}$.

The program can also handle $L_{eq,\cdot\cdot}$'s from an ASCII
format dump file, which may be created using any ASCII
text editor.

2.2 Installation

It is recommended that the program be installed on a
computer with a hard disk. This will allow greater
data file storage capacity than a floppy disk based
system. Also, data access is much faster from a hard
disk; therefore, the program's calculations will be
performed quicker on a hard disk based computer. The
following steps are recommended for the installation:

1. Create a subdirectory called NOISE under the root
    directory.

2. Copy NOISE.EXE from the distribution diskette to
    C:\NOISE\NOISE.EXE.

The program will then be executable as follows:

1. Ensure that C:\NOISE is the current default
    directory.

2. Type NOISE ‹Enter›.

For those using the program on an IBM EGA or compatible
display adapter, the program may be invoked with the /e
option (for Enhanced). This option allows the computer
to make full use of the EGA to produce high resolution
graphics in full colour. Note that this option is
available only on an EGA machine. Using the /e option
on a CGA or Hercules machine will cause an error.

Any files the program produces will be found in the
subdirectory C:\NOISE.

2.3 Using the Program

Program structure is outlined in Figure 1. Once the
program is running, the user interacts with the various
screen menus to select the desired actions.

The Main Menu lists the following options:

1. Enter Noise Dosimetry Data
2. Perform Statistical Analysis
3. Quit

Each option is described in the following sections.

2.3.1 Enter Noise Dosimetry Data

Noise dosimetry data may come in one of several forms:

1. Start and stop times and the accumulated dose for that time,
2. Elapsed sampling time and the accumulated dose for that time,
3. $L_{eq,8}$'s, and
4. $L_{eq,16}$'s.

The above four data types correspond to the options in the Data Entry menu:

1. Enter Start and Stop Times
2. Enter Elapsed Time
3. Enter/Edit $L_{eq,8}$ Data Directly
4. Enter/Edit $L_{eq,16}$ Data Directly
5. Return to Main Menu

Noise dosimetry data consisting of times and doses may be referred to as raw data, since there have been no calculations performed on them. Usually, these data will be collected directly from the dosimeter.

$L_{eq,8}$ and $L_{eq,16}$ data are the results of calculations performed on raw dosimetry data, or may be obtained from previous reports.

Further calculations are usually performed on $L_{eq,16}$'s to generate the statistics (including L_{Trade}) which are included in reports.

FIGURE 1
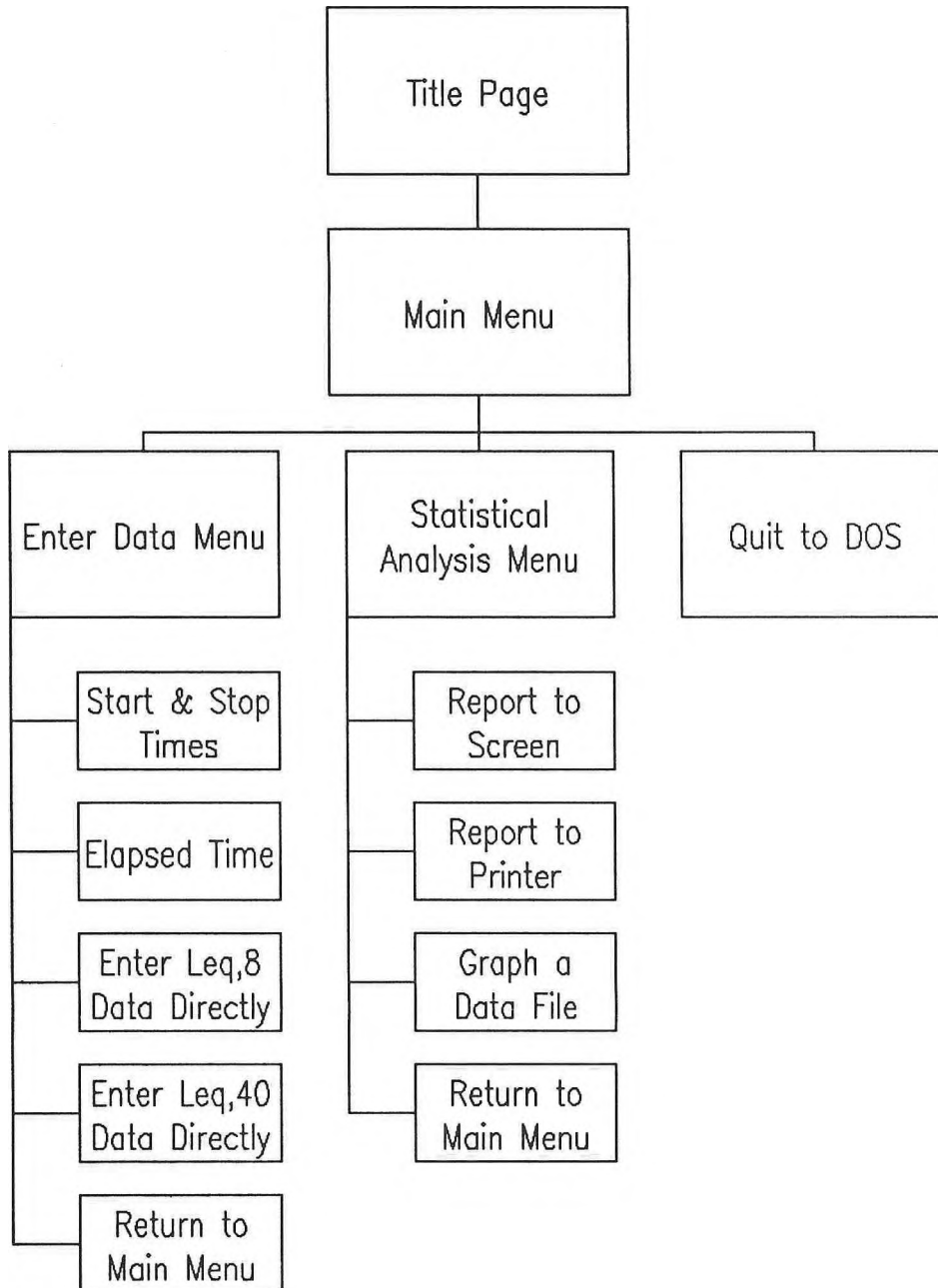
2.3.1.1 <u>Entry of Raw Dosimetry Data</u>

Entry of raw dosimetry data consists of performing the following steps:

1. Select the desired option from the menu.
2. Enter a file name for this set of data.
3. Enter the data. (Usually several sets of data are entered for each worker.)
4. Calculate the $L_{eq,..}$ for this worker, and save the data and the $L_{eq,..}$ to file.
5. Continue to the next worker, or quit when all the data have been entered.

2.3.1.2 <u>Entry of $L_{eq,..}$ Data</u>

The direct entry of $L_{eq,.}$ or $L_{eq,..}$ data consists of performing the following steps:

1. Select the desired option from the menu.
2. Enter a file name for this set of data.
3. Enter the $L_{eq,.}$'s of $L_{eq,..}$'s.
4. Quit when all the data have been entered.

2.3.2 <u>Processing Data</u>

The Statistical Analysis menu lists the following options:

1. Analyze Data
2. Graph Data
3. Return to Main Menu

The first option above, Analyze Data, calculates the statistics listed in Section 2.1.

The second option above, Graph Data, may be used to visualize the distribution of the data. Such a graph may indicate the presence of outliers or other significant information.

3.0 <u>STATUS OF THE PROGRAM</u>

The program has been in use in Ontario Hydro for some time. There it has proven to be a much needed, user friendly, time saving device.

The program was offered to the Canadian Standard Organization to be used as a support for the Standard. If requested, the program will be expanded further to accommodate the rest of the formulas from the rest of the Appendices.

4.0 **REFERENCES**

1. CAN/CSA Z107.56-M86 "Procedures for the Measurements of Occupational Noise Exposure", Canadian Standard Association, 1986.

2. Behar, A. and Plener, R. "Noise Exposure – Sampling Strategy and Risk Assessment," American Industrial Hygiene Association J.45(2):105-109, 1984.

3. Leidel, N.A., Busch, K.A. and Lynch, J.R. "Occupational Exposure Sampling Strategy Manual", NIOSH publication 77-173, Cincinnati, Ohio, USA, 1977.