# ACOUSTICAL MEASUREMENTS IN SOME CANADIAN HOMES

J.S. Bradley, Institute for Research in Construction,
National Research Council, Ottawa, K1A 0R6.

ABSTRACT

The means and standard deviations of several acoustical quantities are presented from measurements in 602 multiple residence homes. Although not a random sample, the homes included approximately equal numbers of apartment blocks and row housing as well as owners and renters from three different urban areas. The acoustical values included background noise levels and complete transmission loss measures of common walls.

SOMMAIRE

L'auteur présente, à partir de mesures effectuées dans 602 habitations à logements multiples, les moyennes et les écarts types de plusieurs quantitiés acoustiques. Même s'il ne s'agissait pas d'un échantillonnage au hasard, il était constitué d'un nombre approximativement égal d'immeubles et de maisons en rangée, et de propriétaires et de locataires de trois régions urbains. Les valeurs acoustiques qui ont été mesureés sont les suivantes: les niveaux de bruit de fond, les temps de réverbération et la perte par transmission des murs mitoyens.

## INTRODUCTION

As part of a large survey to relate subjective and objective measures of party walls between adjacent homes, values of several acoustical quantities were obtained in a large number of Canadian homes. In the complete survey residents in 602 homes, (301 pairs of homes), were interviewed. The homes were evenly distributed among three Canadian urban areas: Toronto, Vancouver, and Montreal, and were approximately evenly divided between apartment blocks and row housing. There was also an approximately even split between owners and renters for each type of housing. Homes included in the survey were selected from available row housing and apartment blocks to give the broadest possible range of STC values while fulfilling the required balance between building types and between owners and renters. Thus the survey data do not represent a random sample of all types of Canadian homes. In spite of this limitation, the data provided a large sample of measurements that can be used to obtain 'typical' values of several acoustical quantities for these types of multiple residence buildings. Such information is often useful for making calculations of expected effects under such 'typical' conditions, and is published here so that others can make use of this data.

The main goals of the survey were to relate subjective and objective measures of party wall sound insulation, to evaluate various sound insulation measures with respect to subjective judgements, to determine other factors influencing subjective judgements, and to produce data to aid in determining acceptable levels of sound insulation between homes. The results of analyses to study these factors will be published in other papers as they become available.

## MEASUREMENTS

The acoustical measurements included integrated A-weighted background noise levels in each of the 602 homes, and complete sound transmission loss measurements of the 301 party walls. Background noise measurements were made using Metrosonics dB-301 integrating dosimeters positioned in the living room of each home for a 24 hour period. These provided A-weighted LEQ, (energy averaged sound level), measurements for the day, night, and complete 24 hour periods, and are referred to as LEQD, LEQN, and LEQ24 respectively. The day period was from 7:00 a.m. to 10:00 p.m. and the night period was from 10:00 p.m. to 7:00 a.m.

Sound transmission loss measurements were made generally in accordance with ASTM E336 procedures[1], and normally between living rooms. Sound levels were recorded in the source and receiving rooms with the noise source on and in the receiving room with the noise source off to obtain background noise levels. Reverberation times, RT, were measured in the receiving room in 1/3 octave bands from 100 to 4000 Hz to include all bands required for the ASTM E336 standard as well as those required by the related ISO standards[2]. The transmission loss, TL, was calculated in each 1/3 octave band according to equation (1).

$$TL = NR + 10.\log(S/A) \qquad (1)$$

where $NR = SPLs - SPLr$

and NR is the noise reduction between rooms in dB
SPLs is the space averaged source room sound pressure level in dB
SPLr is the space averaged receiving rooom sound pressure level in dB
S is the area of the common wall in $m^2$
A is the total sound absorption in the receiving room in metric sabins

From the 1/3 octave TL values the overall sound transmission class, STC, was calculated according to ASTM E413[3], as well as the difference in A-weighted levels, DA, between the source and receiving room with a pink source spectrum.

## RESULTS

The mean and standard deviation of the principal variables are given in Table I. The mean LEQ24 was 46.2 dBA with a standard deviation of just under 8 dBA. As would be expected the daytime LEQ was slightly higher and the nightime LEQ was a few decibels lower. The standard deviations were quite similar for all three measures. The distribution of LEQ24 values in Figure 1 is seen to be quite regular.

TABLE I Means and Standard Deviations of Principal Quantities

| Measure | Mean | Standard Deviation |
|---|---|---|
| LEQ24 | 46.2 dBA | 7.9 dBA |
| LEQD | 47.5 dBA | 8.0 dBA |
| LEQN | 39.8 dBA | 8.4 dBA |
| STC | 49.7 | 4.7 |
| DA | 51.3 dB | 5.1 dB |
| Volume | 57.0 $m^3$ | 64.1 $m^3$ |
| Area | 10.7 $m^2$ | 6.0 $m^2$ |

Measured STC values ranged from a low of 30 to a high of 60 with a mean of 49.7 and a standard deviation of 4.7. Thus in spite of efforts to obtain a broad range of STC values most walls had STC values between 45 and 55. Figure 2 shows the distribution of measured STC values. The mean measured DA value as given in Table I was 51.3 dB with a standard deviation of 5.1 dB. Table I also includes the mean and standard deviation of the common wall areas and of the receiving room volumes.

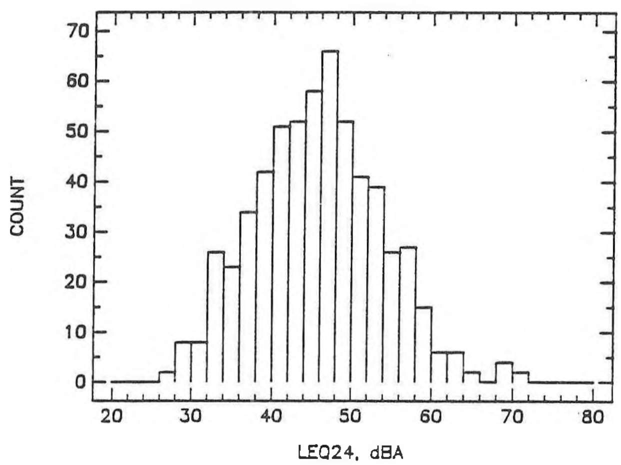


Figure 1. Distribution of Measured LEQ24 Values.

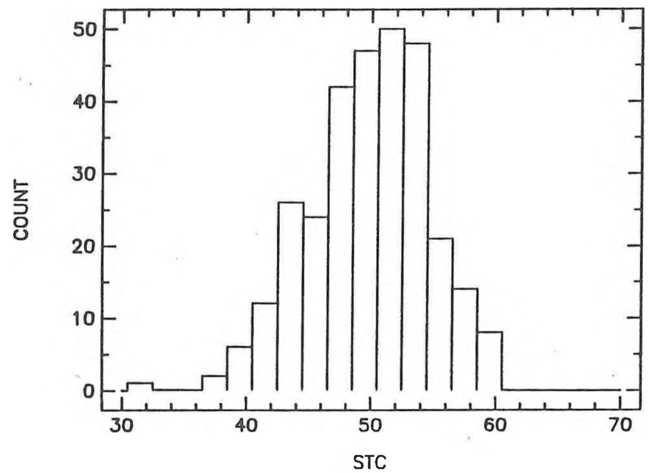


Figure 2. Distribution of Measured STC Values.

Figure 3 plots the mean 1/3 octave NR as well as 1 standard deviation above and below the mean values. Data for TL values are similarly plotted in Figure 4. The 1/3 octave means and standard deviations of the NR and TL values are also given in Table II.

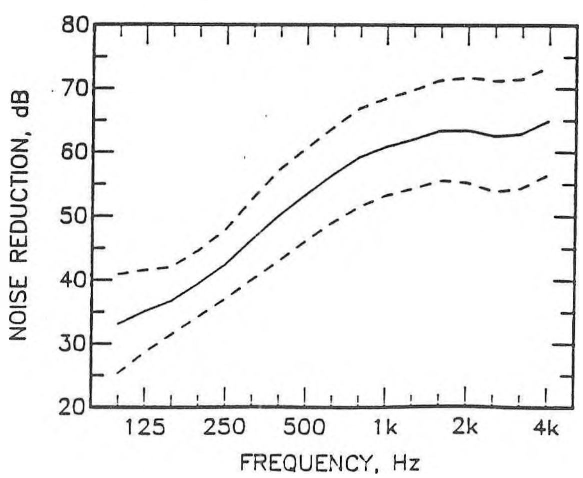


Figure 3. Mean NR Values versus Frequency ——, and ± 1. Standard Deviation - - -.

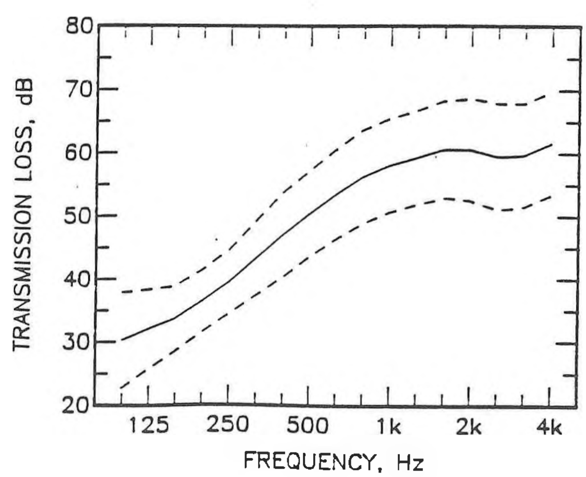


Figure 4. Mean TL Values versus Frequency ——, and ± 1. Standard Deviation - - -.

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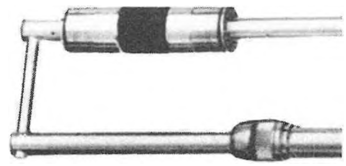

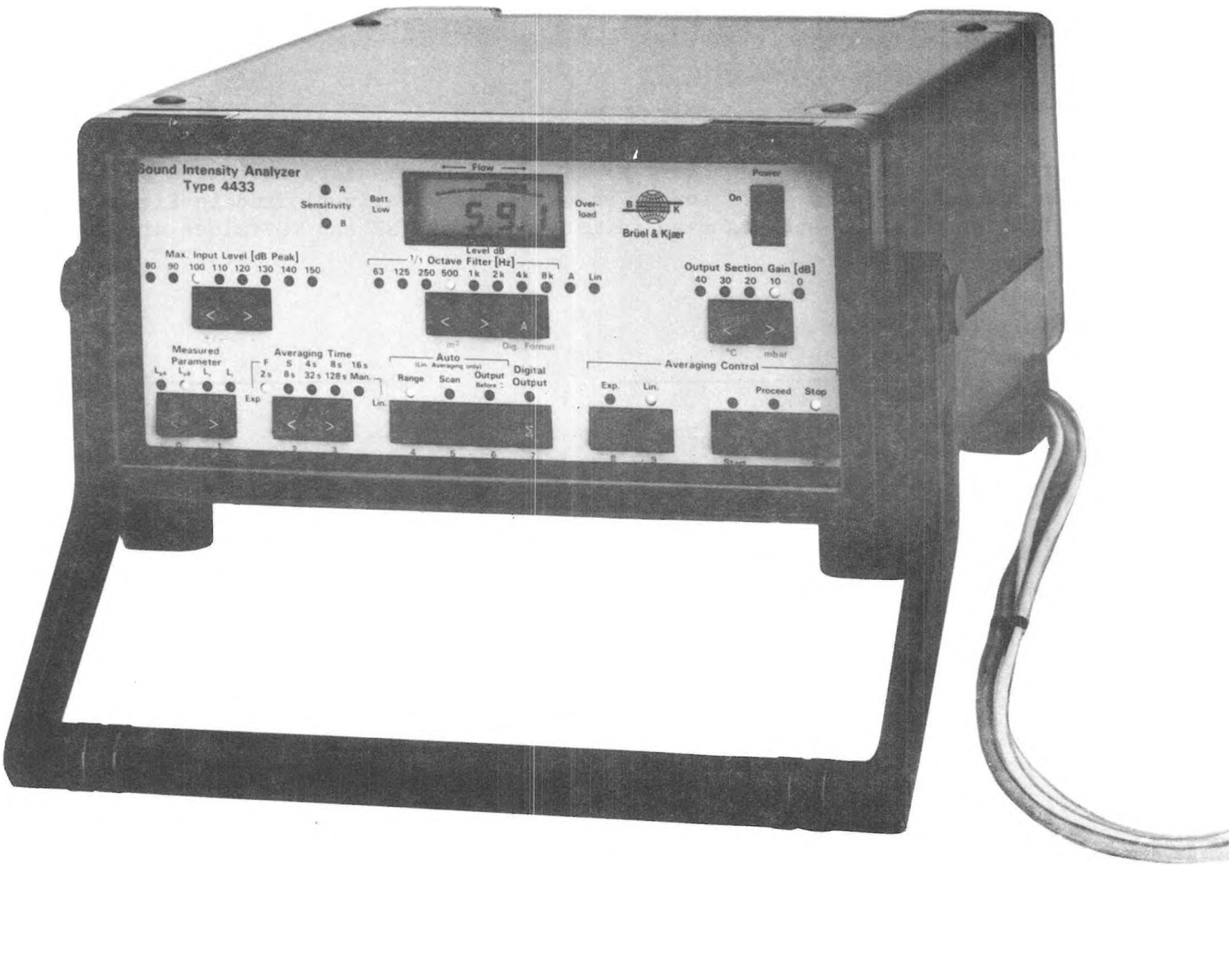

# nd Intensity Analysis


For years, Bruel & Kjaer has led the industry in the measurement and analysis of sound intensity. The newest addition to the line is the Type 4433, an analyser so portable, it can be used in virtually any field condition yet so accurate and fast, it can provide sound power determinations in a matter of minutes.

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TABLE II. NR and TL 1/3 Octave Means and Standard Deviations in dB

| Frequency | NR Mean | NR Standard Deviation | TL Mean | TL Standard Deviation |
|---|---|---|---|---|
| 100 | 33.1 | 7.8 | 30.3 | 7.6 |
| 125 | 35.1 | 6.5 | 32.0 | 6.3 |
| 160 | 36.8 | 5.3 | 33.6 | 5.2 |
| 200 | 39.5 | 5.2 | 36.4 | 5.0 |
| 250 | 42.5 | 5.4 | 39.5 | 5.1 |
| 315 | 46.4 | 6.3 | 43.4 | 5.9 |
| 400 | 50.1 | 7.1 | 47.1 | 6.7 |
| 500 | 53.3 | 7.2 | 50.4 | 6.8 |
| 630 | 56.4 | 7.4 | 53.5 | 7.1 |
| 800 | 59.2 | 7.7 | 56.3 | 7.4 |
| 1000 | 60.9 | 7.6 | 58.1 | 7.4 |
| 1250 | 62.1 | 7.7 | 59.3 | 7.4 |
| 1600 | 63.5 | 7.9 | 60.6 | 7.7 |
| 2000 | 63.5 | 8.3 | 60.5 | 8.1 |
| 2500 | 62.5 | 8.7 | 59.4 | 8.4 |
| 3150 | 62.9 | 8.6 | 59.7 | 8.2 |
| 4000 | 64.9 | 8.5 | 61.6 | 8.2 |

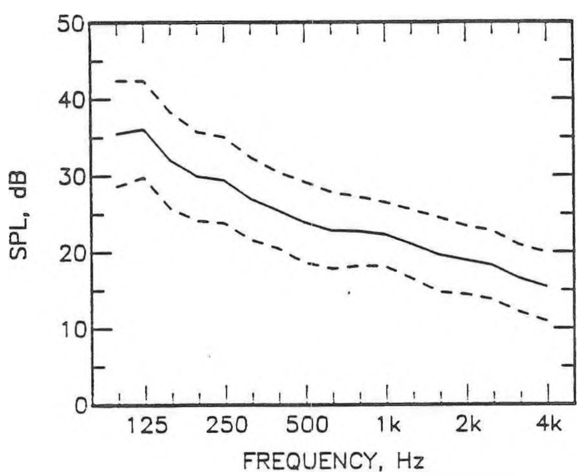


Figure 5. Mean Residual Background Noise Levels Versus Frequency ——, and ± 1. Standard Deviation - - -.

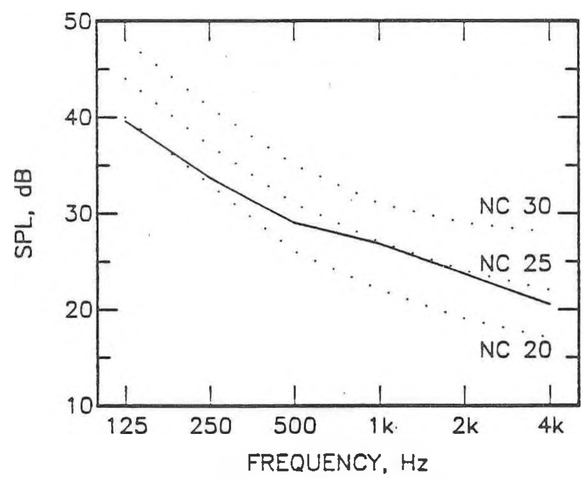


Figure 6. Mean Octave Band Residual Background Noise Levels versus Frequency ——, and NC contours - - -.

Figure 5 plots the mean and a one standard deviation range about the mean of the measured receiving room 1/3 octave background noise levels. These levels represent the residual background noise levels in homes with no occupant activity and so they are not for the same conditions as the LEQ values in Table I. Figure 6 plots the same residual background noise levels in octave bands along with three noise criterion, NC, contours. The overall mean residual background level is thus seen to approximate NC 25.

The mean measured receiving room reverberation times and a one standard deviation range are given in Figure 7. In all 1/3 octave bands the mean reverberation time was close to 0.4 seconds with a standard deviation of just under 0.1 seconds.

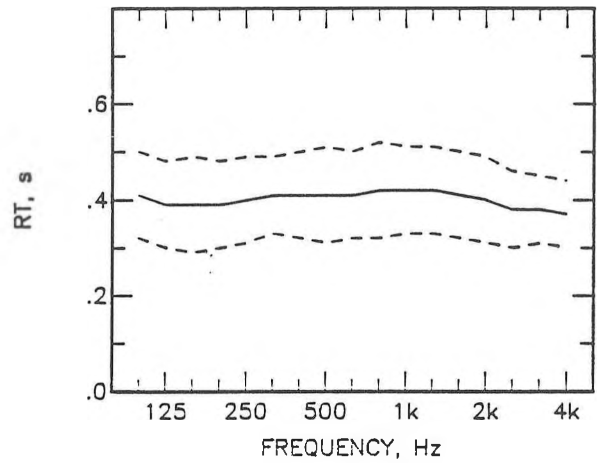


Figure 7. Mean RT versus Frequency ——, and ± 1. Standard Deviation - - -.

CONCLUSIONS

The data presented in this paper can be used to typify acoustical conditions in Canadian homes in multiple residence buildings. The typical home has an LEQ24 of 46.2 dBA and a residual background noise without occupant activity that approximates NC 25. The average party wall has an STC of approximately STC 50, and an average living room has a reverberation time that is close to 0.4 seconds at all measured frequencies. Details of mean 1/3 octave spectra of NR, TL, RT, and residual background levels were also presented. It is hoped that these values will provide a reliable data base for various calculations concerning acoustical conditions in these types of homes.

ACKNOWLEDGEMNTS

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REFERENCES

(1) ASTM E336-84, Measurement of Airborne Sound Insulation in Buildings, American Society for Testing and Materials, Philadelphia, U.S.A., 1984.

(2) ISO 140/4-1978, Field Measurements of Airborne Sound Insulation Between Rooms, International Standards Organization, Geneva, Switzerland

(3) ASTM E413-73 Determination of Sound Transmission Class, American Society for Testing and Materials, Philadelphia, U.S.A., 1973.