NASA CONTRACTOR REPORT

NASA CR-2760

NASA CR-2760

ATMOSPHERIC ABSORPTION OF HIGH FREQUENCY NOISE AND APPLICATION TO FRACTIONAL-OCTAVE BANDS

F. Douglas Shields and H. E. Bass

Prepared by
UNIVERSITY OF MISSISSIPPI
University, Mississippi 38677
for Lewis Research Center

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION • WASHINGTON, D. C. • JUNE 1977

1. Report No.
NASA CR-2760

2. Government Accession No.

3. Recipient's Catalog No.

4. Title and Subtitle
ATMOSPHERIC ABSORPTION OF HIGH FREQUENCY NOISE AND APPLICATION TO FRACTIONAL-OCTAVE BANDS

5. Report Date
June 1977

6. Performing Organization Code

7. Author(s)
F. Douglas Shields and H. E. Bass

8. Performing Organization Report No.
None

9. Performing Organization Name and Address
University of Mississippi
University, Mississippi 38677

10. Work Unit No.

11. Contract or Grant No.
NAS3-19431

13. Type of Report and Period Covered
Contractor Report

12. Sponsoring Agency Name and Address
National Aeronautics and Space Administration
Washington, D. C. 20546

14. Sponsoring Agency Code

15. Supplementary Notes
Final Report. Project Manager, Orlando A. Gutierrez, V/STOL and Noise Division, NASA Lewis Research Center, Cleveland, Ohio

16. Abstract
Pure tone sound absorption coefficients have been measured at 1/12 octave intervals from 4 to 100 kHz at 5.5 K(10° F) temperature intervals between 255.4 and 310.9 K(0° and 100° F) and at 10 percent relative humidity increments between 0 percent and saturation. The measurements were made in a large cylindrical tube (i.d., 25.4 cm; length, 4.8 m). Special solid-dielectric capacitance transducers, one to generate bursts of sound waves and one to terminate the sound path and detect the tone bursts, were constructed to fit inside the tube. The absorption was measured by varying the transmitter receiver separation from 1 to 4 m and observing the decay of multiple reflections or change in amplitude of the first received burst. The resulting absorption was compared with that from a proposed procedure for computing sound absorption in still air, and the agreement was quite good. Absorption of bands of noise was numerically computed by using the pure tone results. The results depended on spectrum shape, on filter type, and nonlinearly on propagation distance. For some of the cases considered, comparison with the extrapolation of ARP-866A showed a difference as large as a factor of 2. However, for many cases, the absorption for a finite band was nearly equal to the pure tone absorption at the center frequency of the band. A recommended prediction procedure is described for 1/3 octave band absorption coefficients.

17. Key Words (Suggested by Author(s))
Atmospheric sound absorption
Band absorption
Atmospheric acoustics
1/3 Octave prediction procedure

18. Distribution Statement
Unclassified - unlimited
STAR category 71

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price*
Unclassified	Unclassified	238	A11

* For sale by the National Technical Information Service, Springfield, Virginia 22161

TABLE OF CONTENTS

Section | Page

ATMOSPHERIC ABSORPTION OF HIGH FREQUENCY NOISE AND APPLICATION TO FRACTIONAL-OCTAVE BANDS

BY F. DOUGLAS SHIELDS AND H. E. BASS
DEPARTMENT OF PHYSICS & ASTRONOMY
THE UNIVERSITY OF MISSISSIPPI
UNIVERSITY, MISSISSIPPI 38677

1. SUMMARY

This report presents the results of a NASA-Lewis sponsored study of atmospheric absorption of noise in the frequency range of 4 kHz to 100 kHz, for temperatures from 255.4°K (0°F) to 310.9°K (100°F) and at relative humidities from 0% to saturation. The measurements were made in a large cylindrical tube (25.4 cm I.D. by 4.8 m long). Special solid-dielectric capacitance transducers were constructed which fit inside the tube. One of these transducers generated bursts of sound waves and was mounted so that it could be moved inside the large sound tube. A second transducer of similar construction terminated the sound path and detected the tone bursts. The absorption was determined from the decay rate for the burst measured as a function of the propagation distance as the burst bounced back and forth in the tube.

Pure tone absorption coefficients were measured at 1/12 octave intervals from 4 kHz to 100 kHz. The temperature was varied in 5.5°K (10°F) intervals from 255.4°K (0°F) to 310.9°K (100°F). The relative humidity was varied in 10% increments from 0% to saturation. The resulting absorption was compared to a proposed procedure for computing sound absorption for pure tones in still air and the agreement was found to be quite good under most conditions. The results for absorption of pure tones were then applied to the prediction of attenuation of bands of noise. The band absorption was found to depend significantly on the shape of the noise spectrum and the type of filter used as well as the atmospheric conditions and propagation distance.

It was also found that the band loss coefficient does not depend on propagation distance in a simple way. However, for many cases considered the deviation between the 1/3 octave band loss and the readily computed pure tone absorption coefficient at the center frequency of the band was found to be small.

This report presents the proposed procedures for calculating pure tone and broad band atmospheric attenuation as well as the experimental data obtained.

2. INTRODUCTION

Since the early measurements of Duff (ref. 1), absorption of sound in air has proven to be a fertile field of scientific investigation. The first systematic measurements were make by Knudsen (ref. 2) in the 1930's. The observed absorption was explained theoretically by Kneser (ref. 3) in terms of viscous and thermal conduction losses (classical absorption) and vibrational relaxation of oxygen. This theory did much to explain the effect of humidity on the relaxation absorption. This and later work were stimulated by studies of architectural acoustics, hence the frequency range of primary interest was that important in auditorium design, i.e., 200 Hz to 10 kHz. Greenspan (ref. 4) measured the absorption of sound in air at high frequencies (greater than 1 MHz) and established that rotational relaxation also makes a significant contribution to sound absorption even at low frequencies. In the 1950's, increased interest in community noise in the frequency range from 100 Hz to 1 kHz and large propagation distances prompted further measurements. It was recognized that the simple model of Kneser did not provide reliable predictions under these conditions. As a result, in 1964, Committee A21 of the Society of Automotive engineers issued an empirical prediction procedure (ref. 5) which provided a significant improvement over the basic procedure of Kneser. As is the case with any empirical technique, the accuracy of the prediction procedure was limited by the data on which it was based. In 1967, Harris (ref. 6) devised an improved empirical technique based on the impressive amount of data which he had collected. This data was limited to frequencies below 15 kHz, therefore, predictions based on this empirical technique at higher frequencies or at largely different atmospheric conditions could not be considered reliable.

Since 1967, several major developments have occurred which increase the accuracy of absorption predictions. In 1969 Piercy (ref. 7) recognized that vibrational relaxation of nitrogen is a major source of absorption at audible frequencies. Monk (ref. 8) and Evans, et.al., (ref. 9) considered a kinetic model for air absorption which included the effects of simultaneous relaxation of nitrogen and oxygen. During this period, experimental studies of atmospheric absorption under a wider variety of atmospheric conditions (although still a limited frequency range) were accumulating. In 1971, the S1 Committee of the American National Standards Institute (ANSI) appointed the S1-57 Working Group to examine theoretical and experimental knowledge of sound absorption in still air. This working group, chaired by Dr. Joseph Piercy, developed a prediction technique for pure tone absorption which is based on the fundamental physics of sound absorption and available experimental data. This procedure is empirical only in the sense that measured sound absorption was used to determine the microscopic energy transfer rates or vibrational relaxation times. Since it is firmly based on physical principles, there is no reason why this technique can not be applied outside the region of conditions spanned by present experimental data. However, the numerical parameters used in the procedure become less certain for frequencies above 10 kHz and temperatures far above or below 294.3°K.

So far, only pure tone absorption has been considered. In principle, the absorption of a band of noise can be predicted if the variation of the pure tone absorption coefficient with frequency is known. However, in practice the process of converting from pure tone values to loss coefficients for bands of noise involves numerical evaluation of an integral. In order to avoid this complication, ARP-866A (ref. 5) recommends using the pure tone absorption coefficient at band center at frequencies up to 4 kHz and at some frequency lower than the center frequency for bands with a center frequency above 4 kHz. This process recognizes that most spectra are falling off rapidly at high frequencies but is at best a first approximation. For most noise control applications, frequencies above 4 kHz are not very important so the procedure used in ARP-866A should be acceptable.

Much modern aerodynamic research in jet noise is done with scale models as small as 1/10 to 1/20 full scale. Such models frequently produce significant noise at frequencies up to 100 kHz. If the measured acoustic emmission from such models is to be compared to theory or emissions from other models measured with different atmospheric conditions, the measured noise spectrum must be corrected for atmospheric absorption. Since there was little pure tone absorption data in the frequency range from 20 kHz to 100 kHz, there was no way to compute with confidence the loss for bands of noise in this frequency range. It was decided, therefore, to make pure tone absorption measurements over this frequency range for a variety of atmospheric conditions, to compare these values to the predictions of the S1-57 Working Group, to use these results as a basis for computing band loss coefficients, and finally to compare the band loss coefficients with ARP-866A. The results of this program conducted under contract NAS3-19431 with NASA-Lewis Research Center are described in this report.

The work divides naturally into two parts. Sections (3) through (5) of this report are devoted to the calculation and measurement of the pure tone absorption coefficients. The second part, discussed in Section (6) treats absorption of bands of noise. The prediction procedures developed in Section (6) for absorption of bands of noise assume the pure tone absorption can be accurately computed. Although the procedures are independent of the numerical values of pure tone absorption coefficients, the tables of band loss coefficients given in Appendix C, which use the method of Section (6), are based on the pure tone prediction procedure of Section (3).

The S1-57 Working Group of the American National Standards Institute, chaired by Dr. Joseph Piercy, provided useful comments, suggestions, and advice. L. C. Sutherland of Wyle Laboratories assisted in computing atmospheric absorption of bands of noise, Alan Marsh of DyTec Engineering provided many of the figures included in the report, and Landon Evans of The Boeing Company made valuable suggestions concerning presentation of results.

3. THEORY OF SOUND ABSORPTION IN AIR

3.1 Sound Absorption Mechanisms

A rigorous theory for sound absorption in still air has been developed and will be published as a theoretical background document (ref. 10) in support of a new standard for sound absorption in air. This chapter will give a brief outline of the absorption mechanisms for sound absorption in still air and will describe a proposed prediction procedure (ref. 11).

The mechanisms which contribute to the absorption of sound in still air are vibrational relaxation absorption, rotational relaxation absorption, and absorption due to viscosity and thermal conduction (classical absorption). At frequencies below 1 MHz, it is convenient to combine classical and rotational relaxation absorption since they both vary as the frequency squared. Vibrational relaxation absorption is due primarily to the relaxation of nitrogen and oxygen. The total absorption of sound in still air, then, is given by a sum of the absorption due to vibrational relaxation of nitrogen ($\alpha_{vib,N}$), vibrational relaxation of oxygen ($\alpha_{vib,O}$), and combined rotational relaxation and classical mechanisms (α_{CR}). The absorption per wavelength ($\alpha\lambda$, nepers) due to each of these mechanisms is given in figure 3.1 for a temperature of 293.15°K, relative humidity of 70%, and at atmospheric pressure. It can be seen that under these conditions, nitrogen relaxation makes the largest contribution at low frequencies and oxygen relaxation makes the largest contribution at intermediate frequencies. Classical and rotational relaxation absorption are most important at higher frequencies.

As the amount of water vapor in the air changes, the position of the peaks in the $\alpha_{vib}\lambda$ versus frequency curves changes. In general, the peaks shift toward higher frequencies as the water vapor content increases (see figure 3.2). However, the two curves shift at different rates with increasing water vapor concentration. The frequency at which $\alpha_{vib}\lambda$ has a maximum is referred to as the relaxation frequency for

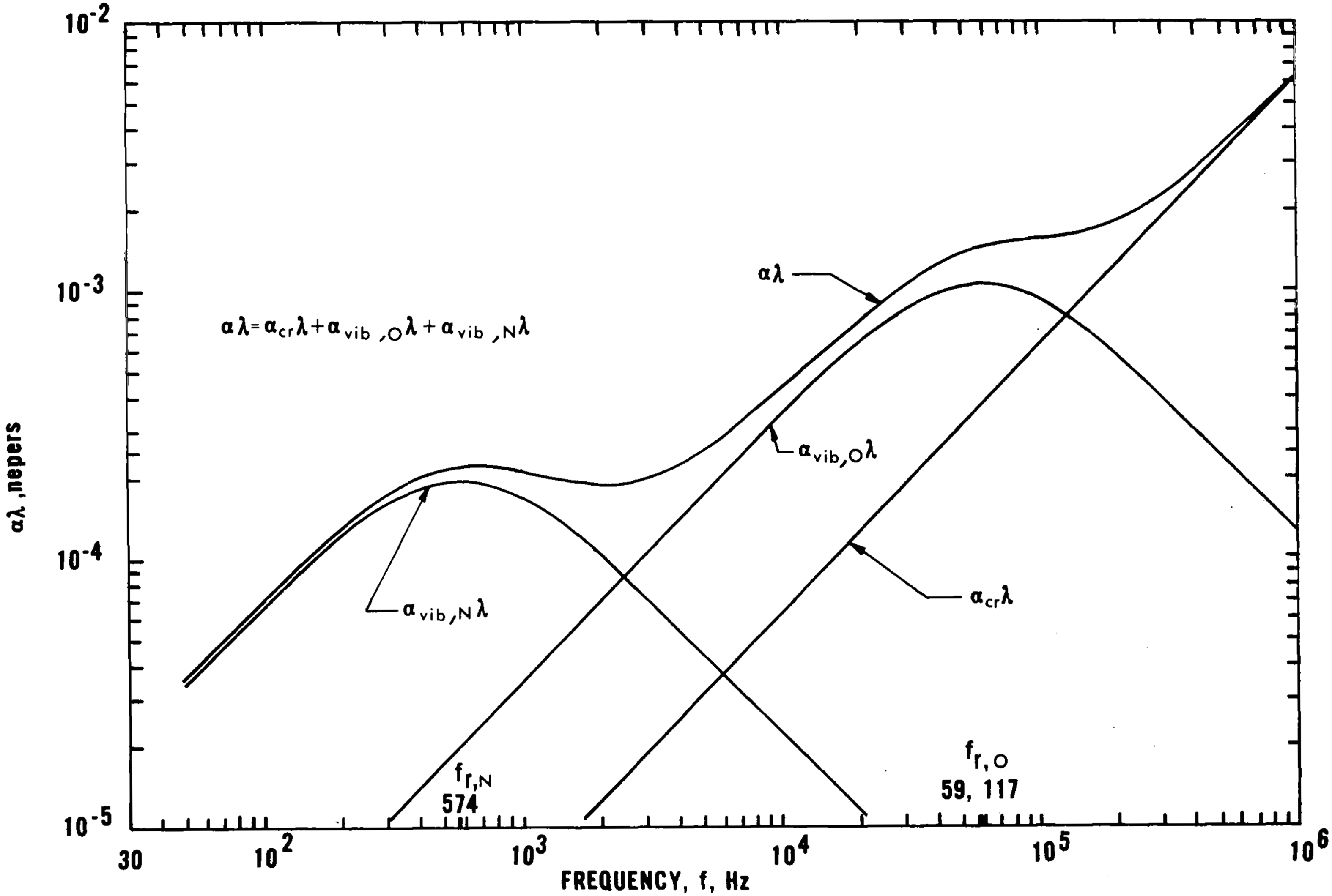


Figure 3.1 Absorption Components as a Function of Frequency, T = 293.15°K, h = 1.6145%, P = 1 atm.

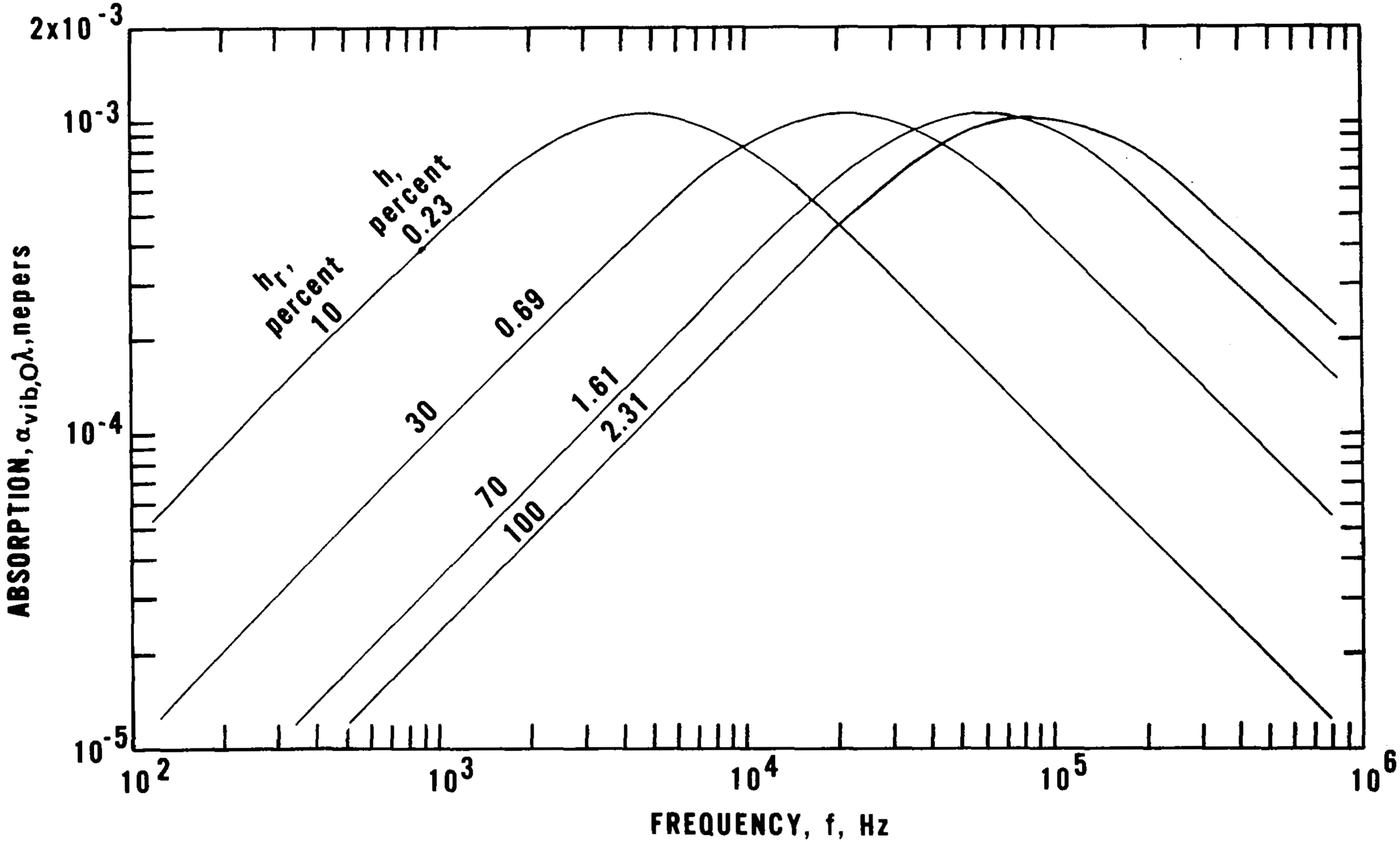


Figure 3.2 Absorption Due to Vibrational Relaxation of Oxygen as a Function of Water Vapor Concentration, T = 293.15°K, P = 1 atm.

the molecule of concern. If the relaxation frequencies $f_{r,N}$ and $f_{r,O}$ are known as a function of water vapor content, the absorption can be computed precisely since α_{CR} is well established (ref. 12). The values of $f_{r,N}$ and $f_{r,O}$ depend upon the number of collisions which take place between H_2O molecules and N_2 and O_2 molecules respectively, hence they depend upon the concentration of H_2O or absolute humidity, h. The absolute humidity can be computed from the relative humidity, h_r, as shown in figure 3.3 and also by the method given later in this chapter.

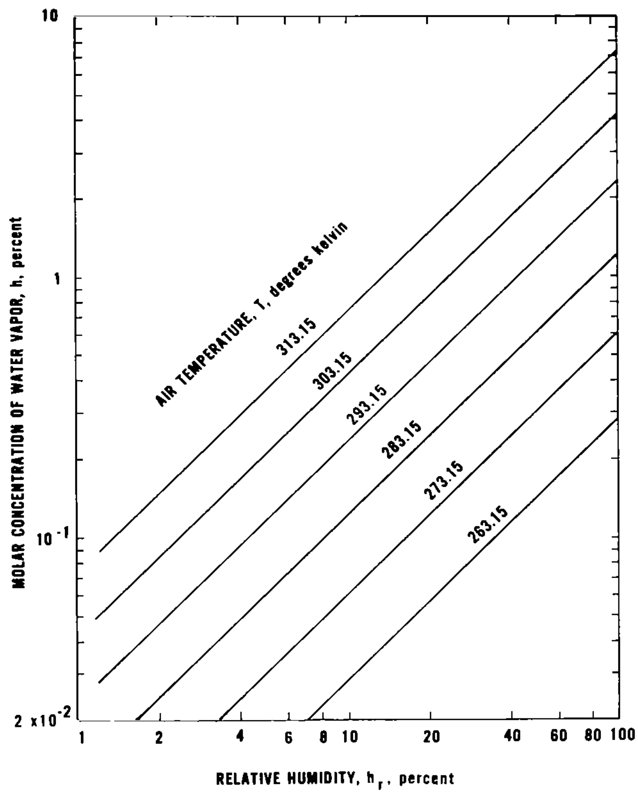


Figure 3.3 Molar Concentration of Water Vapor for Various Relative Humidities and Air Temperatures ($P/P_o=1$)

As the temperature decreases, for a given relative humidity, the absolute humidity decreases, hence $f_{r,N}$ and $f_{r,O}$ decrease. This effect gives rise to the largest variation of absorption with temperature.

There are other, smaller, temperature dependent effects. The first of these is due to the variation in vibrational specific heats of N_2 and O_2 with temperature. The effect of the variation in specific heat on the absorption due to the vibrational relaxation of O_2 is shown in figure 3.4. As the temperature increases so does the absorption when holding the absolute humidity constant. An even smaller temperature effect is due to the change in viscosity, thermal conductivity, and rotational relaxation frequency with temperature. Each of these effects tends to increase the absorption slightly with increasing temperature, all other factors being constant.

The final parameter which affects the observed absorption is pressure. An increase in pressure has the same effect as a decrease in frequency, provided the pressure increase is not so large as to effect the ideality of the gas. For most atmospheric applications on the surface of the earth this effect is small.

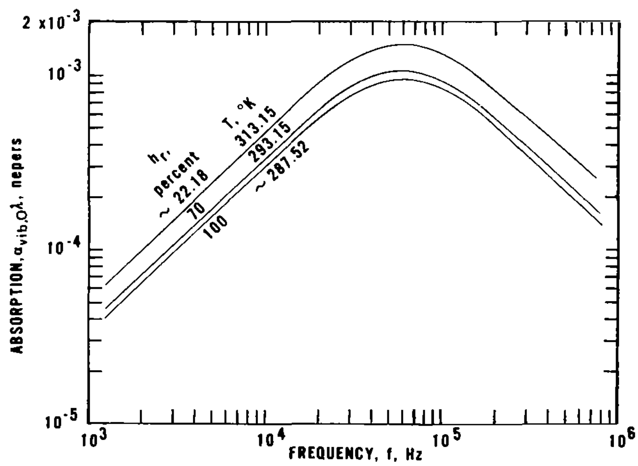


Figure 3.4 Temperature Dependence of Absorption Due to Vibrational Relaxation of Oxygen, h = 1.614504%

3.2 Simplified Expressions for Pure Tone Absorption

As explained in topic 3.1, the sound absorption in air (α) can be considered to be the sum of contributions due to the vibrational relaxation of oxygen, the vibrational relaxation of nitrogen, rotational relaxation and classical absorption due to viscosity and heat conduction. The last two can be collected into a single term and α written as, $\alpha = \alpha_{vib,O} + \alpha_{vib,N} + \alpha_{CR}$, where $\alpha_{CR} = \alpha_{Cl} + \alpha_{rot}$.

The classical absorption can be written in terms of the coefficients of viscosity and thermal conductivity as

$$\alpha_{Cl} = [\omega^2/(2\rho^\circ c^3)][4\mu/3 + (\gamma - 1)\kappa/(\gamma c_v)], \quad \text{nepers-m}^{-1} \qquad (3.1)$$

where

ω = 2π times the acoustic frequency (sec^{-1})

ρ° = equilibrium gas density in kg-m^{-3}

c = speed of sound in m-sec^{-1}

c_v = specific heat at constant volume in $\text{J-(kg-mole)}^{-1}\text{-}^\circ\text{K}^{-1}$

γ = ratio of specific heats

μ = coefficient of viscosity in kg-m-sec^{-1}

and

κ = coefficient of thermal conductivity in $\text{J-(kg-mole)}^{-1}\text{-}^\circ\text{K}^{-1}\text{-kg-m-sec}^{-1}$.

At frequencies much lower than the rotational relaxation frequency (≈100 MHz for air), the absorption due to rotational relaxation can be written as

$$\alpha_{rot} = \tfrac{1}{2}[\omega^2/(\gamma P c)]\mu[\gamma(\gamma - 1)R/(1.25\ c_p)]Z_{rot} \qquad (3.2)$$

where

P = the ambient pressure in N-m^{-2}

c_p = specific heat at constant pressure in $\text{J-(kg-mole)}^{-1}\text{-}^\circ\text{K}^{-1}$

and

Z_{rot} = rotational collision number.

The rotational collision number which is the number of molecular collisions required to establish rotational equilibrium has been measured over a range of temperatures and can be represented as (ref. 12)

$$Z_{rot} = 60.8 \exp -(16.8/T^{1/3}), \qquad (3.3)$$

where

T = temperature in °K.

Equations (3.1) and (3.2) can be simplified by making some approximations. First, if we use the Euken expression,

$$\kappa = (15R\mu/4)[4c_v/(15R) + 3/5] \quad \text{J-(kg-mole)}^{-1}\text{-°K-kg-m}^{-1}\text{-sec}^{-1} \qquad (3.4)$$

where

R = universal gas constant in J-(kg-mole)$^{-1}$-°K^{-1}

and with values of γ, c_p, and c_v for air, equation (3.1) becomes

$$\alpha_{Cl} = \tfrac{1}{2}[\omega^2/(\gamma Pc)](1.88\mu), \qquad \text{nepers-m}^{-1}. \qquad (3.5)$$

Recognizing that with these substitutions,

$$\alpha_{rot}/\alpha_{Cl} = 0.0681\ Z_{rot}, \qquad (3.6)$$

we can write the sum of classical and rotational relaxation absorption, α_{CR},

$$\alpha_{CR} = \tfrac{1}{2}[\omega^2/(\gamma Pc)]\mu(1.88)[1 + 0.0681\ Z_{rot}], \text{ nepers-m}^{-1}. \qquad (3.7)$$

Further simplification results when the coefficient of viscosity is written in the form of Sutherland's equation

$$\mu = BT^{1/2}/(1 + S/T), \text{ kg-m}^{-1}\text{-sec}^{-1} \qquad (3.8)$$

where

B = empirical parameter = 1.458×10^{-6} kg-m^{-1}-sec^{-1}-°K$^{-1/2}$ for air

S = empirical parameter = 110.4°K for air.

With this substitution and

$$c = 343.23\ (T/T_o)^{1/2}, \text{ m-sec}^{-1} \qquad (3.9)$$

where

c = speed of sound

and T_o = 293.15°K, equation (3.7) becomes

$$\alpha_{CR} = 5.578 \times 10^{-9}[(T/T_o)/(T + 110.4)][1 + 4.14 \exp -(16.8/T^{1/3})] \times f^2/(P/P_o). \qquad (3.10)$$

Evaluating equation (3.10) for various temperatures indicates that a simplified empirical equation of the form

$$\alpha_{CR} = 18.4 \times 10^{-12}(T/T_o)^{1/2} f^2/(P/P_o), \text{ nepers-m}^{-1} \qquad (3.11)$$

is within 2 percent of equation (3.10) for temperatures between 213°K and 373°K.

The absorption due to vibrational relaxation of nitrogen and oxygen both have the form

$$\alpha_{vib,j} = \frac{\pi S_j}{c} \frac{f^2/f_{r,j}}{1 + (f/f_{r,j})^2}, \text{ nepers-m}^{-1} \tag{3.12}$$

where

$\alpha_{vib,j}$ = absorption due to vibrational relaxation of oxygen or nitrogen

S_j = relaxation strength

$f_{r,j}$ = relaxation frequency in Hz.

The relaxation strengths are readily found for oxygen and nitrogen since they are

$$S_j = c_j' R/[(c_p - c_j')c_v] \tag{3.13}$$

where

c_j' = vibrational specific heat of nitrogen or oxygen

$= x_j(\theta_j/T)^2 e^{-(\theta_j/T)}/[1 - e^{-(\theta_j/T)}]^2 R$

where

x_j = mole fraction of the component, 0.20948 for oxygen and 0.78084 for nitrogen

and θ_j = characteristic vibrational temperature (2239.1°K for oxygen and 3352.0°K for nitrogen).

Thus far, all quantities have been expressed in terms of nepers-m^{-1}. Using these units, the signal amplitude, A, at some distance, R, from a source of amplitude, A_o, ignoring geometric effects, would be given by $A = A_o e^{-R\alpha}$. It is more common to express the absorption in units of db-m^{-1} where

$$1 \text{ neper-m}^{-1} = 8.686 \text{ db-m}^{-1}.$$

If the symbol "a" is used to denote the absorption coefficient in db/m, and since decibel levels are related to the square of the signal amplitude, it follows that

$$-aR = 10 \log(A/A_o)^2 \text{ or } A = A_o \times 10^{-aR/20} \tag{3.14}$$

Combining equations (3.11), (3.12), and (3.13) gives an expression for the total absorption as

$$a(f) = 8.686(T/T_0)^{1/2}[f^2/(P/P_0)]\{1.84 \times 10^{-11} + 2.19 \times 10^{-4}(T/T_0)^{-1}(P/P_0) \times (2239/T)^2 [\exp(-2239/T)]/[f_{r,O} + (f^2/f_{r,O})] + 8.16 \times 10^{-4}(T/T_0)^{-1} \times (P/P_0)(3352/T)^2 [\exp(-3352/T)]/[f_{r,N} + (f^2/f_{r,N})]\} \quad (3.15)^{**}$$

where

$a(f)$ = absorption coefficient in db/m

T = temperature in °K

T_0 = reference temperature, 293.15°K

f = acoustic frequency in Hz

P = ambient atmosphere pressure, N/m^2

P_0 = reference pressure, 1.013×10^5 N/m^2

$f_{r,O}$ = relaxation frequency of oxygen

$f_{r,N}$ = relaxation frequency of nitrogen.

The values for $f_{r,O}$ and $f_{r,N}$ are not accurately known over the range of humidity and temperature covered in this study. Improved values of $f_{r,O}$ can be obtained from the experimental results reported here. For our prediction procedure , the values of $f_{r,O}$ and $f_{r,N}$ suggested in reference 11 were used,

$$f_{r,O} = (P/P_0)\ \{24 + 4.41 \times 10^4 h\ [(0.05 + h)/(0.391 + h)]\},\ \text{Hz} \quad (3.16)^*$$

$$f_{r,N} = (P/P_0)\ (T/T_0)^{-1/2}\ [9 + 350h\ \exp\{-6.142\ [(T/T_0)^{-1/3} - 1]\}],\ \text{Hz} \quad (3.17)^*$$

where h, the absolute humidity, in percent can be written as

$$h = h_r(P_{sat}/P_0)/(P/P_0),\ \text{percent}, \quad (3.18)^*$$

where

h_r = relative humidity in percent

and

P_{sat} = partial pressure of saturated water vapor, N/m^2.

Using the Goff-Gratch equation,

$$\log_{10} (P_{sat}/P_0) = 10.79586[1 - (T_{01}/T)] - 5.02808 \log_{10}(T/T_{01}) + 1.50474 \times 10^{-4}(1 - 10^{-8.29692[(T/T_{01})-1]}) + 0.42873 \times 10^{-3}(10^{4.76955[1 - (T_{01}/T)]} - 1) - 2.2195983 \quad (3.19)^*$$

where $T_{01} = 273.16°K$.

The procedure for computing a is as follows:

1. Determine P_{sat}/P_0 from equation 3.19.
2. Compute absolute humidity using equation 3.18.
3. Compute $f_{r,O}$ and $f_{r,N}$ from equations 3.16 and 3.17.
4. Compute a in db/m using equation 3.15.

A program to do this calculation, written in FORTRAN is given in Appendix B.3, and is entitled AIRAB.

3.3 Comparison with Prior Experimental Results

During the course of this investigation, a comprehensive review of prior experimental measurements of sound absorption in still air was released by L. C. Sutherland of Wyle Laboratories under contract to DOT (ref. 13). Although the analysis used and conclusions drawn are too lengthy to reproduce here, Sutherland concluded that the equations presented in Section 3.2 provide an excellent representation of prior work. The reader should refer to the original report for details. It should be noted that in all previously published work, there are a total of less than 1500 data points; the experimental work reported here represents 6,847 points.

Following the publication of the report mentioned above, three other papers have appeared which provide some additional information on sound absorption is still air. In reference 12 Bass and Sutherland report a review of very high frequency (1 mHz to 100 mHz) sound absorption in air over a range of temperatures (295°K to 773°K) which allowed them to determine the temperature dependence of the rotational relaxation time of air hence α_{CR}. Their results include those of Bass and Keeton (ref. 14) and are reflected in equation (3.15). A more recent paper by Bass, Keeton, and Williams (ref. 15) examines the temperature dependence of the vibrational relaxation frequency for oxygen/water vapor mixtures. Their results are consistent with the lack of a temperature dependence in equation (3.16) over the range of temperatures of concern in this report (255°K to 310°K).

4. EXPERIMENTAL PROCEDURE

4.1 Experimental System

The experimental portion of this study consisted in measuring sound absorption in air at frequencies from 4 kHz to 100 kHz at 1/12 octave intervals and at temperatures from 255.4°K to 310.9°K at 5.5°K intervals and relative humidities from 0% to 100% at 10% intervals. The system used to make these measurements is diagrammed in figure 4.1. A series of bursts of plane sound waves from 2 to 10 milliseconds long was generated at the sound source and then allowed to reflect back and forth in the sound tube. The tube was made of aluminum and has a 25.4 cm internal diameter, a 0.95 cm wall and is 4.8 meters long. There are suitable systems to control and maintain uniformity in temperature and relative humidity along the entire tube length. The amplitude of the sound wave in each echo burst was measured at each reflection by the microphone that terminates the opposite end of the sound tube. The path length for the sound can be varied by moving the sound source within the sound tube. As discussed later, this variation in sound path length enabled the separation of transmission and reflection losses.

4.1.1 Sound Source and Microphone Transducers

The sound source and microphone used in this experiment, shown in figure 4.2, are larger versions of the solid dielectric capacitor microphones described by Kuhl (ref. 16) and previously used in this laboratory. They consist of a thin dielectric sheet metalized on one side, stretched tightly across a metal backing plate with the metalized surface on the outside and insulated from the backing plate. A DC voltage (100 to 200V) is applied between metalized coating and the backing plate. When used as a speaker, an AC voltage of the desired frequency is applied in series with the polarizing voltage. The AC voltage produced when the system is used as a microphone is amplified by a high input impedance amplifier.

DIAGRAM OF EXPERIMENTAL APPARATUS

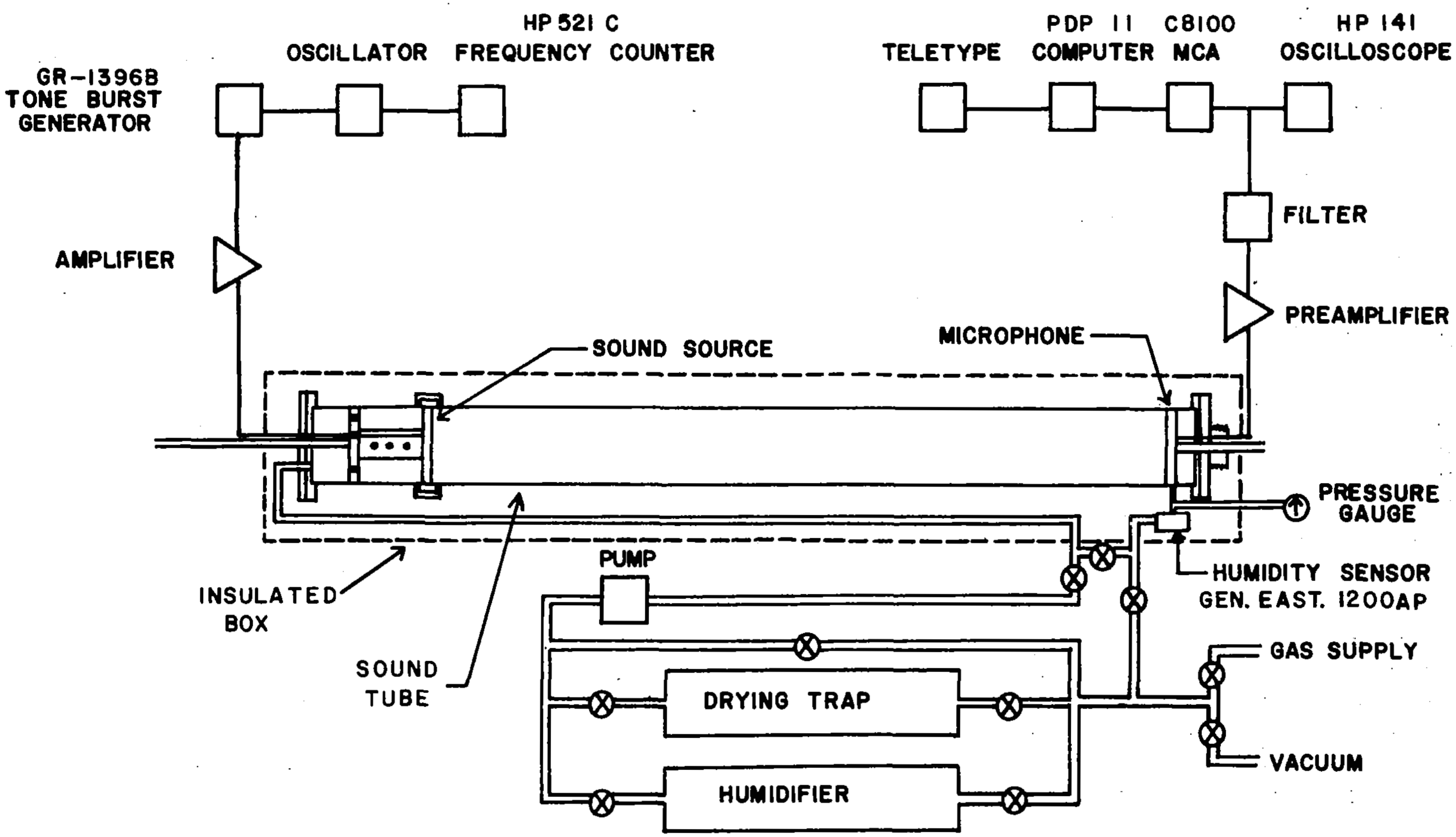


Figure 4.1 Diagram of the Experimental System for Measuring Sound Absorption

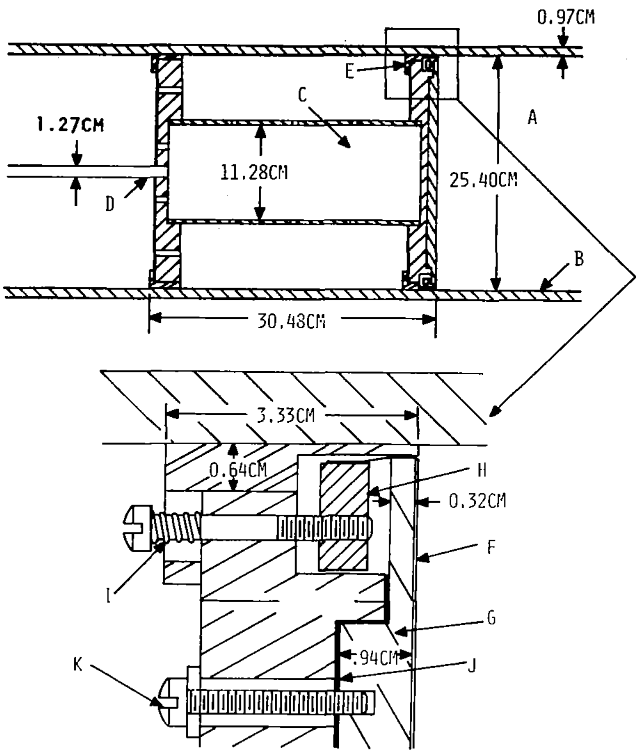


Figure 4.2 Diagram and Construction Details of the Transducers. A - sound tube cross section, B - sound tube wall, C - moveable speaker piston, D - rod for moving speaker, E - Teflon ring, F - 0.00064 cm aluminized mylar, G - backing plate, H - tension ring, I - compression spring, J - insulation, Teflon impregnated glass sheet, and K - insulated screw for holding the backing plate.

Experiments were conducted using a 11.43 cm diameter prototype speaker-microphone system to measure the effects of changing the dielectric material, bias voltage and backing plate surface on the sensitivity, frequency response, linearity, and reflection coefficient of the transducer. A 0.64 cm diameter capacitance microphone with a calibrated frequency response exceeding 100 kHz was used to measure the frequency response of various transducers. Originally, this microphone was considered for use as the receiver in the absorption experiments, but investigations showed that the 0.64 cm microphone had poor recovery characteristics when amplifying short tone bursts of sine waves on the order of 2 to 5 msec. The insertion of the microphone in the end plate also affected the reflection of the sound at high frequencies. The successful construction of the capacitor transducers with frequency response exceeding 100 kHz and with adequate sensitivity led to a decision to use these transducers as both microphone and sound source. Tests were conducted using 6.35×10^{-4} cm Kapton coated with aluminum and 6.35×10^{-4} cm mylar coated with gold, aluminum and chromium as the dielectric. No measurable effect on the sensitivity or frequency response was noted, and 6.35×10^{-4} cm mylar coated with aluminum was chosen to be used in the final transducers as the solid dielectric. Tests were conducted on backing plates with a smooth lathe finish (0.003cm/revolution, depth of groove less than 0.0003cm), with a polished finish, and with a coarse lathe finish (0.038cm/revolution, depth of grooves 0.008cm). No measurable difference was detected between the two smooth plates, but a uniform increase of 10 db in sensitivity was observed with the grooved backing plate. For the transducers used in the measuring system, the backing plate was polished flat and smooth. Figure 4.3 shows a plot of the output of one of these transducers as a function of frequency as measured by a 0.64 cm capacitance microphone located one meter from the transducer on its axis.

The output increased as the square of the frequency and was still increasing at the upper frequency limit of the electronics. The dip in output at about 40 kHz was very puzzling at first but has now been traced to the effect of Fresnel diffraction on the 0.64 cm microphone. In fact, the details of the Fresnel diffraction pattern were traced out by moving the 0.64 cm microphone through the radiation field of the transducer. This adds confidence that this transducer generated plane coherent waves.

Both the sound source and microphone were constructed so as to completely fill the cross sectional area of the sound tube. Figure 4.2 shows some of the details of the construction of these transducers. The sound source is a spool shaped plunger that could be slipped back and forth in the sound tube by a 1.27 cm stainless steel rod that passes through an O-ring seal in the end plate that terminates the sound tube. The mylar film is attached to the floating ring, H, and is held under tension as it is stretched across the backing plate by three springs labeled "I" in

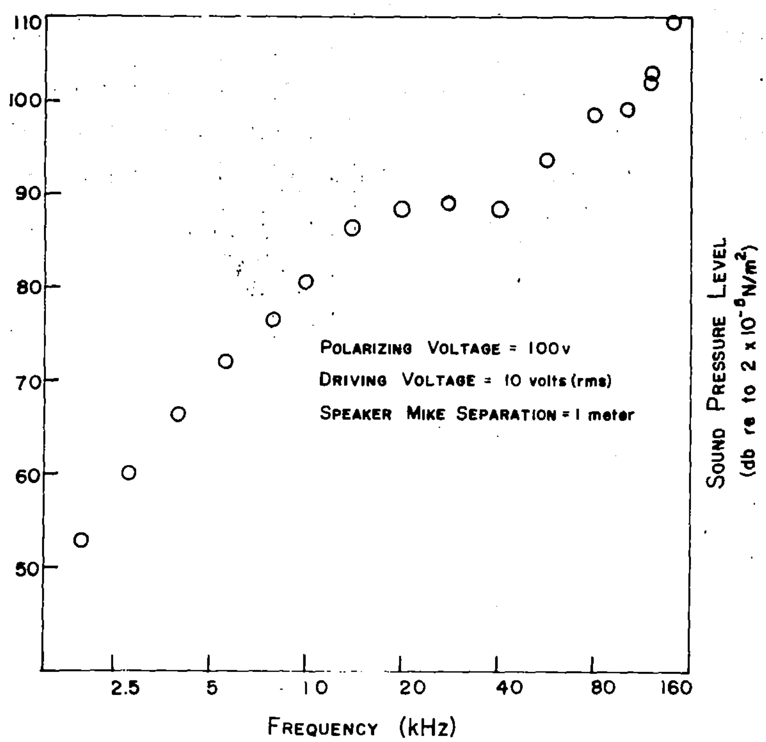


Figure 4.3 Output of the Solid-dielectric Capacitance Transducer. The transducer is 25.4 cm in diameter and the output is measured with a 0.64 cm B & K capacitance microphone located one meter from the transducer surface and on its axis.

figure 4.2. Teflon gaskets around the outside edges of the two ends of the "spool" allow the plunger to fit snugly and yet slip easily inside the sound tube.

The microphone, which terminates the other end of the sound tube, has essentially the same construction as the right-hand end of the speaker "spool." The microphone plate is connected by a rod to a bellows in the end plate of the sound tube. By stretching this bellows it is possible to move the microphone back toward the end of the sound tube about 1.91 cm so as to expose exit ports for circulating the test gas. This motion was accomplished by use of a pneumatic valve.

4.1.2 Electronic Equipment and Sound Burst Generation

The electronic components for generating and detecting the sound bursts are shown in the block diagram in figure 4.1. The bursts of sine waves to be applied to the speaker were produced by a General Radio 1396-B tone burst generator which alternately interrupted and passed the sinusoidal input signal from an oscillator. The frequency of this signal was varied from 4 kHz to 100 kHz and was monitored with a Hewlett-Packard 521C frequency counter. The tone burst generator controlled the burst duration and the interval between bursts. The length of the burst was maintained less than the time needed for the sound wave to travel down the sound tube and back in order to avoid the effect of standing waves. Typically, this burst time varied from 2 to 20 milliseconds as the effective length of the tube was varied. The time between bursts had to be varied to insure that the echoes from one tone burst had decreased to background noise level due to absorption before the next burst was produced. At low frequencies, temperatures, and humidities sound absorption is small and a single burst was reflected for as long as a few seconds before being reduced to the background noise level. At high frequencies a period of less than 100 msec between bursts was required.

The tone bursts from the GR 1396 were amplified by a Krohn-Hite amplifier and capacitively coupled to the DC-biased transducer previously described. The received signal was amplified with a Princeton Applied Research amplifier and passed through a tuned filter prior to being displayed on a Hewlett-Packard 141 Storage Oscilloscope and the Canberra 8100 Multichannel Analyzer.

Although it is relatively easy to display each exponentially decaying echo pattern on a storage oscilloscope, it is not so easy to get an accurate measure of these decaying burst heights out in a short enough time to allow the needed number of measurements to be made in a reasonable period of time. To accomplish these measurements a Canberra Data Acquisition System was used as discussed below. This system included a Basic Quanta pulse height analyzer with a 1024 channel storage.

4.1.3 Temperature and Humidity Systems

Perhaps the most difficult experimental problem encountered was that of controlling the environmental conditions of temperature and humidity. For the purpose of controlling the temperature, the sound tube was wrapped with 0.953 cm O.D. copper tubing. To insure good thermal contact the copper tubing was pulled down tightly against the aluminum tube with refrigeration tape. The individual turns in the copper coils were about 2.54 cm between centers. To cover the complete 4.8 meter length of the tube, 6 coils consisting of 31 turns each were connected in parallel to 2.54 cm copper entrance and exhaust manifolds. In order to insure uniform flow, care was taken to keep the flow resistance the same in each of the six parallel coils. Antifreeze solution was circulated through these coils from a Forma Scientific Company Model 2324 temperature controlled bath. This bath is capable of removing 650 Btu/hour at 255°K, the circulating pump supplies 760 LPM at a 0.91 m head and its temperature controller is sensitive to ±0.02°K. Temperature control and heating were accomplished by a 650 watt heater enabling the circulated fluid to either heat or cool the sound tube. Of course, the entrance and exit lines for circulating the antifreeze had to be carefully insulated.

The sound tube and the associated cooling coils were surrounded by 15.24 cm of polyurethane insulation and enclosed in a box (5.2m)x(0.6m)x (0.6m) made of 1.91 cm plywood. All joints were taped with refrigeration tape. Temperature was monitored at 60.69 cm intervals along the sound tube by copper-constantan thermocouples mounted in thermal contact with the outside wall of the sound tube. The thermocouple voltages were read using a Hewlett-Packard Model DY 2010A Data Acquisition system. This system, which is capable of reading twenty-five channels of either voltage or frequency, was used to read the control variables before each absorption measurement. This system was interfaced to the PDP-11 computer in the Canberra system and these values became part of the hard copy output from the Canberra for each absorption measurement. With this system it was possible to maintain the temperature of the sound tube both uniform and constant to within a few tenths of a degree Kelvin.

A second circulating system was required to establish and maintain the desired humidity. This circulating system is diagrammed in figure 4.1. In this diagram, the part within the dotted lines is enclosed in the temperature controlled box.

To establish the desired humidity within the sound tube the microphone was pulled back toward the end of the sound tube approximately 1.91 cm exposing four 0.64 cm holes in the tube wall. The motion of the microphone was communicated through the end plate by a bellows that is connected to the end plate with an O-ring seal. The sound source was then moved back until a similar set of four holes in the tube wall were exposed to allow a by-pass path for the circulating gas around the speaker surface and back into the sound tube in the region between the two ends of the moveable plunger. From there the gas passed through holes in the spindle and rear surface of the plunger and exited through a 1.91 cm O.D. tube connected through a swagelock fitting to the end plate.

To establish vapor equilibrium within the sound tube, the pump in figure 4.1 circulated the gas through the sound tube. Care was exercised in circulating the gas and in moving the speaker to maintain a positive pressure on the face of the transducers. This was necessary to avoid air pockets being formed between the mylar and the backing plate. The humidity was monitored with a General Eastern Dew Point Hygrometer Model 1200AP. This unit is sensitive to dew point changes of 0.0278°K and measures dew points to an accuracy of 0.278°K using a platinum resistance thermometer sensor with a calibration traceable to the National Bureau of Standards.

The circulating gas could be circulated either through a trap to add moisture or through another to remove moisture as shown in figure 4.1. The pump was capable of circulating the gas at a rate of 0.03 cubic meters per minute. At this rate the gas within the sound tube was completely replaced about every 8 minutes.

Experience was required to determine the best technique for establishing the desired humidity within the tube. Typically, dry air was first introduced into the system and dry air absorption measurements were made. Next, the air was circulated through the humidifier for a few seconds to add moisture. Then the traps were closed off and the by-pass valve opened and the gas circulated from fifteen minutes to one hour while the humidity was monitored. The process was repeated until the desired humidity was established within the tube. The dew point was again determined at the end of the measurements which usually required from 3 1/2 to 4 hours. The experimental dew point was assumed to be the average between the initial and final dew points. Their average values and the variation during the measurement are given in Table 5.1.

4.2 Test Procedure

The large amount of repetitive experimental data to be taken dictated the establishment of a definite test procedure. This was as follows:

a) Sound source and microphone transducers were moved to their outermost positions, uncovering the flow ports in the tube walls.

b) A particular equilibrium temperature and relative humidity condition was set in the sound tube as described in Section 4.1.3.

c) Flow was stopped through sound tube and the transducers moved inward past the flow ports.

d) First of four effective tube lengths for which absorption data were taken at each temperature-humidity condition was set. The tube length was set by positioning the sound source at different locations within sound tube.

e) Atmospheric absorption data for each individual frequency was taken as described in 4.1.2. After sufficient bursts were generated to satisfy statistic requirements the next frequency was set and the procedure repeated until data for all 57 discrete frequencies between 4 and 100 kHz were obtained.

f) The second effective tube length was set by repositioning the sound source and procedure described under e) repeated.

g) Steps d) and e) were repeated for the other two effective tube lengths.

h) After data for all four effective tube lengths were obtained, both transducers were moved to their outermost positions, flow reestablished through dew point hygrometer to obtain an "end of test" reading of humidity.

i) A new temperature-relative humidity condition was set and the whole procedure repeated.

The number of bursts analyzed for each frequency varied from 10 to 2000. The number of sinewaves generated on each burst was a function of the frequency and varied from 25 sinewaves per burst at 4 kHz to 1000 sinewaves per burst at 100 kHz.

Measurements were first made at each temperature in dry air. Then the range of humidities from 10 to 90% were covered at each temperature. Generally the measurements at a particular temperature took about one week and proceeded from 10 to 90% R.H. Before the temperature was changed the system was pumped down and fresh gas introduced. Before adding water an abbreviated check run was made on the dry air. In appendix A.2 a comparison is made between the results of these dry air check runs and the original dry air values.

4.2.1 Signal Handling Procedure

The tone burst generator produced a series of tone bursts and the echo pattern of these bursts was continuously digitized and added in memory. Data acquisition time was set at 2 seconds for high frequencies and long burst length and 10 seconds for low frequencies and short burst lengths.

The signal from the microphone passed from a B & K 2612 cathode follower to a PAR preamplifier, then to a filter and on to the analyzer. Prior to testing, an analysis was made of the Fourier components of the tone bursts as a function of the tone burst length and time between bursts. This analysis indicated that a narrow but variable band pass filter could be used to pass the frequencies of interest and reduce the noise. Tests showed that if the 3 db band width of the filter was maintained more than $4/t_o$, where t_o is the length of the burst in seconds, the filter would produce a negligible rounding of the edges of the square burst envelope. Therefore, the pass band of the filter was made as narrow as possible by setting both the low frequency and high frequency cut off at the test frequency.

The data acquired by the multichannel analyzer was analyzed by the PDP-11 using locally developed software written in BASIC. These measured values of the amplitude of the waves in the echo bursts were analyzed as discussed later and the resulting values of the sound absorption printed out with a teletype terminal with final results outputed on paper tape.

In addition to the acquisition of data associated with the absorption measurement, the PDP-11 had an interface to a Hewlett-Packard 2901A Input Scanner and 2401C Integrating Digital Voltmeter. This enabled the acquisition and storage of data relating to the temperature, the frequency, and the pressure for each absorption measurement.

Figure 4.4 illustrates the characteristic decay of the initial and reflected bursts in a single echo pattern. The average amplitudes of the sine wave in each echo burst are labeled A_1, A_2, A_3, ... , A_n in the diagram. These amplitudes must be measured accurately in order to determine the value of sound absorption. At high frequencies the initial burst is quickly absorbed, but at low frequencies and temperatures a longer train of reflected bursts from each generated burst is observed.

The most accurate method of measuring the amplitude of each tone burst envelope would be a measurement of the peak amplitude of each sine wave in the burst. A technique used in nuclear pulse analysis was adapted to this task. The amplitude of the peak height of each sine wave was sampled, converted to a digital value and stored in memory by the Canberra Basic Quanta System (the multichannel analyzer with the PDP-11 computer interfaced). The technique for analog to digital conversion involved a peak sample and hold circuit, the conversion of this analog

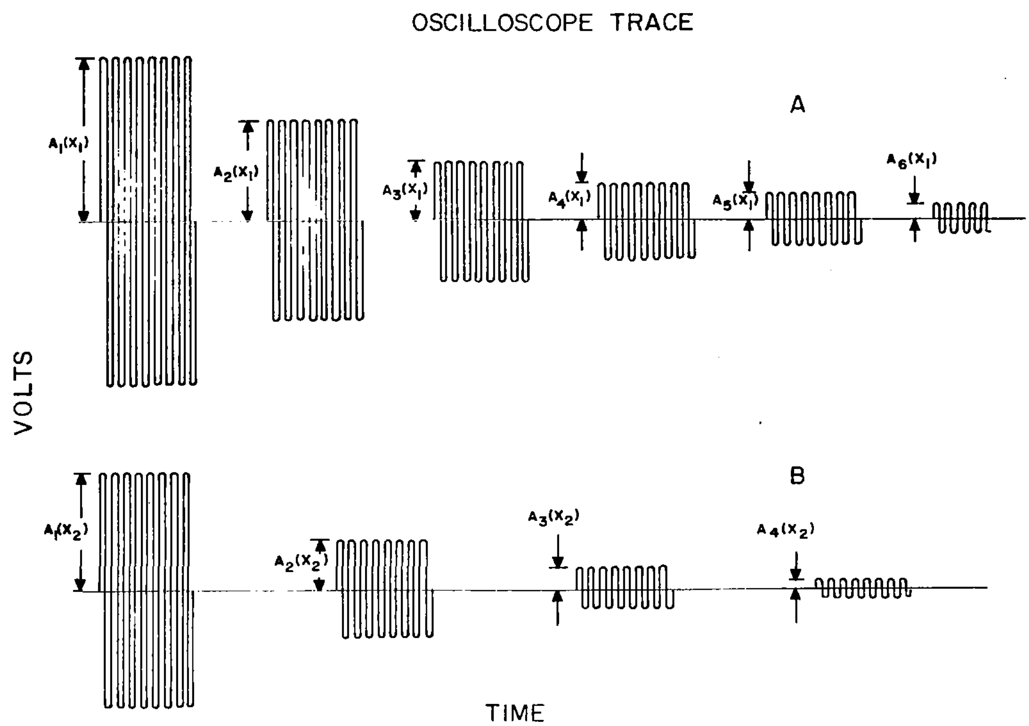


Figure 4.4 Part A is a diagram of the oscilloscope trace of an echo decay pattern. Part B shows how the echoes separate and decrease in amplitude as the speaker-microphone separation is increased.

signal to a digital value, and its storage in one to 1024 channels of memory, each channel representing a distinct value of amplitude. Each sinewave amplitude was stored as a count in the channel representative of its amplitude value. The accumulation of counts in the different channels allowed the determination of the mean amplitude of each wave burst. The unique ADC and sampling process associated with this multichannel analyzer allowed each sine wave in each tone burst to be sampled with 0.1% resolution for frequencies up to 60 kHz. Because the data acquisition and storage time was dependent on the channel addressed, above 60 kHz it was not possible to count every pulse and retain 1024 channel resolution. We chose to use 1000 channels and count alternate sine wave peaks for the pulses addressed in channels 500 to 1000. At 100 kHz with a 5 millisecond tone burst, each burst represented the acquisition and storage of 500 counts.

4.2.2 Data Analysis to Obtain Measured Absorption Coefficients

The data output used in obtaining the absorption can be understood by considering figure 4.4. This figure displays the decaying sound burst as indicated by the voltage coming out of the microphone. The electronic system discussed above enabled us to measure the average amplitude of the sine waves in each reflected burst. These amplitudes are labeled $A_1(x_1)$, $A_2(x_1)$, $A_3(x_1)$, ... , $A_n(x_1)$ in the diagram. The sound bursts were initiated by the sound source in one end of the sound tube at a repetition rate dictated by the ring time for the decaying burst. At high frequencies where the absorption is large only the first received burst was detected and the repetition rate was high. At the lowest humidities and frequencies the absorption was so low that up to a hundred echoes were necessary to extinguish the burst and in this case the repetition rate had to be decreased correspondingly.

As the separation between the sound source and microphone is increased, the echo bursts separate in time and decrease in amplitude as shown in figure 4.4. If the amplitudes of the different echo bursts as a function of the distance between the sound source and the microphone are labeled $A_1(x)$, $A_2(x)$, $A_3(x)$, ... , $A_n(x)$, then the height of the nth burst as a function of x is

$$A_n(x) = [A_o e^{-\alpha x}] e^{-2(n-1)(\alpha x+\beta)} , \quad (4.1)$$

where

A_o is the amplitude of the sound wave at the source,

α is the total absorption coefficient in neper per unit length

and

β is the reflection coefficient for the ends of the tube.

Unless the surfaces of the microphone and speaker were carefully aligned parallel, interference effects were observed at high frequencies that caused the echo decay pattern to be non-exponential. This was attributed to a variation in phase in the wave across the surface of the large transducer that resulted from the wavefront making an angle with the transducer surface. Since this angle was doubled with each reflection, at high frequencies, where the wavelength was a small fraction of the tube diameter, a variation in alignment of a few thousands of a centimeter caused very noticeable effects on the decay pattern. The decay pattern was also very sensitive to concentration and temperature gradients in the tube, evidently due to the effect such gradients had upon the shape of the wavefront and hence the variation in phase across the surface of the transducer.

In order to minimize the error introduced by this phenomena, at high frequencies (40 to 100 kHz) the absorption was obtained from the variation of the initial burst height with distance. In this case n is set equal to 1 in equation 4.1 and

$$A_1(x) = A_o e^{-\alpha x}, \tag{4.2}$$

thus the absorption coefficient was obtained from the slope of the plot of $\log(A_1)$ vs x.

At the lower frequencies (4 to 40 kHz) the absorption was so small that the attenuation of the sound in a single transversal of the tube was insufficient to measure accurately. At these frequencies the absorption was obtained from the variation of the decay constant of the echo pattern with distance. In this case, from equation 4.1,

$$2(\alpha x + \beta) = \log_e[A_n(x)/A_{n+1}(x)]. \tag{4.3}$$

and α is 1/2 the slope of the log of the decay constant when plotted as a function of distance. For this purpose the data acquisition PDP-11 was programmed to calculate a decay constant at each position by making a least squares fit to the peak highs in the decaying bursts. Measurements were generally made at 1, 2, 3 and 4 meter separation between the speaker and microphone and stored in the computer until the end of the run. The absorption values calculated by the two methods were then calculated, printed out and punched on paper tape. Generally, the two methods agreed over the central range of frequencies. A lack of agreement in the two methods was found to be a good indication that equilibrium conditions had not been established in the tube before measurements began, in which case the data was reacquired after establishing suitable equilibrium conditions.

The computer program used to acquire and analyze the data is given in Appendix B.1.

4.3 Correction for the Tube

Kirchhoff (ref. 17) in the 1860's worked out the theory for the absorption of sound in a circular tube due to viscosity and thermal conductivity. However, the analytical equation which he developed for the tube absorption fails when the ratio of the tube diameter to wavelength becomes large. We have developed a numerical solution to his basic equation for the propagation constant (ref. 18) and applied it in the past to measurements at low pressure (ref. 19). Here, the same solution was used to get the absorption due to tube wall losses. The results of this calculation are compared to measured values in argon in figure 4.5. The measured absorption should be the sum of the free

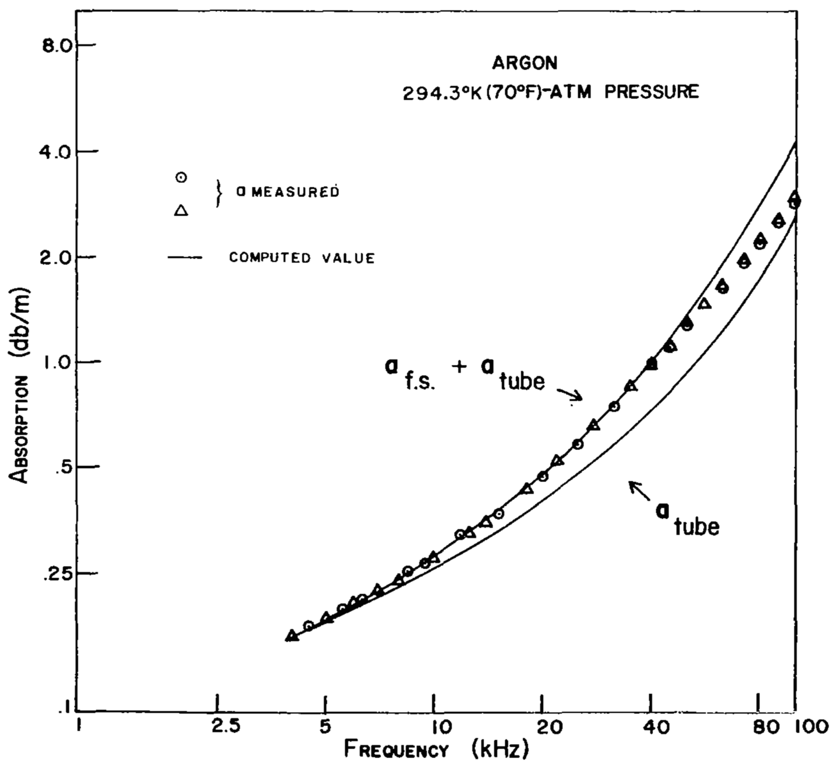


Figure 4.5 Comparison of Measured and Calculated Absorption in Argon. The solid curve is calculated from a numerical solution of the Kirchhoff equation for sound absorption in a circular tube. (See reference 19.)

space absorption ($a_{f.s.}$) and tube absorption (a_{tube}). The free space absorption, which is the desired result, is the difference between the upper and lower curves in figure 4.5. Clearly, measured values at high frequency are lower than those expected from this theory. Since the free space absorption for argon can be rigorously computed (ref. 20), the problem must be in the tube correction term. Figure 4.6 shows similar results for nitrogen. For nitrogen, which more closely approximates air, the

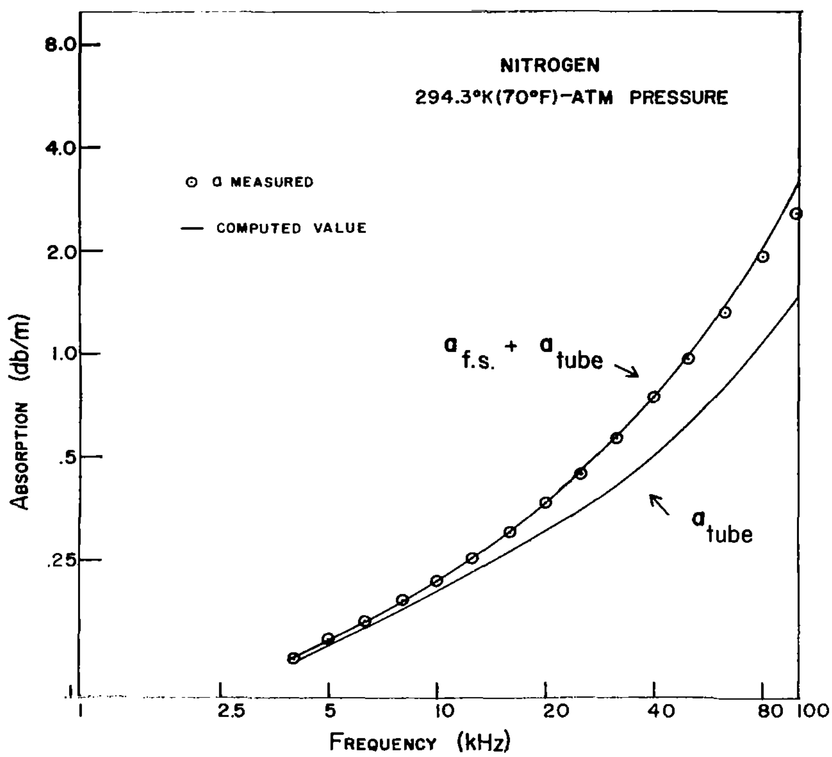


Figure 4.6 Comparison of Measured and Calculated Absorption in Nitrogen. The solid curve is the sum of the classical losses, calculated from a numerical solution of Kirchhoff's equation and the rotational relaxation absorption assuming a rotational relaxation frequency of 313 MHz

difference between computed and measured total absorption is much less. This is in part due to the fact that nitrogen has a greater free space absorption (with respect to the tube losses) which can be accurately predicted. A more important difference, however, is probably the longer wavelength which results from the larger sound velocity in nitrogen. Figure 4.7 shows the error in the absorption assuming all the error is due to the calculation of tube absorption.

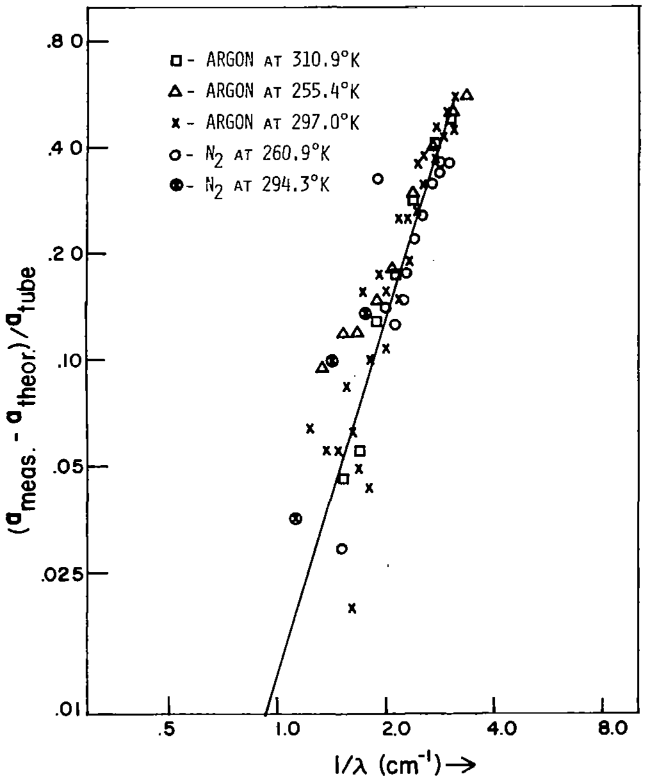


Figure 4.7 The Fractional Error in the Theoretical Tube Correction as a Function of the Reciprocal of the Sound Wavelength for the 25.4 cm Diameter Tube. Solid line is given by $(a_{meas} - a_{theor})/a_{tube} = 0.014(1/\lambda)^{3.1}$, when λ is in cm.

It can be seen that for a given wavelength the error is relatively independent of gas and temperature. This feature suggests that the source of error is in the decreased wavelength encountered at high frequencies and also suggests a means of correcting the measured absorption for tube losses in the absence of an accurate technique of computing that term. The corrected tube absorption, then, is written as

$$a_{tc} = a_{tube}[1.0 - 0.014(1/\lambda)^{3.1}] \qquad (4.4)$$

where

a_{tc} = corrected tube absorption, db/meter

a_{tube} = tube absorption calculated using the numerical solution to the wave equation, db/meter

and, λ = wavelength in cm.

The free space absorption can be computed as

$$a_{fs} = a_{meas} - a_{tc} \qquad \text{db/meter} \quad (4.5)$$

where

a_{meas} = measured absorption in db/meter.

The computer program used to correct the measured absorption to free space conditions is given in Appendix B.2. The free space absorption is argon computed using equation (4.5) is shown in figure 4.8.

It should be noted that the different symbols shown in figure 4.8 represent data taken three months apart. The speaker diaphram was replaced between these measurements. We conclude, therefore, that the tube absorption was independent of minor day to day variations in the system.

The use of an empirical correction introduces the possibility that at least part of the correction term could actually be compensating for an inaccuracy in the procedure used to calculate sound absorption. For example, if the rotational relaxation frequency used in the prediction procedure was too low, the experimental points at high frequency should fall below prediction. Similarly, if the viscosity assumed for argon was too high, the experimental results would fall below predicted values. Actually, these basic physical properties are known quite accurately, however, in order to insure that errors in these quantities or some unidentified term in the free space absorption was not responsible for the observed discrepancy, a new tube was constructed.

The second tube was a smaller scale replica of the primary tube. It was 110 cm long and 5.715 cm inside diameter. Figure 4.9 shows

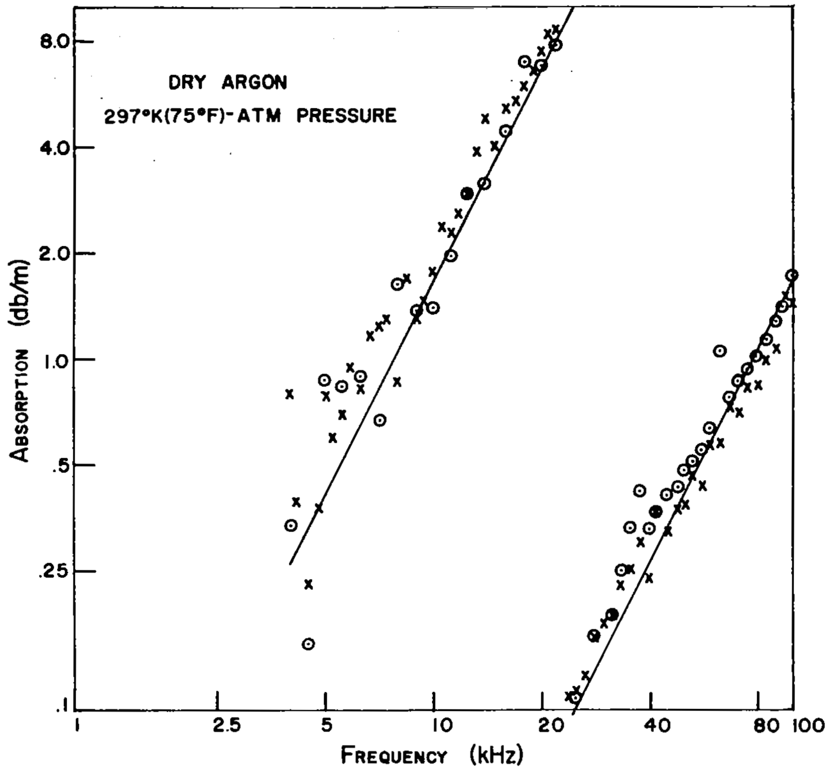


Figure 4.8 The Free Space Absorption of Sound In Argon. The data represented by the x's were taken November 19, 1975, and those represented by ⊙'s were taken February 16, 1976. The solid curve is the classical free space absorption due to viscosity and thermal conductivity. Measured values were corrected by equation (4.5).

experimental measurements made in the new tube with nitrogen and argon along with the theoretical curve with no empirical correction. At higher frequencies, the systematic deviation between measured and calculated total absorption is now absent. It is clear, therefore, that the discrepancy observed in the large tube is associated with the tube diameter and does not represent an error in the method used to compute free field absorption. This conclusion is further substantiated by the measurements made in the small tube shown in figure 4.10. In this figure, the absorption

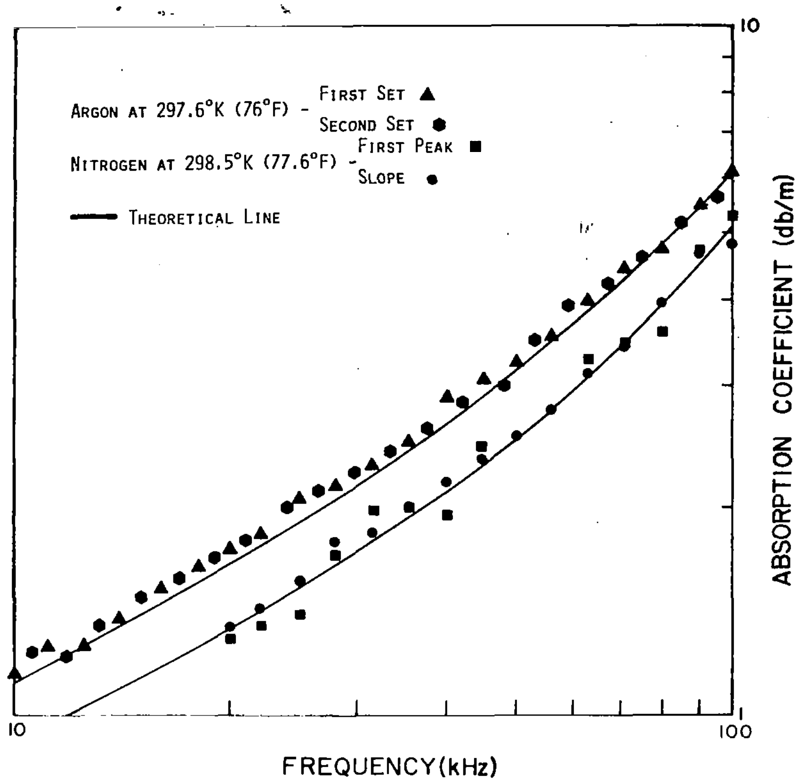


Figure 4.9 Absorption in Argon and Nitrogen Measured Using the Smaller Tube. (110 cm long x 5.715 cm inside diameter)

measured in the small tube in dry air converted to free field conditions with no empirical correction term is compared to that measured in the large tube corrected with the empirical term. The excellent agreement indicates to us that the empirical correction is justified and accurate. In calculating a_{tube}, for both the small and large tube the energy and tangential momentum accommodation coefficients for argon were taken from the literature as 0.7 and 0.9 respectively. The corresponding values for N_2 and air were assumed to be 0.6 and 0.8. The uncertainty in these values produces a negligible error in the calculated a_{tube}.

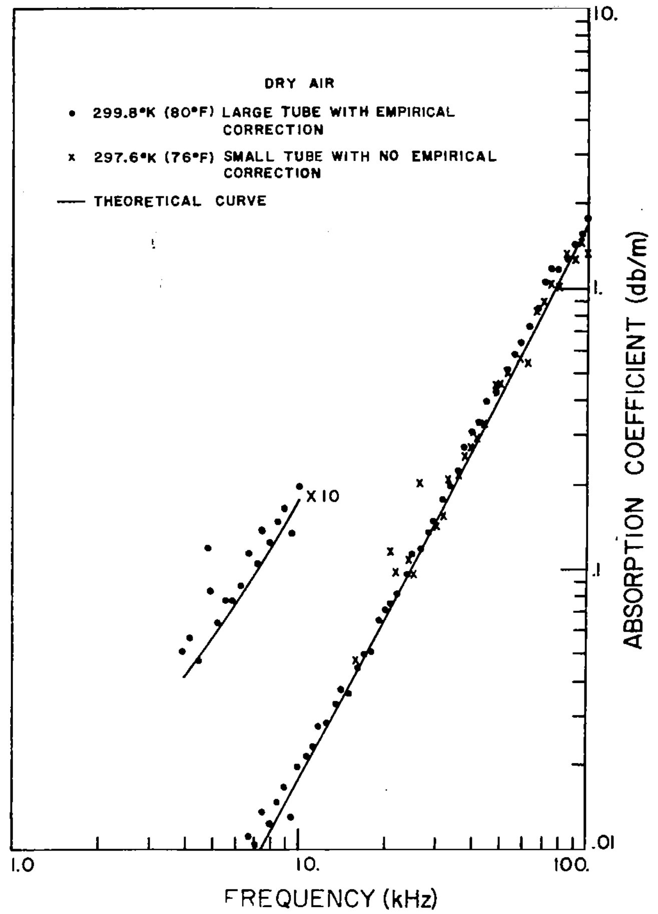


Figure 4.10 The Free Space Sound Absorption in Dry Air as Measured In Two Different Size Tubes. Large tube: 480 cm long x 25.4 cm I.D.; small tube: 110 cm long x 5.715 cm I.D.

5 DISCUSSION OF EXPERIMENTAL RESULTS

5.1 Pure Tone Results

Graphs and computer printouts of measured pure tone absorption in db/m corrected for tube effects are given in Appendix A.1. Also included are the predicted values calculated using the computational technique described in section 3.2. A typical graph is given here as figure 5.1.

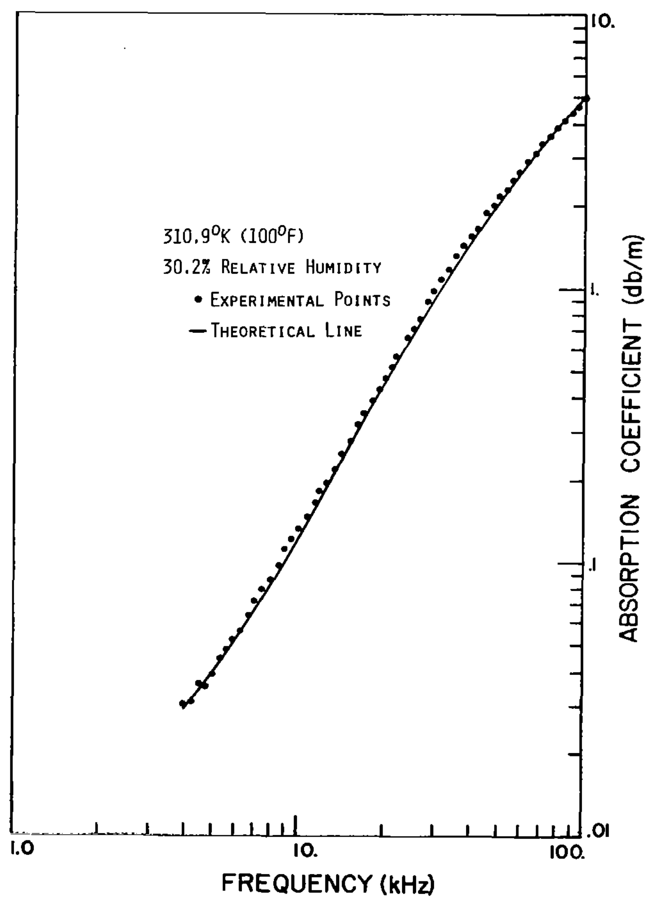


Figure 5.1 Sample Measured and Predicted Absorption Coefficients

The most striking feature of figure 5.1 and the figures in Appendix A.1 is the excellent agreement between predicted and measured absorption. A more careful examination will disclose some differences which will be discussed in this section. The general agreement between theory and experiment is very satisfying since a great deal of effort was involved in developing the equations in Section 3.2. It is also satisfying that the experiment suggests some slight improvements to this theory.

The original plan called for measurements in 10% relative humidity increments from 0% to saturation. In order to provide a ready comparison to calculations, it was decided to express all relative humidities in terms of the relative humidity which would be measured over water. At low temperatures, the actual relative humidity, which one would measure with an instrument such as a dew point hygrometer, would be that over ice. There is a significant difference here, so one must be careful when defining this term. We chose to follow the customary practice of using the vapor pressure of water to compute relative humidity. Therefore, at low temperatures, it was not possible to achieve 80 or 90% relative humidity because these humidities, calculated from the vapor pressure of water, correspond to greater than 100% relative humidity when the vapor pressure of ice is used. In addition, at saturation conditions the acoustic signal was very noisy and was not very stable with time. For this reason, some of the measurements at saturation were omitted. Enough were made, however, to insure that the absorption continues to vary as expected. Other omissions in the data in Appendix A.1 consist of a few individual frequencies where the measured value contained an obvious error, and some low frequency and low humidity values where the absorption was so small that the measured values were deemed unreliable. The actual experimental grid of dew points in °K is given in table 5.1. These were the values actually read from the dew point hygrometer. The experimental dew point was taken to be the average of the dew point measured at the beginning of the run and the value measured after the data had been collected (approximately three hours later). The deviation between the average dew point and beginning or final values are also given in table 5.1 as the uncertainty. These dew points are expressed as relative humidities in table 5.2.

Measured Dew Points (°K)

Temperature (°K)	Target Relative Humidity % 10	20	30	40	50	60	70	80	90	100
255.4	233.6±1.3	240.9±0.7	245.3±0.1	247.7±0.1	250.0±0.1	251.8±0.1	253.4±0.1	--	--	--
260.9	237.5±1.4	245.7±0.3	249.3±0.2	251.9±0.6	254.8±0.1	256.7±0.1	258.5±0.1	259.5±0.3	--	--
266.5	242.9±0.3	249.5±0.2	254.1±0.2	257.2±0.1	259.4±0.1	261.4±0.2	263.1±0.2	264.7±0.1	266.2±0.1	--
272.1	246.7±0.4	253.9±0.1	258.3±0.1	261.7±0.1	263.6±0.5	266.2± -	267.5±0.2	269.4±0.2	271.3±0.2	--
277.6	250.6±0.3	258.4±0.1	262.9±0.1	266.2±0.1	268.8±0.1	270.9±0.1	272.5±0.1	275.5±0.1	276.0±0.1	--
283.2	254.6±0.2	262.3±0.2	267.3±0.1	270.7±0.3	273.2±0.1	275.9±0.0	277.9±0.1	279.9±0.1	281.5±0.2	--
288.7	260.6±0.1	266.8±0.1	271.7± -	275.1±0.1	278.4±0.1	281.0±0.1	283.2±0.1	285.2±0.1	287.0±0.1	--
294.3	262.8±0.1	270.6±0.1	276.2±0.0	280.1±0.1	283.4±0.0	286.2±0.1	288.7±0.1	290.8±0.1	292.4±0.1	--
299.8	266.3±0.2	275.2±0.2	281.0±0.0	285.1±0.1	288.5±0.1	291.4±0.1	293.9±0.1	296.1±0.1	298.0±0.1	--
305.4	270.8±0.0	279.8±0.1	285.7±0.1	289.9±0.1	293.7±0.1	296.6±0.1	299.3±0.1	301.4±0.1	303.4±0.1	--
310.9	274.2±0.1	284.1±0.1	290.5±0.1	295.0±0.1	298.7±0.1	304.5±0.1	301.5±0.1	306.8±0.1	308.8±0.2	--

Table 5.1 Experimental Dew Point Grid

Actual Relative Humidity Grid

Temperature (°K)	Target Relative Humidity % 10	20	30	40	50	60	70	80	90	100
255.4	8.3±2.0	20.2±1.7	29.0±0.2	40.4±0.4	50.0±0.6	59.7±0.7	70.0±0.7	--	--	--
260.9	8.0±2.2	19.8±0.8	29.4±0.8	38.1±2.3	50.3±0.6	59.7±0.6	70.7±0.4	78.4±2.5	--	--
266.5	9.9±0.6	19.5±0.5	30.5±0.5	39.0±0.5	50.0±0.6	59.7±1.0	69.6±1.5	80.0±0.4	91.7±0.9	--
272.1	9.5±0.6	19.7±0.1	29.5±0.4	40.4±0.4	47.9±2.4	60.0± -	67.6±1.0	79.2±1.3	92.9±1.7	--
277.6	9.4±0.5	20.0±0.3	30.2±0.3	40.4±0.2	50.3±0.3	60.3±0.3	69.0±0.3	80.3±0.7	89.6±0.7	100
283.2	9.4±0.3	19.5±0.4	30.5±0.2	40.4±0.1	49.8±0.2	60.5±0.0	70.0±0.3	80.3±0.6	89.7±0.7	100
288.7	11.5±0.1	20.2±0.2	30.7± -	39.8±0.2	50.2±0.4	60.2±0.2	69.7±0.3	79.3±0.3	89.3±0.6	--
294.3	10.1±0.1	19.9±0.2	30.3±0.0	39.9±0.3	49.8±0.1	60.0±0.2	70.2±0.5	80.0±0.3	89.3±0.3	100
299.8	9.7±0.3	20.2±0.3	30.5±0.0	40.0±0.3	49.8±0.4	60.0±0.2	70.0±0.3	80.0±0.3	89.7±0.3	100
305.4	10.6±0.0	20.4±0.1	30.3±0.1	39.7±0.2	50.0±0.2	59.8±0.4	70.2±0.2	79.6±0.3	89.1±0.6	100
310.9	10.1±0.1	20.0±0.1	30.2±0.1	40.0±0.1	50.0±0.2	58.8±0.2	70.0±0.2	79.8±0.3	89.2±0.9	100

Table 5.2 Experimental Relative Humidity Grid

A careful examination of the experimental data in Appendix A will reveal a systematic difference between measured absorption and the predictions of the equations in Section 3.2. This difference is most noticeable at 10% relative humidity and a temperature of 299.9 °K. This difference is beyond the range of experimental scatter. On first examination, we felt the difference was possibly due to an error in humidity so several of the runs were repeated. The second runs removed some discrepancies and confirmed others. For example, as discussed in the following section on experimental error, a point by point comparison of the data at 299.9°K and 10% RH taken on March 22, 1976, with that taken on May 21, 1976, showed an average difference of 0.006 db. We conclude that the difference between experiment and theory is real and that some improvement is required in the prediction procedure. The variation of this difference with humidity leads us to conclude that the problem is in the oxygen relaxation frequency. Figures 5.2 and 5.3 give predicted values of the

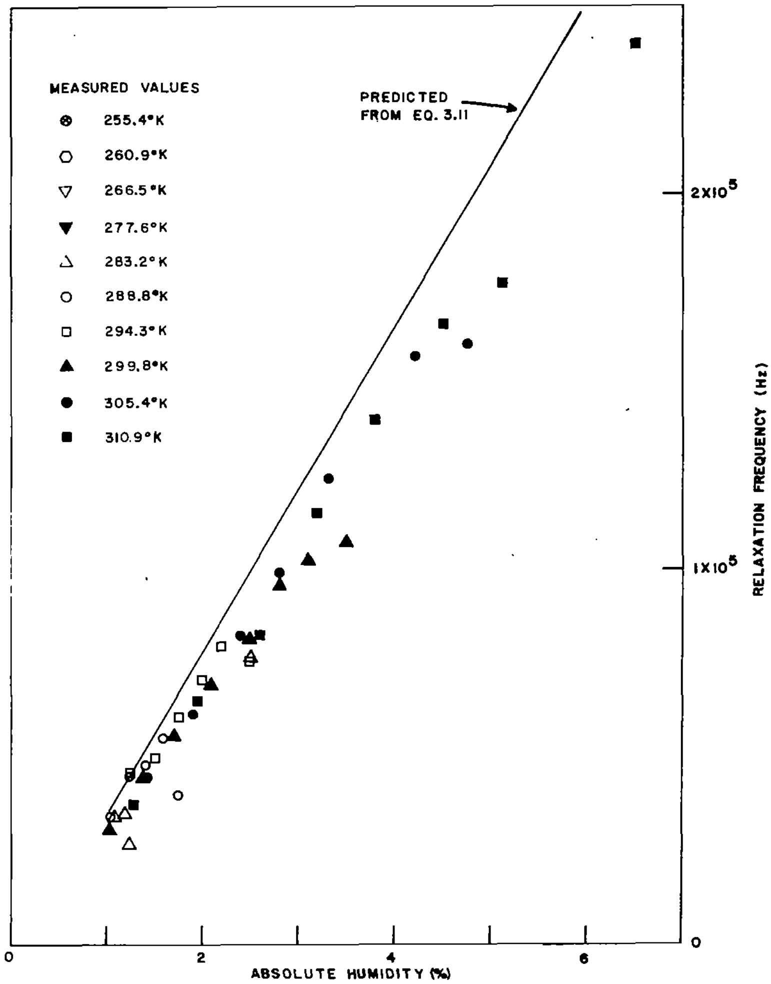


Figure 5.2 Comparison of Experimentally Obtained Values of the Relaxation Frequency of Oxygen in Air as a Function of Absolute Humidity (h) with Predicted Values from Equation 3.11.

relaxation frequency of oxygen, $f_{r,O}$, using equation 3.11 and the values determined in this study. In order to extract values of $f_{r,O}$ from the experimentally measured absorption, the experimental points were first corrected for tube effects to give the free field absorption. Then the classical absorption and nitrogen vibrational relaxation absorption, computed as described in Section 3.2, were subtracted from the free field absorption leaving the absorption due to the vibrational relaxation of

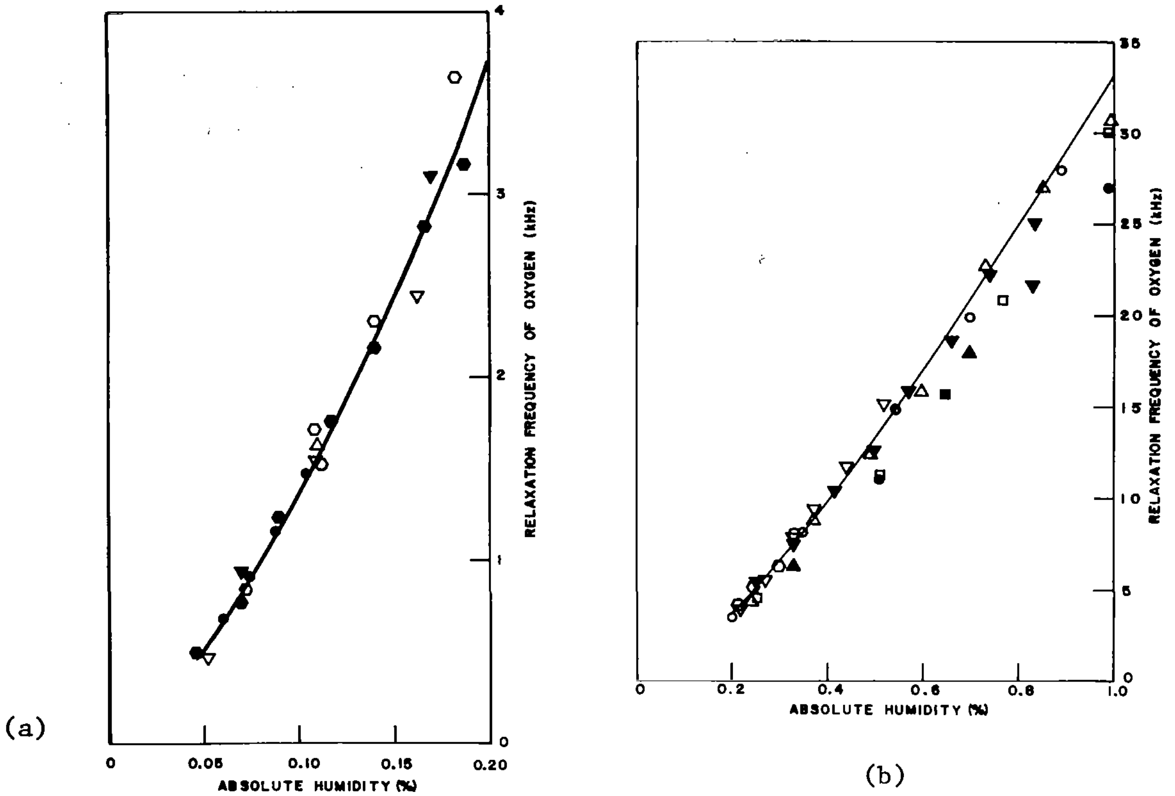


Figure 5.3 Comparison of Experimentally Obtained Values of the Relaxation Frequency of Oxygen in Air as a Function of Absolute Humidity (h). See figure 5.2 for symbols list.

oxygen. Finally, the oxygen relaxation absorption was computed using equation 3.16 with several values of $f_{r,O}$ above and below the value from equation 3.11. The value of $f_{r,O}$ which gave the smallest standard deviation between predicted and measured relaxation absorption was taken to be the correct value for $f_{r,O}$ at that humidity. These values are given in figure 5.2. It can readily be seen that at high values of the absolute humidity, h, equation 3.11 predicts a relaxation frequency significantly higher than that measured here. At lower humidities or temperatures where there exist prior experimental measurements, the agreement is quite good. At high humidities and temperatures, the vibrational relaxation of oxygen is shifted upward in frequency to where it is a small part of the total absorption hence there is no noticeable difference between experiment and theory as shown in the graphs of Appendix A. It was not possible in the time allotted to modify the equations in Section 3.2 accordingly. This modification will be made in the following months and the results published in the open literature. This difference will also be brought to the attention fo the S1-57 Working Group so that modifications can be incorporated in the proposed ANSI standard.

5.2 Error Analysis

There are several potential sources of error in the experimental measurements. These include an error in dew point, an error in frequency, an error in pressure, an error in temperature, error in lengths, errors due to gas impurities, and error in absorption measurement. Each of these terms will be examined below, however, it will be shown that errors in the measurement of these quantities is small compared to errors not directly associated with these definable parameters.

Dew point: The dew point could be read with the dew point hygrometer to within 0.06°K. The platinum resistance thermometer in the hygrometer has a calibration traceable to the National Bureau of Standards and is accurate to within ±0.06°K. The dew point was measured before and after each run. The deviation of the initial and final dew points from the average provides the best measure of changes in dew point with time and hence error in the dew point. In order to determine the effect the deviations listed in Tables 5.1 and 5.2 would have on the measurements, the average relative humidity was replaced by the maximum deviation from the average and the predicted absorption, as shown in the tables of Appendix A, was recomputed. The difference between the absorption predicted at the average relative humidity and that predicted for the maximum deviation from the average was taken to be the maximum error in absorption which might have resulted from an error in dew point measurement. In all cases, this error was less than 7 %, a quantity which is smaller than the size of the data points in Figure 5.1.

Frequency: The frequency was simultaneously measured with a GR 1192 Frequency Meter and an HP Digital Voltmeter. In all cases, the frequency was within 0.2% of the target frequency as listed in the Tables in Appendix A. A 0.2% error in frequency will lead to approximately 0.2% error in absorption. This error was only encountered at the lowest frequency (4 kHz) and was equally probable in either direction. Therefore, errors in frequency could give at most a 0.2% scatter in the data at 4 kHz. At 100 kHz, the error in frequency was completely negligible.

Pressure: The pressure was measured on a mercury manometer and monitored with a Texas Instrument Company quartz-bourdon pressure gauge. The pressure readings were good to a few tenths of a percent. However, the pressure varied over the course of measurements by about 0.5% due to the variation in temperature of various parts of the gas handling system and to the change in volume of the system when the speaker moving rod was moved into and out of the sound tube. In some cases, when adding water vapor the pressure occasionally was allowed to go above atmospheric by about 4%. Even so, this variation could produce only a few tenths of a percent change in the absorption.

Temperature: The temperature was monitored by nine thermocouples equally spaced along the outside of the sound tube. A tenth thermocouple of the same type (Copper-Constantan) was placed in an insulated Dewer along with a calibrated thermometer. The temperature at each location was read each time the transducer separation was changed. The reading on the thermocouple in the dewer was compared to the reading on the standard thermometer and always found to be within .4° K. This led us to conclude that the thermocouple accuracy was ±.4° K. The temperature variation over the sound path was never greater than 1°K and generally less than 0.25°K. Based on this, we conclude that the error in temperature was less than 0.7°K with a corresponding error in absorption of less than 0.7%.

Distance: The measurement of the change in distance between the speaker and microphone need be made only to an accuracy of a few millimeters in order for the distance measurement to introduce negligible error in the absorption. This accuracy was easily obtainable with a well calibrated meter stick. Error in the distance measurement, therefore, contributed negligible error to the results.

Gas Purity: The gas purity was carefully controlled in all measurements. The gas used for the measurements was Matheson ultra-high purity air. The listed composition is as follows: Nitrogen 78.084%, Oxygen 20.946%, Argon 0.934%. Carbon dioxide 0.033%, rare gases 0.003%. The dew point is listed as 213.7°K maximum and the hydrocarbon level as less than 0.1 p.p.m. The system was pumped down to 6.67 N/m^2 and leak checked before introducing the test gas. The combined leak and outgassing rate was less than 1.33 N/m^2 per minute. Near the end of the experiment a leak was discovered in the cold trap that allowed some ethylene glycol (antifreeze) into the system. This material has a low vapor pressure and should have a negligible effect upon the absorption. Runs that might have been influenced by this material were repeated to eliminate errors that might have resulted.

The Absorption Measurement: The accuracy of the absorption measurement depended only upon the linearity and stability of the microphone and associated electronics. This linearity was easily checked by measuring the decay constant of the echo decay pattern with different sound levels. (If the electronics were linear the decay constant should be independent of sound amplitude.) No consistent variation from linearity was observed in this check. The stability of the electronics was checked periodically by repeating initial measurements at the end of a run. These tests eliminated non-stability and non-linearity in the electronics as a source of appreciable error in the results.

Generally the signal to noise ratio was so great as to eliminate noise as a factor. Only at high humidities where the transducer output decreased or at very small absorptions, where the decrease in amplitude between reflections was very small, was there any problem in resolving accurately the heights of the various peaks.

This discussion of error in definable parameters sets an upper limit of error in the absorption at approximately 1%. This figure can be compared with the difference between measured values. As explained in the section on experimental procedure, measurements were first made on dry air at each temperature and then later (sometimes as much as 5 months later) abbreviated check runs were made on dry air each time fresh gas was introduced into the system. A point by point comparison has been made between the check runs and the original runs in Appendix A.2. The next to the bottom row in Table A.2.1 gives the average percentage difference in the measured values at each temperature, counting all differences as positive. This can be taken as a measure of the accuracy of an individual measurement. The bottom row in this table gives the average percentage difference, counting this difference negative when the second value is larger than the first. The values in this row, therefore, are a measure of the consistent error that might result from long term changes in calibration. We consider these two rows to be "worst case" values since the absorption in dry air is small and the check runs were sometimes made before temperature equilibrium was well established.

In making check runs one of the runs repeated was at 299.9°K and 10% RH. The first was made on March 22 and the second on May 21. A point by point comparison of these measurements is given in Table A.2.2 in the appendix. These two runs were made on different gas samples, before and after the discovery and correction of the ethylene glycol leak, and before and after the measurements with the small tube. Even with these changes and time lag, the examination of the data, point by point, shows an average difference of approximately 1% in the total absorption measured at the individual frequencies. This difference in the two sets of data was too small to plot on a 299.9°K/10% RH curve in Appendix A.1.

Probably the largest source of error is not accounted for in the above analysis and arises due to a departure of the sound from plane wave propagation. As already mentioned, the response of the microphone was very sensitive to changes in the shape of the wavefront and to the angle the wavefront made with the large transducer surface. At the highest frequencies, the wavelength was only a few millimeters long and such changes produce interference effects across the surface of the transducer. In addition, at certain frequencies on occasions the echo pulses were not square. An examination of the pulse showed an interfering wave overlapping part of the pulse and extending into the region between pulses. This phenomena was interpreted as being due to transverse or higher order vibrational modes within the tube, and sometimes could be associated with an air pocket between the mylar and the backing plate on either the microphone or speaker. We can conclude that temperature gradients, concentration gradients and alignment limitations probably are the primary source of experimental error. These effects produce disturbances in the shape of the wavefront that cause changes in the microphone response that far exceed that due simply to the variation in the sound absorption. Such errors, however, should be random from run to run. Errors attributed to these effects were sufficiently large to warrant repeating part or all of only 12 out of 113 runs. The runs repeated for this purpose were: (all written as °K/% RH) 266.5°/30%, 266.5°/50%, 272.0°/20%, 268.7°/10%, 268.7°/20%, 268.7°/30%, 283.2°/10%, 283.2°/20%, 283.2°/30%, 283.2°/40%, 294.3°/10%, and 305.4°/80%. The check runs eliminated some obvious errors but reveal no change in the calibration of the system or consistent error in the original data. The rest of the tables and figures of Appendix A.1 contain data with only minor editing to remove obvious errors.

Tube Corrections: One of the most difficult problems in any experimental effort to measure low frequency sound absorption is the correction for secondary effects. The tube method used here was chosen because, hopefully, the only secondary effect that would have to be considered would be the wall losses and these could be reliably treated theoretically. As discussed in the experimental section, over most of the frequency range this proved to be the case. At the high frequency range (60 to 100 kHz) a small empirical term was developed to bring the theoretical tube loss into agreement with experimental results. In order to insure that the tube losses were being correctly calculated by this method, a small tube was constructed and used to measure absorption in argon, nitrogen and air. With this tube no empirical term was necessary and the free space absorption measured with this tube agreed with the high frequency values measured using the large tube (see figures 4.9 and 4.10).

Of course, the accuracy of the free space absorption measurements is dependent upon the accuracy with which the tube correction can be made. The accuracy of this correction is especially critical at the smallest values of absorption shown in the figures in Appendix A. At 4 kHz, for example, the tube absorption is approximately 0.15 db/m. As seen in the figures,this is 50 times the free space absorption in dry air. Therefore, any error in the tube correction or the measurement causes an error 50 times as great in the reported free space absorption. At higher humidities and frequencies this ratio is much more favorable and over most of the range the tube and free space absorption are the same order of magnitude.

To obtain a check on the accuracy of the tube correction, we examined the measurements in dry nitrogen since this gas closely approximates air and in this gas the free space absorption is accurately known, being due only to the classical effects of viscosity and thermal conductivity plus a small contribution due to rotational relaxation. (In this frequency and temperature interval vibrational relaxation absorption is negligible in nitrogen.) The computer program for the numerical solution for the tube absorption plus the empirical term was used to correct the absorption measurements in nitrogen to free space conditions. The average difference between these measured values corrected to free space conditions and the theoretical free space absorption divided by the tube absorption was taken as a measure of the percentage error in the tube correction. This comparison between theoretical and measured values in nitrogen gives an average error of 0.2% in the tube correction in the frequency interval 4 to 25 kHz and 0.6% in the frequency interval from 25 to 100 kHz.

6 CALCULATION OF ATMOSPHERIC ABSORPTION FOR BANDS OF NOISE

6.1 ANALYSIS

6.1.1 Known Source Spectrum

The measurements and theory described in the previous sections considered the absorption of a pure tone. In practical applications, it is more common to encounter a finite band of noise. Therefore, a procedure is required which will allow the pure tone results to be applied to propagation of bands. The band loss is defined as the difference in decibels between an integral over frequency of the power spectral density at the source and an integral over the same band at the receiver. Defining

$$B_i = \int_0^\infty W(f)T_i(f)df \qquad \text{watts/m}^3 \qquad (6.1)$$

where

B_i = band power for the ith band

$W(f)$ = acoustic power spectral density

$T_i(f)$ = transmission function of the filter (0 to 1)

and

f = acoustic frequency in Hz,

the band loss ΔL_i in db becomes

$$\Delta L_i = -10 \log_{10} (B_i(R)/B_i(0)) \qquad \text{db} \qquad (6.2)$$

where

$B_i(R)$ = band power for the ith band a distance R from the source

$B_i(0)$ = band power for the ith band at the source.

The sound pressure, P, at a distance R from a source with sound pressure P_o can be written as

$$P = P_o 10^{-aR/20} \qquad \text{newt/m}^2 \qquad (6.3)$$

where

a = pure tone absorption coefficient in db/m

R = propagation distance in meters

and spreading losses have been ignored. Spreading losses can be added to the final result without loss of generality. Since the acoustic energy is proportional to the square of the rms pressure amplitude,

$$W(f,R) = W(f,0)10^{-aR/10} \qquad \text{joules/m}^3 \quad (6.4)$$

where W(f,0) = energy density at frequency f at the source, joules/m^3, so the band loss ΔL_i becomes

$$\Delta L_i = -10 \log_{10} \int_o^{\infty} W(f,0)T_i(f)10^{-aR/10}\, df \Big/ \int_o^{\infty} W(f,0)T_i(f)df, \qquad \text{db.} \quad (6.5)$$

Due to the complex form of a(f), equation (6.5) can not be evaluated in closed form even for simple functions W(f,0) and $T_i(f)$. In order to evaluate ΔL_i, then, numerical integration is required. Therefore, evaluation of band loss becomes merely the performance of this numerical integration for the required conditions.

It is informative to set up the numerical problem in a way that makes the results easy to interpret. This can be done by writing W(f,0), $T_i(f)$, and $10^{-aR/10}$ in the form $(f/f_j)^q$ where f_j is a reference frequency and q is a constant to be determined. In this form, the integrals in equation (6.5) can be divided up into small segments over which q is constant. This procedure allows one to identify the important properties of ΔL_i.

While setting up this procedure, we will assume the band is a fraction of an octave in width so that

$$f_{i+1}/f_i = r \qquad (6.6)$$

where

f_{i+1}= center frequency of the i+l band, Hz

f_i= center frequency of the ith band, Hz

and

r = frequency ratio between band centers.

We will further divide the ith band into b segments by defining a set of frequencies in the band

$$f_j = f_i[r^{-1/2}][r^{(j-1)/b}] \quad \text{Hz} \qquad (6.7)$$

where

f_j = a geometrically spaced frequency in the ith band, Hz

f_i = center frequency of the band, Hz

b = number of segments into which the band is divided.

This procedure is illustrated in figure 6.1.

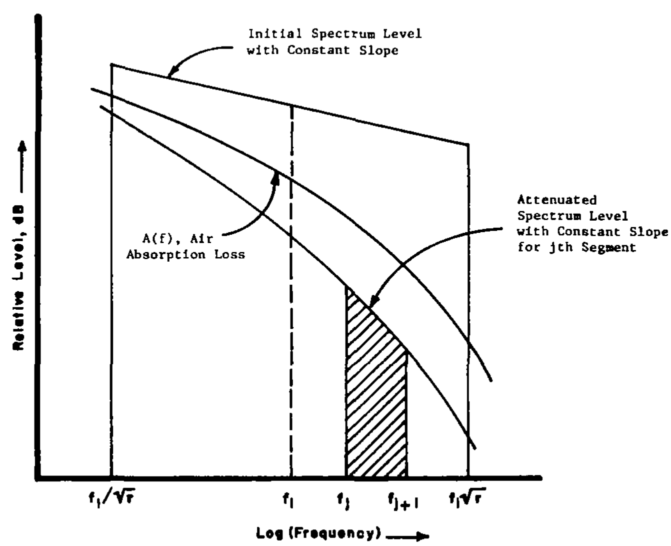


Figure 6.1 Illustration of Segmentation of the ith Band for Integration of Attenuated Spectrum Level

The band level L_i of the ith band can be written as

$$L_i = 10 \log_{10} \int_0^{\infty} W(f,0)T_i(f)10^{-aR/10}\, df/W_{ref}, \text{ db} \qquad (6.8)$$

$T_i(f)$ = the filter response for the ith band

and

W_{ref} = arbitrary reference power.

If we let L_{io} be the band level at the source, then

$$L_{io} = 10 \log_{10} \int_0^\infty W(f,0)T_i(f)df/W_{ref}, \qquad \text{db.} \qquad (6.9)$$

By comparison to equation (6.5),

$$\Delta L_i = L_i - L_{io}, \qquad \text{db.} \qquad (6.10)$$

Over a finite band, the source spectrum W(f,0) will generally vary. If the variation takes the form of a sharp spike then narrow band analysis is required. However, if the variation is smooth over a band, then a constant slope for the input spectrum will be a reasonable approximation. In this case, the spectrum level L_k for any band with a center frequency f_k can be written in terms of the spectrum level L_i of any other band with center frequency f_i as

$$L_k = L_i + 10m \log_{10} (f_k/f_i) \qquad \text{db.} \qquad (6.11)$$

The term m serves to characterize the slope of the source spectrum which is assumed to be independent of frequency. If one writes the energy density at any frequency, f, as

$$W(f) = W(f_i)\ (f/f_i)^{m'}, \qquad \text{joules/m}^3 \quad (6.12)$$

then for a fractional octave band filter it can be shown that $m' = m - 1$. For a fractional octave band filter, if $m' = 0$, then the source consists of white noise and the spectrum level will increase for successive bands at a rate of 10 db/decade since the filter increases in width as the center frequency of the filter increases. If $m = 0$, the fractional octave band spectrum level will remain constant (pink noise) but the energy density must decrease with increasing frequency. (For a fixed bandwidth filter, $m' = m$.) We are concerned here with fractional octave band filters where $m' = m - 1$.

If one plots spectrum level versus log f, 10m is the slope of the line, i.e., when f/f_i varies by 10, L_k changes by 10m. The slope of the input spectrum level, then, is 10m db/decade. Over a single bandwidth the slope is given by

$$S_B = 10m \log(r) = 10(m' + 1)\log(r) \quad \text{db/(band)}^{-1}. \qquad (6.13)$$

It is generally more meaningful to specify S_B, the input spectrum slope/band and then compute an effective value of m over the bandwidth using equation (6.13). S_B for the ith band can be found from the source spectrum level by taking the difference between the level for the i + 1 band and the i - 1 band and dividing by two.

So far we have considered only the change in the source level with frequency. Next consider the change in absorption coefficient a with frequency. Following the suggestion of L. C. Sutherland, we will represent the absorption by a function which varies linearly with log f, i.e.,

$$10^{-a(f)R/10} \approx A(f_j)\ (f/f_j)^{-n} \tag{6.14}$$

where

$A(f_j) = 10^{-a(f_j)R/10}$ = atmospheric transmission at f_j

f_j = the lower frequency of some band segment

n = a constant to be determined.

Taking the $\log_{10}$ of both sides,

$$-a(f)R = -10n\ \log_{10}(f/f_j) - a(f_j)R \quad \text{db} \tag{6.15}$$

or

$$n = [a(f)R - a(f_j)R]/(10\ \log_{10}\ (f/f_j)). \tag{6.16}$$

If the band is divided into b constant percentage segments, from equation (6.7).

$$f_{j+1} = f_j r^{1/b} \quad \text{Hz.} \tag{6.17}$$

Using equation (6.16) for the jth segment of the band,

$$n = \frac{[a(f_{j+1}) - a(f_j)]R}{(10/b)\ \log_{10}\ (r)} \ . \tag{6.18}$$

As was done for the slope of the input spectrum, it is useful to define a slope of the attenuation curve, S_A, as

$$S_A = 10n\ \log_{10}(r), \text{ db/octave.} \tag{6.19}$$

However, in this case, S_A is not a constant over the width of the band. S_A is a measure of how rapidly the air absorption is changing over the total propagation path.

The only term remaining in equation (6.5) which must be considered before evaluating ΔL_i is $T_i(f)$. There are two cases which will be considered in detail here:

Case #1 - Perfect 1/3 octave band filter

$$T_i = 0 \text{ for } f < f_i/(2)^{1/6} \text{ or } f > f_i(2)^{1/6} \qquad (6.20)$$

$$T_i = 1 \text{ otherwise}$$

If we had chosen to define the bandpass as $f > f_i(10)^{+.05}$ to $f < f_i(10)^{-.05}$, the result over a single band would differ from those based on equation (6.20) by approximately .04 percent.

Case #2 - ANSI Class III 1/3 octave band filter (minimum limits)

$$\left.\begin{array}{lll} T_i = 1 & & \text{for } 9\, f_i/10 \le f \le 10\, f_i/9 \\ T_i = (8/13 + 2500(f/f_i - f_i/f)^6)^{-1} & & \text{for } f_i/5 < f < 9\, f_i/10 \\ & & \text{and } 10\, f_i/9 < f < 5\, f_i \\ T_i = 10^{-7.5} & & \text{for } f < f_i/5 \text{ or } f > 5\, f_i. \end{array}\right\} \qquad (6.21)$$

Most real analog filters closely approximate Case #2, an ANSI Class III filter, while digital filters come closer to Case #1. We will again find it convenient to write the filter response in terms of the ratio f/f_j, i.e.

$$T_j(f) = (f/f_j)^k T(f_j), \qquad (6.22)$$

where

$T_j(f)$ = the filter function at some frequency f in the jth segment

f_j = lower frequency for the jth segment

$T(f_j)$ = filter function at f_j

k = constant to be determined.

Using the same procedure as before, k is the filter roll off per decade

$$k = \log_{10} \frac{[T(f_{j+1})/T(f_j)]}{(10/b)\log_{10} r}, \quad \text{db/decade} \qquad (6.23)$$

and

$$S_F = -10k \log_{10} r \qquad \text{db/band} \qquad (6.24)$$

gives the filter roll off per band. One must be careful with the signs here since the sign on both k and S_F will change at f_i. Below f_i, k is always negative (or zero) and above f_i, it is always positive (or zero).

Using equations (6.1), (6.4), (6.12), (6.14) and (6.22), the attenuated band power over the jth segment is

$$B_j(R) = \int_{f_j}^{f_{j+1}} W(f_j,0)\ (f/f_j)^{m'-n+k}\ A(f_j)T(f_j)df, \text{ watts/m}^3 \qquad (6.25)$$

and the source band power level for the same segment is

$$B_j(0) = \int_{f_j}^{f_{j+1}} W(f_j,R_o)\ (f/f_j)^{m'+k} T(f_j)df \qquad (6.26)$$

where

$W(f_j,0)$ = source energy density at $f_j = W(f_i)[r^{-1/2}\ r^{(j-1)/b}]^{m'}$

m' = slope parameter of input spectrum (equations (6.12), (6.13))

n = slope parameter of attenuation curve (equation (6.18))

k = slope parameter of filter function (equation (6.23))

$A(f_j)$ = atmospheric transmission function at f_j (equation (6.14))

and

$T(f_j)$ = filter transmission function at f_j (equations (6.20) or (6.21)).

Evaluating the integrals in equations (6.25) and (6.26),

$$B_j(R) = A(f_j)T(f_j)W(f_j,0)(m-n+k)^{-1}(r^{(m-n+k)/b}-1)f_j \text{ watts/m}^3 \quad \text{for } m-n+k \neq 0 \qquad (6.27a)$$

or

$$B_j(R) = A(f_j)T(f_j)W(f_j,0)f_j(\ln r)/b \quad \text{for } m-n+k = 0 \qquad (6.27b)$$

and

$$B_j(0) = T(f_j)W(f_j,0)(m+k)^{-1}(r^{(m+k)/b}-1)f_j \text{ watts/m}^3 \quad \text{for } (m+k) \neq 0 \qquad (6.28a)$$

or

$$B_j(0) = T(f_j)W(f_j,0)f_j(\ln r)/b \quad \text{for } m=k = 0 \qquad (6.28b)$$

where

$m = m' + 1$ = one tenth of the slope of the input spectrum level/decade as defined by equation (6.11). The band loss ΔL_i from equation (6.5) can now be written as

$$\Delta L_i = -10 \log \left[\sum_{j=1}^{b} B_j(r) / \sum_{j=1}^{b} B_j(0) \right], \quad \text{db} \qquad (6.29)$$

Evaluation of (6.29) using (6.27) and (6.28) constitute the numerical integration of (6.5) for this case. It should be noted at this point that for the ANSI Class III 1/3 octave band filter, the sums in equation (6.29) must include contributions outside the normal band limits since T(f) does not sharply terminate the integral (equation (6.5)) at $f_i/\sqrt{r}$ and $f_i\sqrt{r}$.

6.1.2 Known Received Spectrum

Up to this point, we have considered the band loss in terms of the source spectrum. In practice, however, it is often necessary to record the spectrum at some distance from the source and then reconstruct the source spectrum. In this case, the slope of the source spectrum, m, is not known before correcting for atmospheric losses. However, the theory can still be applied by writing all the equations in terms of the received spectrum slope. Let W(f,R) be the received energy density. If the received spectrum has a constant slope over the ith band, we can write

$$W(f,R) = W(f_i,R)(f/f_i)^{q'} \tag{6.30}$$

where, as before for the m's,

W(f,R) = energy density at distance R from the source at frequency f, joules/m^3

f_i = center frequency of the band, Hz,

and 10 q' = slope of energy density change/decade.

If we write the slope of the received level per bandwidth as S_B' then

$$S_B' = 10q \log(r) = 10(q'+1) \log_{10} r \quad \text{db/bandwidth} \tag{6.31}$$

where

10q = slope of received spectrum level in db/decade.

The band loss can now be written as

$$\Delta L_i = -10 \log_{10}[\int_0^\infty W(f,R)T_i(f)df \Big/ \int_0^\infty W(f,R)T_i(f)10^{+aR/10}\,df], \quad \text{db} \tag{6.32}$$

since

$$W(f,R) = W(0,f)10^{-aR/10} \text{ from equation (6.4)}$$

Using this procedure, equation (6.27) becomes

$$B_j(R) = T(f_j)W(f_j,R)(q+k)^{-1}(r^{(q+k)/b}-1)f_j \qquad \text{for } q+k \neq 0 \tag{6.33a}$$

or

$$B_j(R) = T(f_j)W(f_j,R)f_j(\ln r)/b \qquad \text{for } q+k = 0 \tag{6.33b}$$

and equation 5.28 becomes

$$B_j(0) = \frac{T(f_j)}{A(f_j)} W(f_j,R)\ (q+n+k)^{-1}(r^{(q+n+k)/b}-1)f_j \qquad \text{for } q+n+k \neq 0 \tag{6.34a}$$

or

$$B_j(0) = \frac{T(f_j)}{A(f_j)} W(f_j,R) f_j (\ln r)/b \qquad \text{for } q + n + k = 0 \qquad (6.34b)$$

In this case, ΔL_i, the band loss in db can still be found from equation (6.29)

6.1.3 Correcting to Standard Conditions

So far, we have derived expressions for computing the band attenuation when the source spectrum is known thus allowing the received spectrum to be computed; and we have done the same for a known received spectrum which would allow one to correct back to the source. There is a third case frequently encountered. That is, the received spectrum is measured at some temperature (T) and relative humidity (RH) and we wish to know what spectrum would have been measured on a day with a standard temperature (T_{ref}) and relative humidity (RH_{ref}). This can be done be combining equations (6.5) and (6.32),

$$\delta = -10 \log_{10}\left[\int_0^\infty W(f,R)T_i(f)df \Big/ \int_0^\infty W(f,R)T_i(f)10^{+a(T,RH)R/10}df\right]$$
$$+10 \log_{10}\left[\int_0^\infty W(f,0)T_i(f)10^{-a(T_{ref},RH_{ref})R/10}df \Big/ \int_0^\infty W(f,0)T_i(f)df\right] \qquad (6.35)$$

where

δ = number of db to be added to measured spectrum to obtain the spectrum one would have measured for the same band on a reference day

$a(T,RH)$ = pure tone absorption coefficient in db/m at temperature, T, and relative humidity, RH

$a(T_{ref},RH_{ref})$ = pure tone absorption coefficient in db/m at the reference temperature, T_{ref}, and humidity, RH_{ref}

and all other terms have been defined.

Equation 6.35 can be simplified by recognizing that

$$W(f,0) = W(f,R)10^{+a(T,RH)R/10},$$

to give

$$\delta = -10 \log_{10}\left[{}_0\int^{\infty} W(f,R)T_i(f)df \Big/ {}_0\int^{\infty} W(f,R)T_i(f)10^{[a(T,RH)-a(T_{ref},RH)]R/10} df\right] \quad (6.36)$$

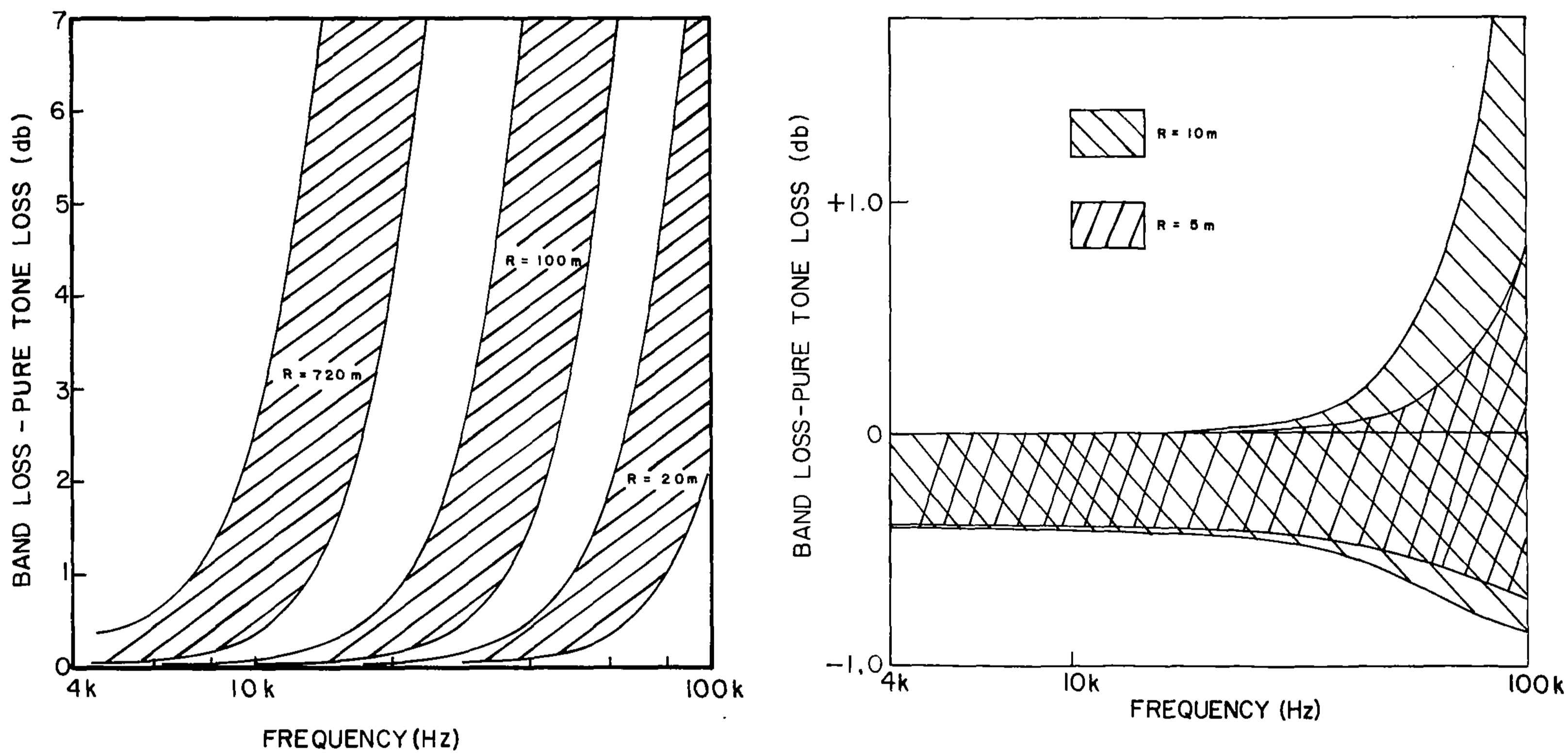
Equation (6.36) is equivalent to first correcting the received spectrum back to the source to get the source spectrum and then computing the loss the source spectrum would have encountered traveling back the same path on a standard day. Actually, for the computations reported here, the programs for evaluating equations (6.5) and (6.33) were merged rather than writing a new program to evaluate equation (6.36).

6.2 Numerical Integration

The results discussed in the following sections were computed using the numerical integrations of equations (6.5) and (6.32), represented by the values of the B_j's given in equations (6.27) and (6.28), and (6.33) and (6.44) respectively. The programs used for the various calculations are included in Appendix B. In all cases, the programs are set up to generate tables for various spectrum (received or source) slopes, atmospheric conditions, and filter types. The function, a(f), is in all cases computed from equation (3.15). The only approximation made was to represent the source spectrum with a constant slope. With this assumption the accuracy of the numerical integration is limited only by the integration step size, b, (B in the programs). A typical value of b was 10 which gave results accurate to within ±.5 db. On a DEC System 1077 each loss coefficient required a computation time of about one second.

6.3 Simplified Technique for Estimating Band Loss

It is often useful to make a rapid assessment of whether, for the experiment of concern, the difference between the readily computed pure tone absorption coefficient and the more difficult to compute band loss coefficient is significant. A guide for such decisions can be found in the following graphs. In figure 6.2 the difference between band loss and pure tone absorption coefficients as a function of frequency is shown for various propagation distances assuming a perfect one-third octave band filter and a flat 1/3 octave band received spectrum, ($S_B' = 0$).



(a)

Long distances

(b)

Short distances

Figure 6.2 Difference Between Band and Pure Tone Loss Coefficients in db as a Function of Propagation Distance, R, for a Range of Atmospheric Conditions (0-100% RH, 263-313°K) and Frequencies. A Flat 1/3 Octave Band Received Spectrum and a Perfect Filter Were Assumed, The hatched areas represent upper and lower bounds corresponding to different atmospheric conditions.

The effect of the source slope is shown in figure 6.3 for a propagation distance of 20 meters and the same range of atmospheric conditions (0-100% RH, 263-313°K). It can be seen that the shape of the received spectrum slope does not radically change the frequency at which the band loss correction becomes significant but does change the magnitude (and sign) of the correction. A similar family of curves would be applicable to different propagation distances.

Figure 6.4 illustrates the differences one might expect when using different types of filters.

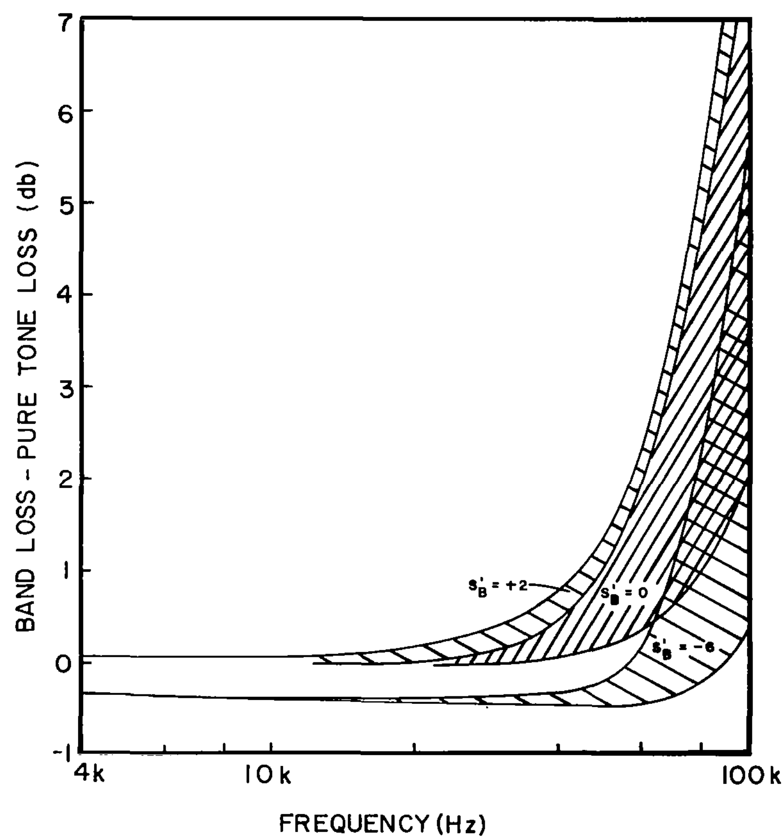


Figure 6.3 Difference Between Band and Pure Tone Loss Coefficients in db for Several Received Spectrum Slopes and Atmospheric Conditions. A Propagation Distance of 20 meters and a Perfect Filter Were Assumed.

Again, it can be seen that the band loss correction factor still becomes important at about the same frequency, however, it should be noted that for the ANSI Class III One Third Octave Band Filter, the correction is much more dependent on the slope of the received spectrum.

If figures 6.2 through 6.4 illustrate that for a large range of conditions the band correction is large enough to be of interest, one of the techniques described in the following sections may be used to compute the band loss coefficient.

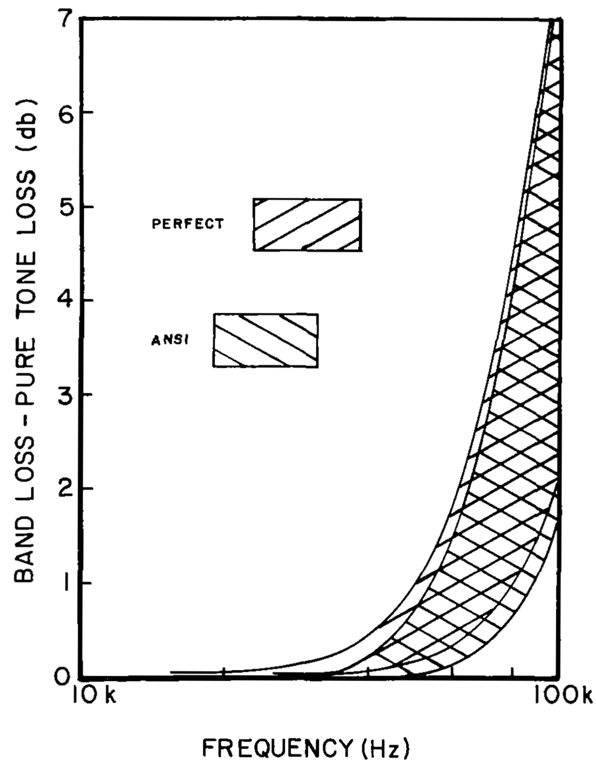


Figure 6.4 Difference Between Band and Pure Tone Loss Coefficients for Different Types of Filters and a Range of Atmospheric Conditions and Frequencies. A Propagation Distance of 20 meters and a Flat Received Spectrum Have Been Assumed.

6.4 USE OF TABLES TO DETERMINE BAND LOSS

The numerical integration described in section 6.2 is the most accurate way to determine the atmospheric absorption for a band of noise. When it is not feasible to resort to numerical integration, one of two techniques can be employed; use of tables or use of correction graphs. The band loss will be a function of relative humidity, temperature and frequency since the pure tone absorption coefficient depends on these parameters. In addition, the band loss will vary non-linearly with propagation distance since the slope of the air attenuation curve, S_A, varies with distance, and the band loss will depend on other parameters; slope of the input spectrum, slope of filter response, and bandwidth of the filter. In all, the band loss is a function of seven variables, therefore, a set of tables to span all possible ranges of the various variables is not practical.

Even though a complete set of tables is not practical, it is not difficult to devise a set which will allow one to cover the range of variables most frequently encountered in the field. A reasonable set of variables for high frequency noise propagation would be

Temperature = 261 to 311°K in 10°K intervals

Relative Humidity = 0, 50, and 100%

S_B = 0, ±2, ±4 db/band = slope of source spectrum

S_B' = 0, ±2, −4, −6 db/band = slope of received spectrum

Frequency = 4 kHz to 100 kHz in 1/3 octave bands

Propagation Distance = 5, 10, 20, 50, 100, 200, 400, 720 meters.

In order to increase the accuracy of interpolating between tables only Δ, a correction factor to be added to the total absorption for a pure tone at band center, is given. One can then obtain the band loss from the equation

$$\Delta L_i = aR + \Delta \quad \text{db} \qquad (6.37)$$

where

a is the pure tone absorption coefficient at the center frequency of the band (see Section 3) in db/m,

R is the propagation distance in meters,

and, Δ is the correction from the tables in db.

Programs to generate such tables for a Perfect 1/3 Octave Band Filter and an ANSI Class III 1/3 Octave Band Filter, defined in equation 6.21, are included in Appendix B. The program gives the pure tone absorption coefficient, a, in db per meter, and values of the correction factor, Δ, for distances mentioned above. Using a set of tables with the grid as above, one should be able to determine Δ to one significant figure and ΔL_B to two significant figures. Tables can also be generated which will give correction factors for a standard day. A program to generate tables of this type is included in Appendix B with abbreviated tables again given in Appendix C.

For application where a different type of filter is to be used, it is recommended that the programs be modified accordingly and a new set of tables be generated.

6.5 Use of Graphs to Determine Band Loss

6.5.1 Known Source Spectrum

When only an estimate of Δ is required or when one is only interested in determining how Δ varies with the several parameters of concern, graphs of Δ can be useful. It is most convenient to prepare such graphs with S_A and S_B as variables where we will use

S_B = input spectrum roll off in db/band (positive means the level increases with increasing frequency) = $(L_{i+1} - L_{i-1})/2$

S_A = slope of air attenuation curve = $[a(f_{i+1}) - a(f_{i-1})]R/2$

where

L_{i+1} = band level of the next higher frequency band

L_{i-1} = band level of the next lower frequency band

$a(f_{i+1})$ = pure tone absorption coefficient at the center frequency of the next higher band in db/m

$a(f_{i-1})$ = pure tone absorption coefficient at the center frequency of the next lower band in db/m

and R = propagation distance in meters.

In order to find Δ from one of the following graphs, determine S_B from the known source spectrum (or S_B' from the recorded spectrum), compute S_A as described above and then using these as the ordinate and abscissa, locate the point (S_B, S_A) on the correction graphs. Next determine which constant Δ curve this point is closest to. This value of Δ can then be used to compute the band loss from equation 6.37. Interpolation between constant Δ curves is possible subject to the limitations discussed below.

Graphs as a correction tool are limited by the determination of S_A. For example, for two different distances say R_1 and R_2, the slope of the attenuation curve over the band at 4 kHz times R_1 might equal the slope of the attenuation curve over the band at 40 kHz times R_2, yet Δ could be quite different due to the way in which S_A varies within the band. In order to examine this effect in detail, a series of correction curves has been developed spanning the range of variables described in the section on tables.

Figure 6.5 was prepared using correction factors computed at 50 m (293°K, 0%RH), 100 m (293°K, 0%RH), and 200 m (293°K, 0%RH). Each calculation at a given distance gives a value of Δ for a particular (S_B, S_A) combination. The three separate calculations gave Δ within $\pm$.2db of each other. In figure 6.6 the values of Δ were computed at distances of 50 m to 400 m at 293°K and 100% relative humidity. A comparison of the two graphs indicates that for a given (S_A, S_B) combination, Δ does not differ more than 1 db over the total propagation path for the conditions considered here. An error of 1 db was only noted for extreme values of S_A ($\approx$20 db/ 1/3 octave). For values of S_A more common for say a 20 meter propagation path ($\approx$5 db/1/3 octave) the correction factor Δ does not vary by more than 0.2 db. One should be careful when applying these results for propagation distances greater than 1000 m. But the small variation in Δ noted for the large change in relative humidity indicates that use of these curves over the temperature range covered by the grid of the previous section should provide Δ within 0.5 db of the correct value.

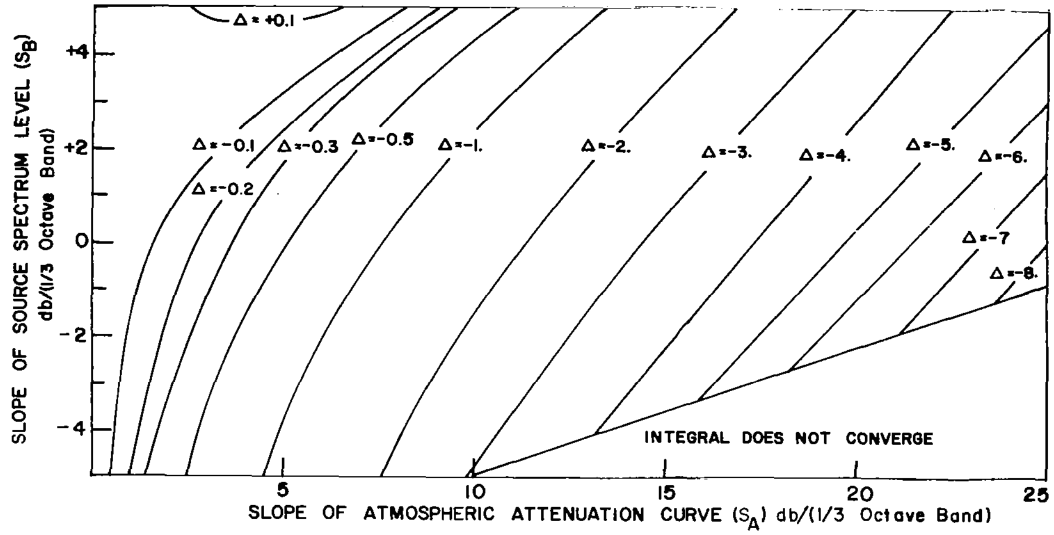


Figure 6.5 Curves of Constant Band Correction Factor (Δ in db) in Terms of the Slope of the Source Spectrum and Atmospheric Attenuation Curve for an ANSI Class III 1/3 Octave Band Filter at 293°K and 0% Relative Humidity.

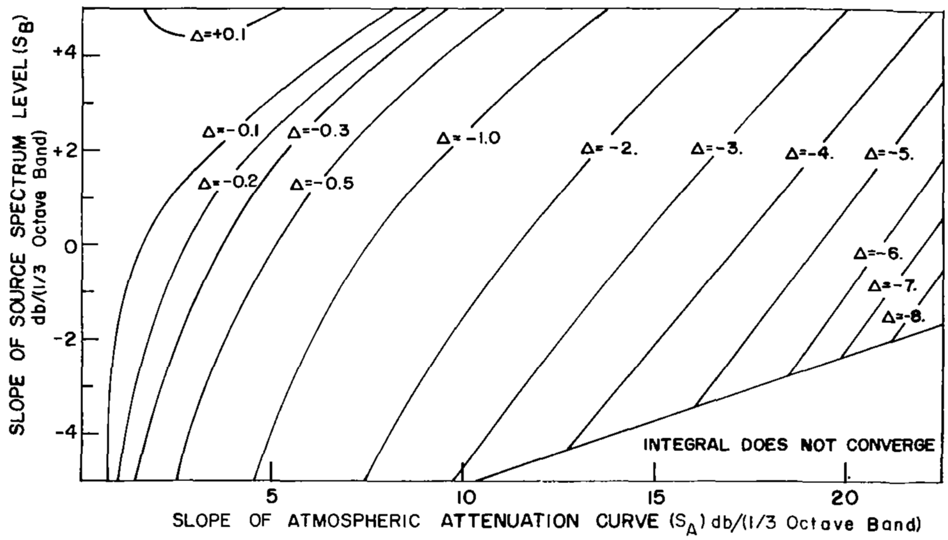


Figure 6.6 Curves of Constant Band Correction Factor (Δ in db) in Terms of the Slope of the Source Spectrum and Atmospheric Attenuation Curve for an ANSI Class III 1/3 Octave Band Filter at 293°K and 100% Relative Humidity.

It should be noted that for $S_B < -4$ db/bandwidth and $S_A > 20$ db/bandwidth, the sum in equation (6.29) in many cases does not converge. For large negative values of S_B and large values of S_A, the energy entering the filter increases more rapidly with decreasing frequency than the filter transmission decreases. Meaningful results can only be obtained by using narrower band analysis. We can write the condition for convergence mathematically as

$$S_F > S_A - S_B$$

where S_F is the roll off of the filter near the band edge per bandwidth.

In figure 6.7 a correction curve for a perfect 1/3 octave band filter is given. The same errors in Δ are encountered but, since the Δ's

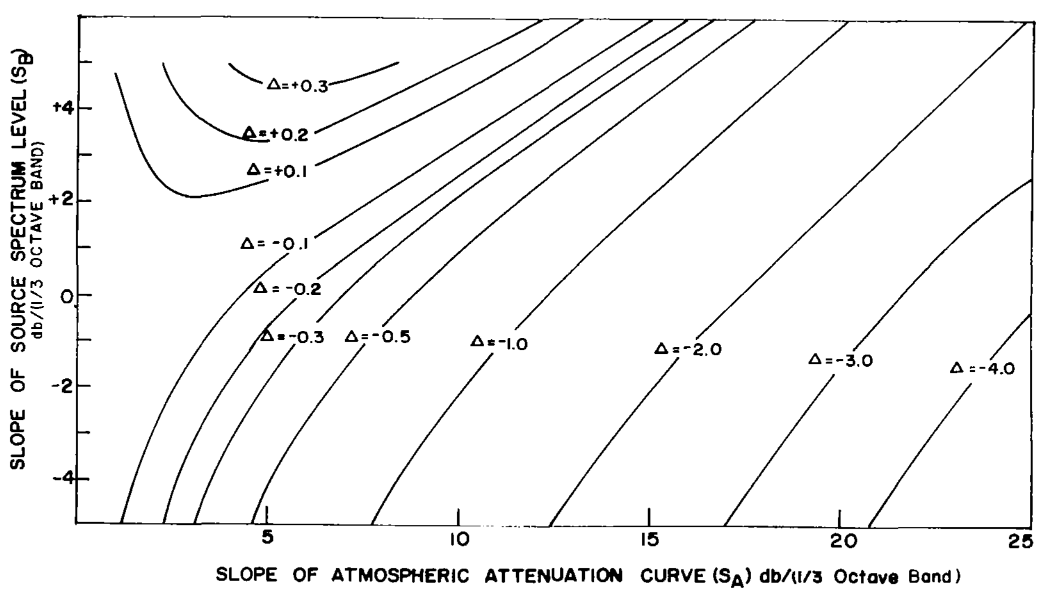


Figure 6.7 Curves of Constant Correction Factor (Δ in db) for a Perfect One Third Octave Band Filter in Terms of Source Spectrum Slope (S_B).

are always smaller for the perfect filter than for the real filter, the error in computing ΔL_i using the correction chart is less than 10% for the conditions considered here. There is no problem of convergence with the perfect filter since $S_F = \infty$.

6.5.2 Known Received Spectrum

If a received spectrum is to be corrected for absorption by the atmosphere, figures 6.8 and 6.9 can be used for ANSI Class III and perfect 1/3 octave band filters respectively. The source spectrum can be found from the received spectrum using the equation

$$\text{Source Band Level} = \text{Received Band Level} + (a(f)\cdot R + \Delta) \text{ db}$$

where

$a(f)$ is the pure tone absorption coefficient/meter at the center frequency of the band

R is the propagation distance in meters

and Δ is the correction factor in db from figure 6.8 or 6.9.

It should be noted that the source spectrum found in this way is the spectrum that would be measured using the same filter if atmospheric absorption was absent.

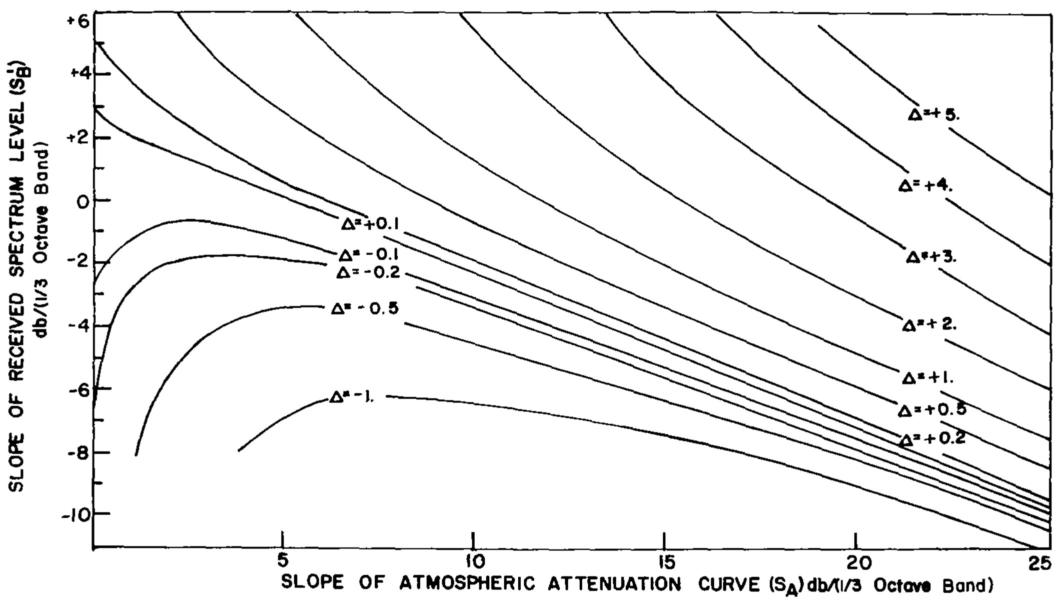


Figure 6.8 Curves of Constant Correction (Δ in db) for an ANSI Class III One Third Octave Band Filter in Terms of the Received Spectrum Slope, S_B'

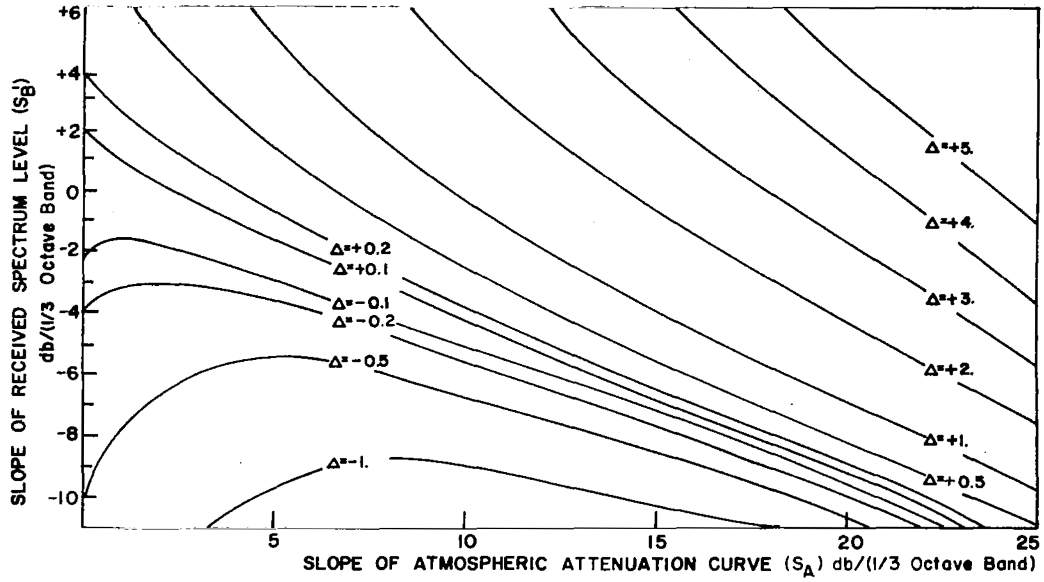


Figure 6.9 Curves of Constant Correction (Δ in db) for a Perfect One Third Octave Band Filter in Terms of the Received Spectrum Slope, S_B'.

6.5.3 Example

As an example of the graphical correction procedure, assume a source spectrum as described in figure 6.10. Further assume that

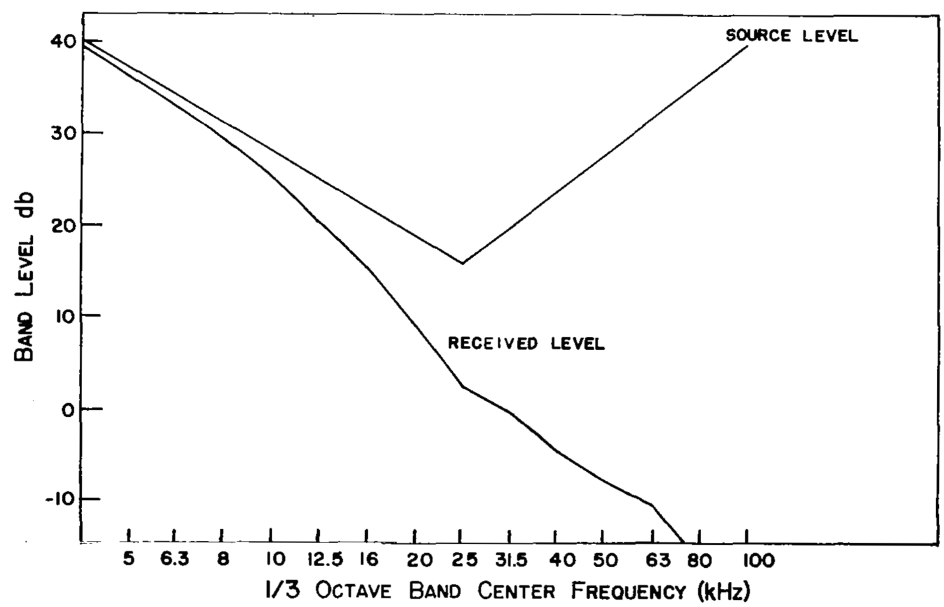


Figure 6.10 Example Source and Received Spectrum Levels.

a microphone is placed 20 meters from the source, the temperature is 293°K, the relative humidity is 50% and the received signal is passed through an ANSI Class III 1/3 Octave Band Filter with transmission characteristics described by equation (6.21). First we will calculate the received spectrum. The appropriate values of S_B, read from figure 6.10, the pure tone attenuation coefficient for band center frequency, and the S_A computed from the pure tone absorption are summarized in table 6.1.

Center Frequency	Source Band Level	S_B (db/(1/3) octave)	Pure Tone Attenuation Coef. (db) aR	S_A (db/(1/3) octave)	Δ (db)	ΔL_i (db)	Received Band Level (db)
4	40		.564				
5	37	-3	.832	.35	-.0	.8	36.2
6.3	34	-3	1.26	.56	-.1	1.2	32.8
8	31	-3	1.96	.85	-.12	1.8	29.2
10	28	-3	2.96	1.24	-.18	2.8	25.2
12.5	25	-3	4.44	1.96	-.28	4.2	20.8
16	22	-3	6.88	2.79	-.4	6.5	15.5
20	19	-3	10.01	3.65	-.55	9.5	9.5
25	16	+.5	14.18	4.84	-.4	13.8	2.2
31.5	20	+4	19.68	6.19	-.1	19.6	.4
40	24	+4	26.55	7.16	-.2	26.4	-2.4
50	28	+4	34.00	8.20	-.4	33.6	-5.6
63	32	+4	42.94	10.15	-.7	42.2	-10.2
80	36	+4	54.30	12.70	-1.2	53.1	-17.1
100	40		68.33				

Table 6.1 Band Loss Coefficient Example Calculation for Source to Receiver Path.

The values of Δ were taken from figure 6.6 since an ANSI Class III 1/3 Octave Band Filter was assumed and the source spectrum slope is known. The band levels one would measure are given as the Corrected Band Level column of table 6.1 where the corrected band level equals the initial band level minus ΔL_i.

In order to check internal consistency and demonstrate further use of the tables, let us now assume we have measured the corrected band level given in the final column of table 6.1 and shown as the received spectrum in figure 6.10. Further assume that we wish to correct the spectrum back to the source using the same atmospheric conditions and filter characteristics. Actually, we could assume any conditions, i.e., a standard day, but such an assumption would not allow us to check internal consistency. The received band levels along with the slope of the received spectrum are given in table 6.2 along with the values of S_A and pure tone absorption used previously. Values of Δ, the correction factor, are now taken from figure 6.8 since the slope of the received spectrum is known. The final column in table 6.2 gives the source level predicted using this procedure. Note that in each case, the reconstructed level equals the level we started with. Hence, the procedure is internally consistent. In some cases, error could be introduced by reading the graph twice.

Center Frequency (kHz)	Received Band Level (db)	S'_B (db/(1/3) octave)	Pure Tone Attenuation Coef. (db) aR	S_A (db/(1/3) octave)	Δ (db)	ΔL_i (db)	Source Band Level (db)
5	36.2		.832				
6.3	32.8	-3.5	1.26	.56	-.2	1.06	34
8	29.2	-3.8	1.96	.85	-.2	1.8	31
10	25.2	-4.2	2.96	1.24	-.3	2.7	28
12.5	20.8	-4.8	4.44	1.96	-.4	4.0	25
16	15.5	-5.6	6.88	2.79	-.7	6.2	22
20	9.5	-6.6	10.01	3.65	-.8	9.2	19
25	2.2	-4.6	14.18	4.84	-.6	13.6	16
31.5	.4	-2.3	19.68	6.19	-.2	19.6	20
40	-2.4	-3.0	26.55	7.16	-.3	26.3	24
50	-5.6	-3.9	34.00	8.20	-.5	33.5	28
63	-10.2	-5.8	42.94	10.15	-.8	42.1	32
80	-17.1		54.30				

Table 6.2 Band Loss Coefficient Example Calculation for Receiver To Source Path

7 PREDICTION PROCEDURE

7.1 Recommended Prediction Procedure

Although the equation for the relaxation frequency of oxygen, equation 3.11, varies from values deduced from this work at high humidity values, the prediction procedure described in Section 3.3 for pure tones agrees well with experimental results over a wide range of temperatures and humidities. Since this prediction procedure does agree well with experiment, and since it differs from the predictions of ARP-866A by as much as a factor of two, we conclude that the prediction procedure for pure tones described in Section 3.3, more specifically equations 3.15 to 3.19, provide the best method of calculating pure tone absorption coefficients available at this time. Further, since the proposed ANSI S1-57 standard for sound absorption in still air when released will reflect an improvement on the procedure of Section 3.3 as a result of this work, it will at that time provide a highly accurate prediction procedure. Until such time as that document is available, for pure tone calculations, we recommend the use of equations 3.15 through 3.19.

It is more difficult to make specific recommendations concerning band loss coefficients due to the large variation in accuracy and complexity involved with the various procedures outlined in Chapter 6. The first step in any application should be to consult Section 6.3 to determine if the difference between the pure tone absorption coefficient and the band loss coefficient (Δ) is significant for the particular application of concern. If not, the equations for pure tone absorption in Section 3.2 (eq. 3.15 to 3.19) can be used with the frequency equal to the center frequency of the band under consideration. If the correction (Δ) is found to be significant, one must choose the graphical correction procedure, preparation of tables, or direct numerical integration. If only a few data points are to be corrected for atmospheric losses, the graphical procedure is preferred (figure 6.6 or 6.7 if the source spectrum shape is known, figure 6.8 or 6.9 if the received spectrum shape is known). If the data are to be corrected by hand and the conditions at which the data are taken are standard, a set of tables should be generated using one of the programs in Appendix B, modified to reflect the propagation distances encountered in the particular experiment of concern and atmospheric conditions most common. If the data is to be corrected in a computer, direct numerical integration using programs in Appendix B and the exact experimental conditions will provide the most accurate results.

Correcting data to standard conditions is a more difficult task to perform manually since two steps are required. When only one spectrum is to be corrected, the received spectrum can be corrected back to the source using the graphical technique of Section 6.4.1 and then corrected back to the receiver assuming reference conditions when computing the pure tone absorption coefficient (a) using the results of Section 6.4.2. Again, when the experimental conditions are standard, tables can be generated using the programs in Appendix B designed for this purpose. Or, if computer manipulation of the data is standard, the program can be used to correct individual data points to standard conditions.

Correcting for atmospheric conditions when the atmosphere along the source to the receiver path is not uniform presents special problems not addressed here. In addition to the fact that the pure tone absorption coefficient, a, is not constant along the path, one must also consider refraction of the sound and turbulance. When the latter two effects are small, the absorption of a pure tone along the path is a simple integral. For bands of noise, when the graphs in Section 6.3 indicate the band correction is not insignificant, the resultant integral becomes more complex and will require additional study.

7.2 Comparison with ARP-866A

A definitive comparison of ARP-866A predicted absorption values with those of this work is complicated by the different ways in which the results are presented. The absorption predicted by ARP-866A is said to be applicable to bands of noise, yet:

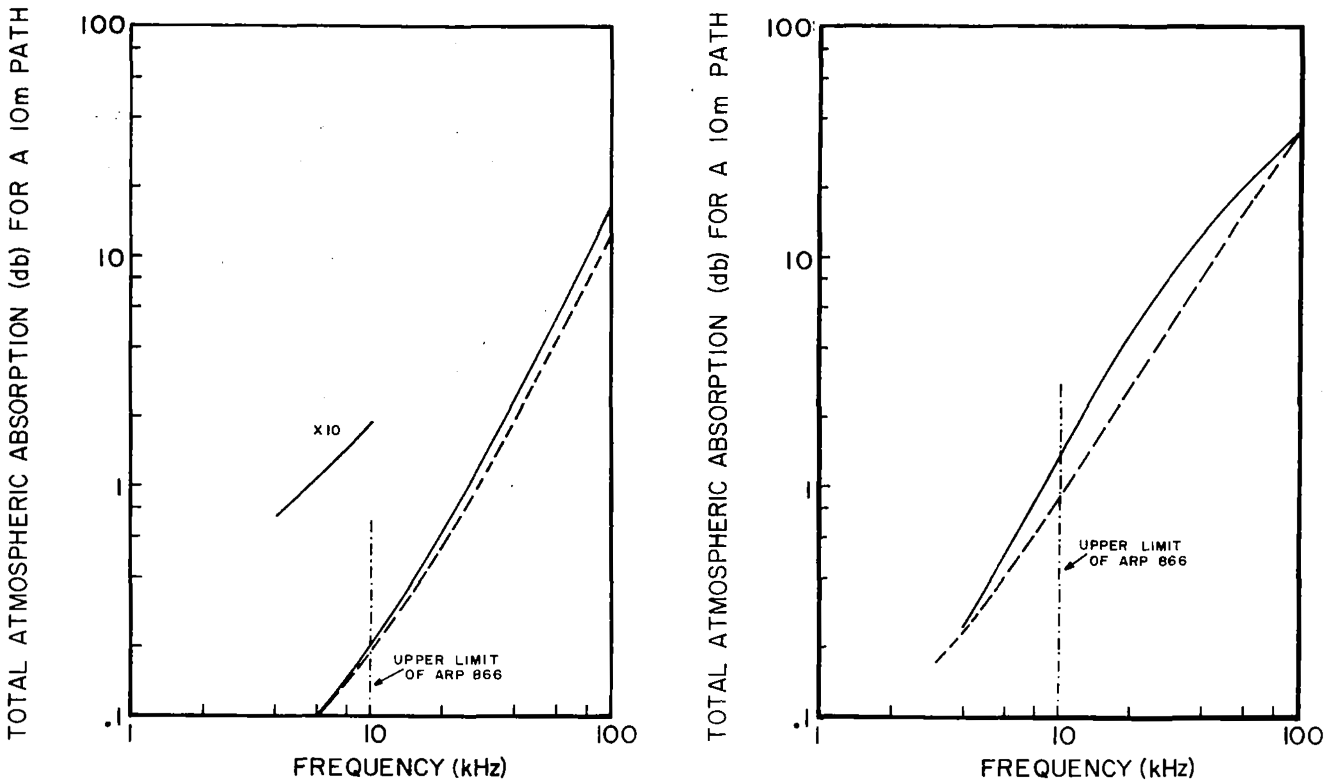
(1) the absorption along a path is found by multiplying the absorption/unit length by the total propagation distance, a procedure known to be analytically inexact

(2) the absorption is independent of the spectrum shape in contrast to the strong dependence known to exist and demonstrated for some cases

(3) the predicted absorption does not depend on filter shape (only on whether the filter is a 1/3 octave band or a full octave band filter).

In order to compare the two prediction procedures, therefore, it is necessary to choose some common point for comparison. We arbitrarily chose the propagation distance to be 10 meters, the received spectrum roll off to be 0 db/ 1/3 octave, and the filter to be an ANSI Class III One Third Octave Band Filter. In figures 6.11 and 6.12 the predictions of this study using the graphical correction procedure are compared to ARP-866A for four representative humidities and temperatures. It should be noted that the curve attributed to ARP-866A above 10 kHz is an extrapolation based on the procedure outlined in ARP-866A, but it is beyond the limits for which that document is applicable.

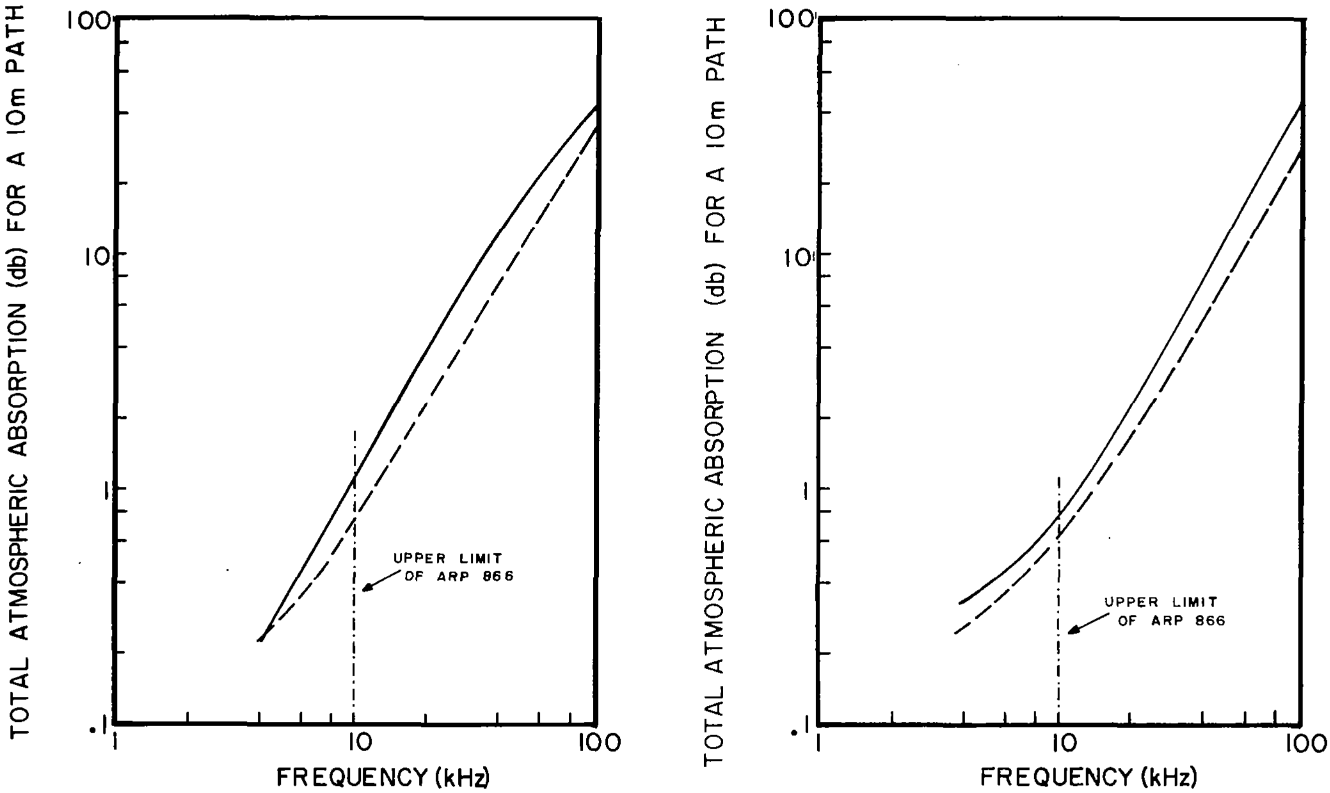
There are several features of these figures which should be noted. First, for the cases considered, the difference between ARP-866A and the procedure recommended in this report in some cases differ by a factor as high as two. This difference is generally largest at high frequencies and is aggravated by the ARP-866A process of computing band loss by using the lowest frequency in the band. However, it is apparent that this is not the only problem with the predictions of ARP-866A as can be seen in figure 6.11(b).



(a) 260.9°K (10°F), 10% RH (b) 288.7°K (60°F), 70% RH

Figure 6.11 Comparison of the Prediction Band on This Study With Those of ARP-866A Assuming a Propagation Distance of 10 Meters, and an ANSI Class III One Third Octave Band Filter. Solid line represents the predictions based on the work presented here; the dashed line is the prediction of ARP-866A. The part of the curve below x 10 has been displaced upward one decade.

A complete comparison would require consideration of different spectrum shapes, propagation distances, filter shapes, etc., but considering the rather crude computational technique employed in ARP-866A and the poor agreement with these new results, extensive comparison with ARP-866A did not seem worth while within this program. Information available from this report could be used for comparison purposes with ARP-866A outputs on the basis of pure tone attenuation.



(a) 294.3°K (70°F), 70% RH

(b) 310.9°K (100°F), 80% RH

Figure 6.12 Comparison of the Prediction Band on This Study With Those of ARP-866A Assuming a Propagation Distance of 10 Meters and an ANSI Class III One Third Octave Band Filter. Solid line represents the predictions based on the work presented here; the dashed line is the prediction of ARP-866A

8 CONCLUDING REMARKS

The experimental work reported here along with prior work at lower frequencies provide overwhelming evidence in support of the prediction technique proposed by Sutherland, Piercy, Bass, Marsh, and Evans for absorption of sound in still air, at least so far as pure tone absorption is concerned. At frequencies well above the relaxation frequency of nitrogen the proposed technique should provide reliable results at frequencies up to 1 MHz at higher and lower temperatures. Additional work on the equation for the oxygen vibrational relaxation frequency at high humidities is needed but this small modification will only slightly improve the excellent agreement between predicted and measured pure tone absorption.

Attenuation of bands of noise is more complex. However, for many cases of interest, the difference between band attenuation and the pure tone absorption coefficient at the center of the band is insignificant. Experimentally, the effect of a finite band width can be reduced by using narrow band analysis, a procedure which is now feasible using digital filters. Extrapolation of ARP-866A to frequencies above its stated limit (10 kHz) can provide only qualitative results. A more precise determination of the band loss requires a knowledge of filter characteristics, spectrum shape and propagation distances.

Based on prior work at different atmospheric conditions and lower frequencies, the physical mechanisms for sound absorption are well understood. The work presented here is the first comprehensive experimental documentation of these mechanisms in the frequency range 4 kHz to 100 kHz and the only quantitative verification of calculations of sound absorption in this frequency range. Based on the quantity and quality of the data presented here and the agreement with theoretical predictions, we conclude that the absorption of sound in the frequency range 4 kHz to 100 kHz, temperature range 255.4°K (0°F) to 310.9°K (100°F), and any value of relative humidity is sufficiently understood and documented.

APPENDIX A EXPERIMENTAL AND CALCULATED ABSORPTION

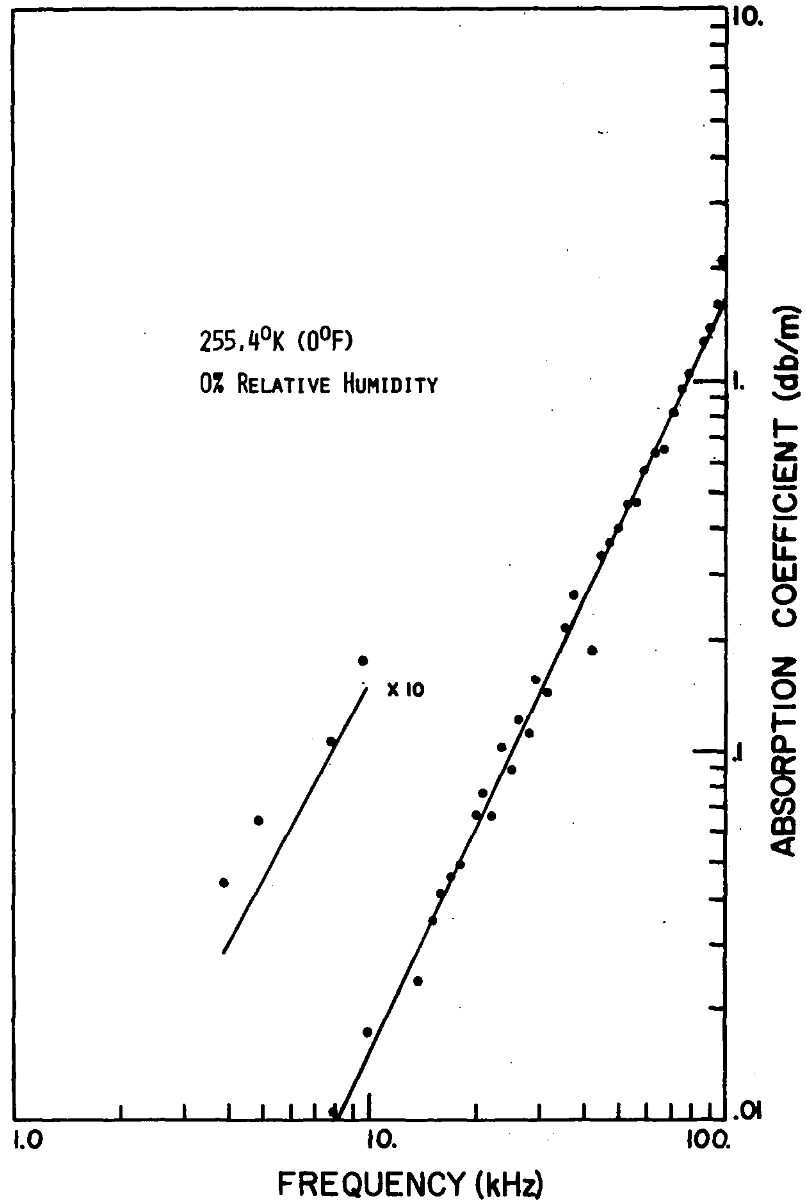
A.1 Figures and Tables for Pure Tone Absorption

The following figures present the experimental results of this study after correcting for tube losses. The experimental values of free field absorption are given by solid points on the graphs. Theoretical predictions based on the theory of Section 3.2 are given by the solid line. At low humidities, the absorption values spanned four decades. In order to get all the data on a single graph with reasonable dimensions, it was necessary to shift the points and line upward one decade at frequencies below 10 kHz. In these cases the shifted line is labeled x10 indicating the absorption values shown have been multiplied by 10.

ABSORPTION OF SOUND IN AIR

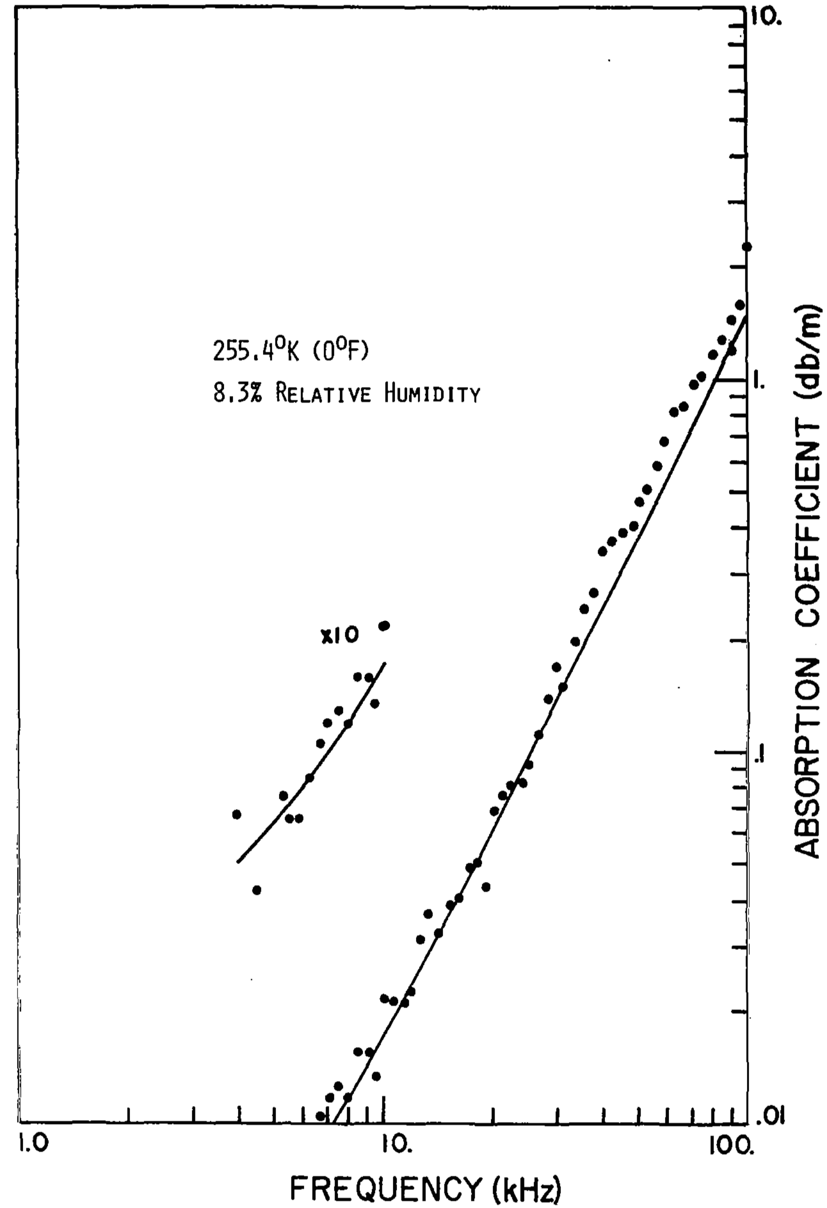
TEMPERATURE =255.4 K RELATIVE HUMIDIT. 0.0 %

FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	2.0063	1.4927
95.0	1.5240	1.3472
90.0	1.3195	1.2092
85.0	1.2187	1.0787
80.0	1.0311	0.9556
75.0	0.9558	0.8399
71.0	0.8194	0.7528
67.0	0.6449	0.6704
63.0	0.6505	0.5928
59.0	0.5811	0.5200
56.0	0.4778	0.4685
53.0	0.4662	0.4197
50.0	0.3989	0.3736
48.0	0.3633	0.3444
45.0	0.3366	0.3028
42.0	0.1872	0.2638
40.0	0.2472	0.2393
37.5	0.2647	0.2104
[illegible]	0.2117	0.1876
[illegible]	0.2157	0.1671
[illegible]	0.1447	0.1487
[illegible]	0.1531	0.1322
[illegible]	0.1122	0.1176
[illegible]	0.1223	0.1054
[illegible]	0.0888	0.0939
[illegible]	0.1037	0.0866
[illegible]	0.0679	0.0728
[illegible]	0.0782	0.0664
[illegible]	0.0577	0.0603
[illegible]	0.0575	0.0545
[illegible]	0.0498	0.0490
[illegible]	0.0463	0.0437
[illegible]	0.0417	0.0388
15.0	0.0351	0.0342
14.0	0.0243	0.0259
10.0	0.0178	0.0155
8.0	0.0108	0.0102
5.0	0.0013	0.0043
4.0	0.0045	0.0030



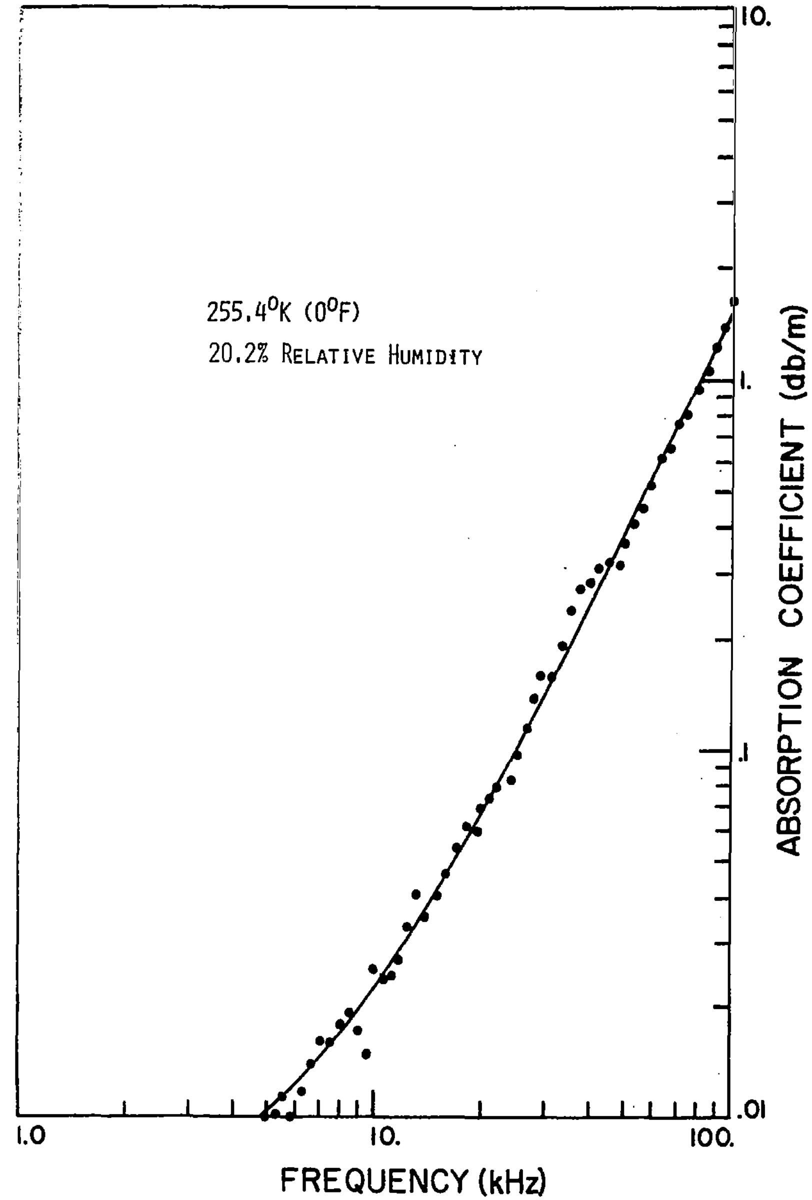
ABSORPTION OF SOUND IN AIR
TEMPERATURE =255.4 K RELATIVE HUMIDITY = 8.3 %

FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	2.2819	1.4948
95.0	1.6049	1.3493
90.0	1.4575	1.2113
85.0	1.2870	1.0807
80.0	1.1757	0.9576
75.0	1.0304	0.8420
71.0	0.9752	0.7549
67.0	0.8520	0.6725
63.0	0.8210	0.5949
59.0	0.6976	0.5221
56.0	0.5943	0.4706
53.0	0.5186	0.4218
50.0	0.4718	0.3757
48.0	0.4069	0.3465
45.0	0.3897	0.3048
42.0	0.3714	0.2659
40.0	0.3473	0.2414
37.5	0.2704	0.2125
35.4	0.2456	0.1897
33.4	0.2007	0.1691
31.5	0.1520	0.1507
29.7	0.1728	0.1343
28.0	0.1404	0.1197
26.5	0.1135	0.1075
25.0	0.0941	0.0959
24.0	0.0833	0.0886
22.0	0.0822	0.0749
21.0	0.0776	0.0685
20.0	0.0710	0.0624
19.0	0.0449	0.0565
18.0	0.0520	0.0510
17.0	0.0497	0.0459
16.0	0.0415	0.0409
15.0	0.0391	0.0363
14.0	0.0337	0.0319
13.2	0.0374	0.0287
12.5	0.0319	0.0260
11.8	0.0230	0.0235
11.2	0.0215	0.0214
10.6	0.0217	0.0195
10.0	0.0223	0.0176
9.5	0.0137	0.0162
9.0	0.0159	0.0148
8.5	0.0160	0.0135
8.0	0.0121	0.0122
7.5	0.0129	0.0111
7.1	0.0118	0.0102
6.7	0.0106	0.0094
6.3	0.0086	0.0086
5.9	0.0066	0.0079
5.6	0.0066	0.0074
5.3	0.0077	0.0069
4.5	0.0043	0.0057
4.0	0.0068	0.0051



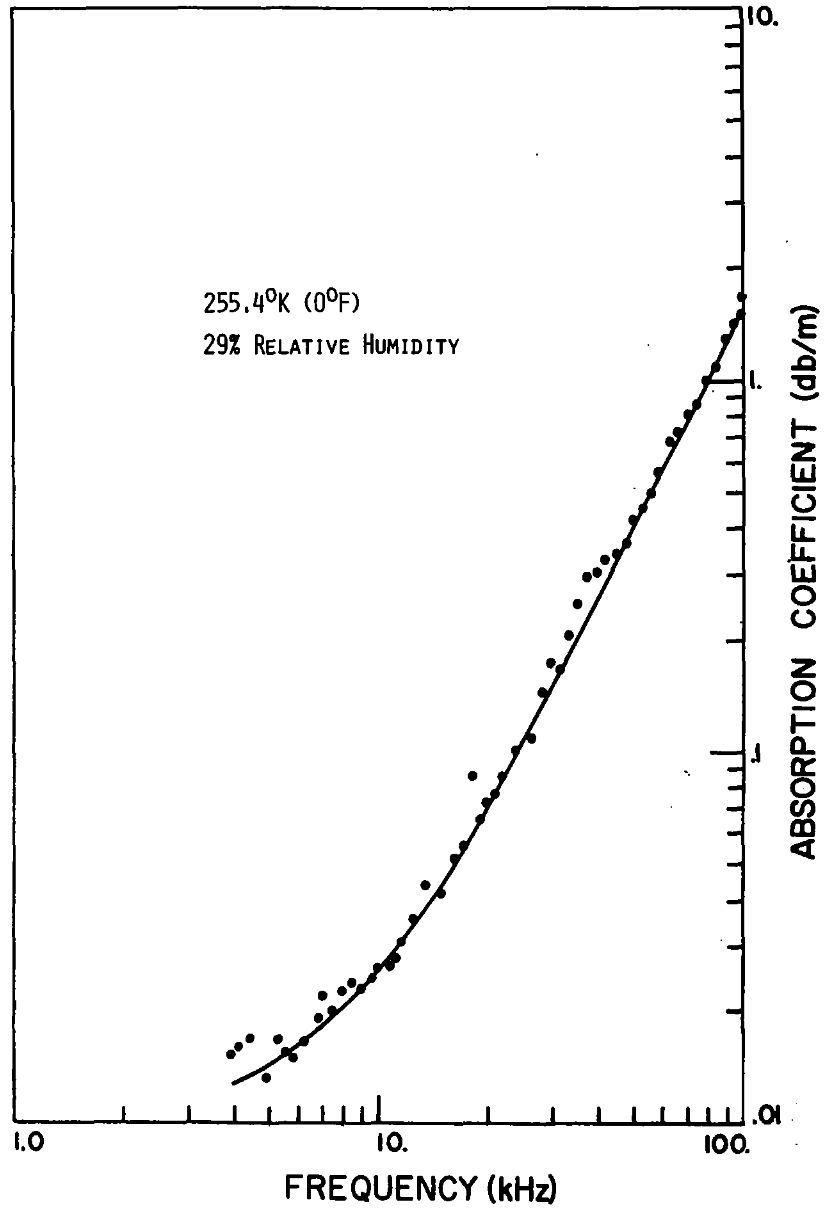
ABSORPTION OF SOUND IN AIR
TEMPERATURE =255.4 K   RELATIVE HUMIDITY = 20.2 %

FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	1.6150	1.4989
95.0	1.3744	1.3535
90.0	1.2329	1.2154
85.0	1.0529	1.0849
80.0	0.9385	0.9618
75.0	0.8161	0.8461
71.0	0.7717	0.7590
67.0	0.6600	0.6766
63.0	0.6233	0.5990
59.0	0.5237	0.5262
56.0	0.4493	0.4748
53.0	0.4121	0.4260
50.0	0.3647	0.3799
48.0	0.3156	0.3506
45.0	0.3211	0.3090
42.0	0.3121	0.2700
40.0	0.2841	0.2456
37.5	0.2762	0.2167
35.4	0.2418	0.1938
33.4	0.1937	0.1733
31.5	0.1587	0.1549
29.7	0.1592	0.1364
28.0	0.1371	0.1238
26.5	0.1147	0.1116
25.0	0.0980	0.1001
24.0	0.0836	0.0928
22.0	0.0792	0.0790
21.0	0.0750	0.0726
20.0	0.0710	0.0665
19.0	0.0605	0.0607
18.0	0.0623	0.0552
17.0	0.0540	0.0500
16.0	0.0467	0.0450
15.0	0.0407	0.0404
14.0	0.0353	0.0361
13.2	0.0412	0.0328
12.5	0.0334	0.0301
11.8	0.0271	0.0275
11.2	0.0248	0.0255
10.6	0.0242	0.0235
10.0	0.0256	0.0217
9.5	0.0152	0.0203
9.0	0.0178	0.0189
8.5	0.0195	0.0176
8.0	0.0182	0.0163
7.5	0.0162	0.0152
7.1	0.0164	0.0143
6.7	0.0143	0.0135
6.3	0.0119	0.0127
5.9	0.0102	0.0120
5.6	0.0113	0.0115
5.3	0.0104	0.0110
5.0	0.0101	0.0105
4.8	0.0148	0.0102
4.5	0.0064	0.0098
4.2	0.0073	0.0094
4.0	0.0092	0.0092



ABSORPTION OF SOUND IN AIR
TEMPERATURE =255.4 K   RELATIVE HUMIDITY = 29.0 %

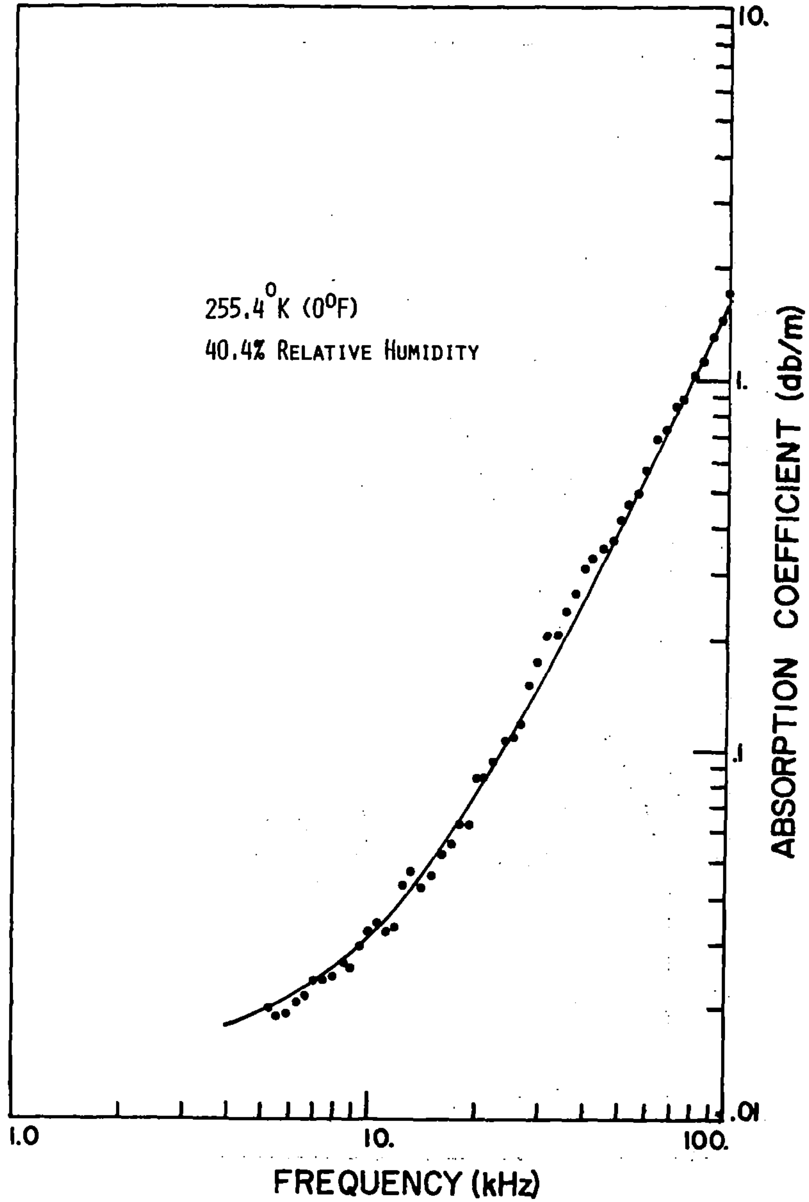
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	1.6636	1.5028
95.0	1.4162	1.3573
90.0	1.2792	1.2193
85.0	1.0975	1.0887
80.0	0.9931	0.9656
75.0	0.8623	0.8500
71.0	0.8120	0.7629
67.0	0.7238	0.6805
63.0	0.6785	0.6029
59.0	0.5618	0.5301
56.0	0.4860	0.4786
53.0	0.4503	0.4298
50.0	0.4202	0.3837
48.0	0.3642	0.3545
45.0	0.3434	0.3128
42.0	0.3290	0.2739
40.0	0.3031	0.2494
37.5	0.2968	0.2205
35.4	0.2482	0.1977
33.4	0.2029	0.1771
31.5	0.1645	0.1587
29.7	0.1743	0.1423
28.0	0.1460	0.1277
26.5	0.1096	0.1155
25.0	0.1042	0.1039
24.0	0.1016	0.0966
22.0	0.0850	0.0829
21.0	0.0760	0.0765
20.0	0.0730	0.0704
19.0	0.0658	0.0645
18.0	0.0851	0.0590
17.0	0.0550	0.0538
16.0	0.0506	0.0489
15.0	0.0416	0.0443
14.0	0.0420	0.0399
13.2	0.0444	0.0367
12.5	0.0356	0.0340
11.8	0.0309	0.0314
11.2	0.0284	0.0294
10.6	0.0272	0.0274
10.0	0.0274	0.0256
9.5	0.0226	0.0241
9.0	0.0231	0.0227
8.5	0.0242	0.0214
8.0	0.0230	0.0202
7.5	0.0202	0.0190
7.1	0.0223	0.0182
6.7	0.0191	0.0173
6.3	0.0166	0.0166
5.9	0.0151	0.0158
5.6	0.0156	0.0153
5.3	0.0169	0.0148
5.0	0.0131	0.0143
4.5	0.0168	0.0136
4.2	0.0166	0.0132
4.0	0.0151	0.0130



ABSORPTION OF SOUND IN AIR

TEMPERATURE =255.4 K   RELATIVE HUMIDITY = 40.4 %

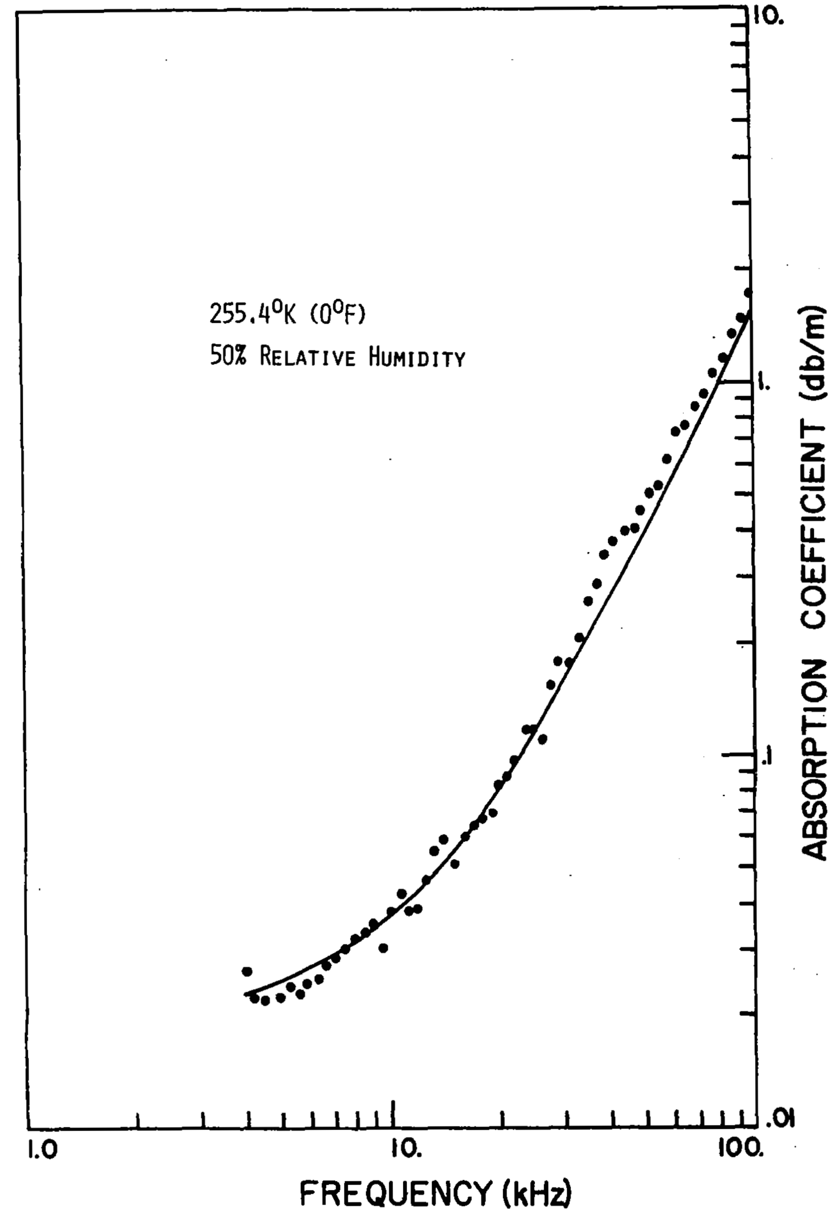
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	1.6936	1.5087
95.0	1.4511	1.3632
90.0	1.3109	1.2252
85.0	1.1332	1.0946
80.0	1.0304	0.9715
75.0	0.8978	0.8559
71.0	0.8445	0.7687
67.0	0.7378	0.6864
63.0	0.6931	0.6088
59.0	0.5747	0.5360
56.0	0.4969	0.4845
53.0	0.4634	0.4357
50.0	0.4240	0.3896
48.0	0.3716	0.3604
45.0	0.3493	0.3187
42.0	0.3346	0.2798
40.0	0.3131	0.2553
37.5	0.2727	0.2264
35.4	0.2411	0.2036
33.4	0.2053	0.1830
31.5	0.1565	0.1646
29.7	0.1750	0.1482
28.0	0.1505	0.1336
26.5	0.1199	0.1214
25.0	0.1091	0.1098
24.0	0.1076	0.1025
22.0	0.0957	0.0888
21.0	0.0859	0.0824
20.0	0.0849	0.0762
19.0	0.0637	0.0704
18.0	0.0643	0.0649
17.0	0.0564	0.0597
16.0	0.0525	0.0547
15.0	0.0464	0.0501
14.0	0.0434	0.0458
13.2	0.0474	0.0425
12.5	0.0436	0.0398
11.8	0.0332	0.0373
11.2	0.0330	0.0352
10.6	0.0347	0.0333
10.0	0.0326	0.0314
9.5	0.0299	0.0300
9.0	0.0260	0.0286
8.5	0.0268	0.0273
8.0	0.0245	0.0260
7.5	0.0240	0.0248
7.1	0.0242	0.0240
6.7	0.0218	0.0231
6.3	0.0210	0.0223
5.9	0.0194	0.0216
5.6	0.0194	0.0210
5.3	0.0204	0.0205



ABSORPTION OF SOUND IN AIR

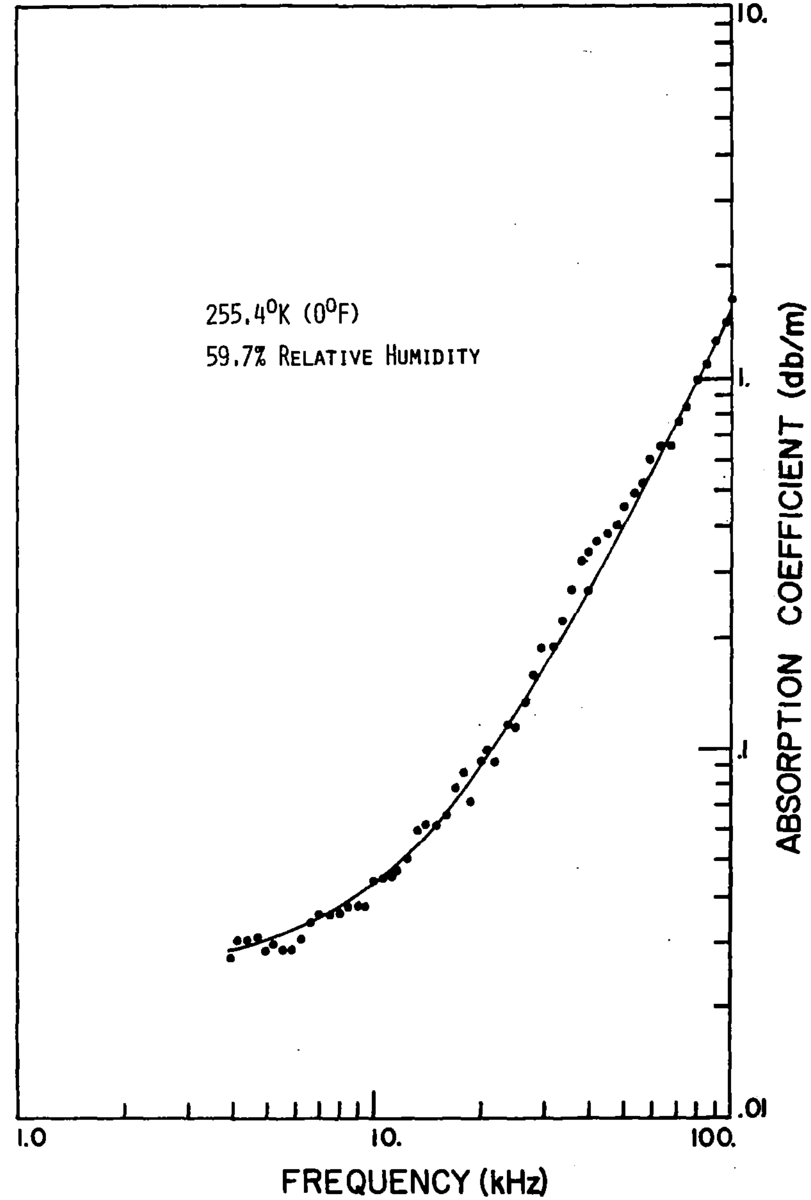
TEMPERATURE =255.4 K   RELATIVE HUMIDITY = 50.0 %

FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	1.7154	1.5144
95.0	1.4702	1.3689
90.0	1.3219	1.2308
85.0	1.1455	1.1003
80.0	1.0471	0.9772
75.0	0.9145	0.8616
71.0	0.8596	0.7744
67.0	0.7529	0.6921
63.0	0.7250	0.6145
59.0	0.6113	0.5416
56.0	0.5276	0.4902
53.0	0.4982	0.4414
50.0	0.4548	0.3953
48.0	0.4005	0.3660
45.0	0.3905	0.3244
42.0	0.3717	0.2854
40.0	0.3471	0.2610
37.5	0.2880	0.2321
35.4	0.2547	0.2092
33.4	0.2052	0.1887
31.5	0.1772	0.1703
29.7	0.1783	0.1538
28.0	0.1537	0.1392
26.5	0.1202	0.1270
25.0	0.1162	0.1155
24.0	0.1167	0.1082
22.0	0.0977	0.0944
21.0	0.0886	0.0880
20.0	0.0825	0.0819
19.0	0.0693	0.0761
18.0	0.0675	0.0705
17.0	0.0652	0.0653
16.0	0.0605	0.0604
15.0	0.0515	0.0557
14.0	0.0598	0.0514
13.2	0.0557	0.0481
12.5	0.0467	0.0454
11.8	0.0389	0.0429
11.2	0.0383	0.0408
10.6	0.0426	0.0389
10.0	0.0382	0.0370
9.5	0.0306	0.0355
9.0	0.0354	0.0341
8.5	0.0334	0.0328
8.0	0.0322	0.0315
7.5	0.0300	0.0303
7.1	0.0284	0.0294
6.7	0.0275	0.0285
6.3	0.0250	0.0277
5.9	0.0245	0.0269
5.6	0.0232	0.0264
5.3	0.0244	0.0258
5.0	0.0229	0.0253
4.5	0.0223	0.0244
4.2	0.0223	0.0239
4.0	0.0263	0.0236



ABSORPTION OF SOUND IN AIR
TEMPERATURE =255.4 K RELATIVE HUMIDITY = 59.7 %

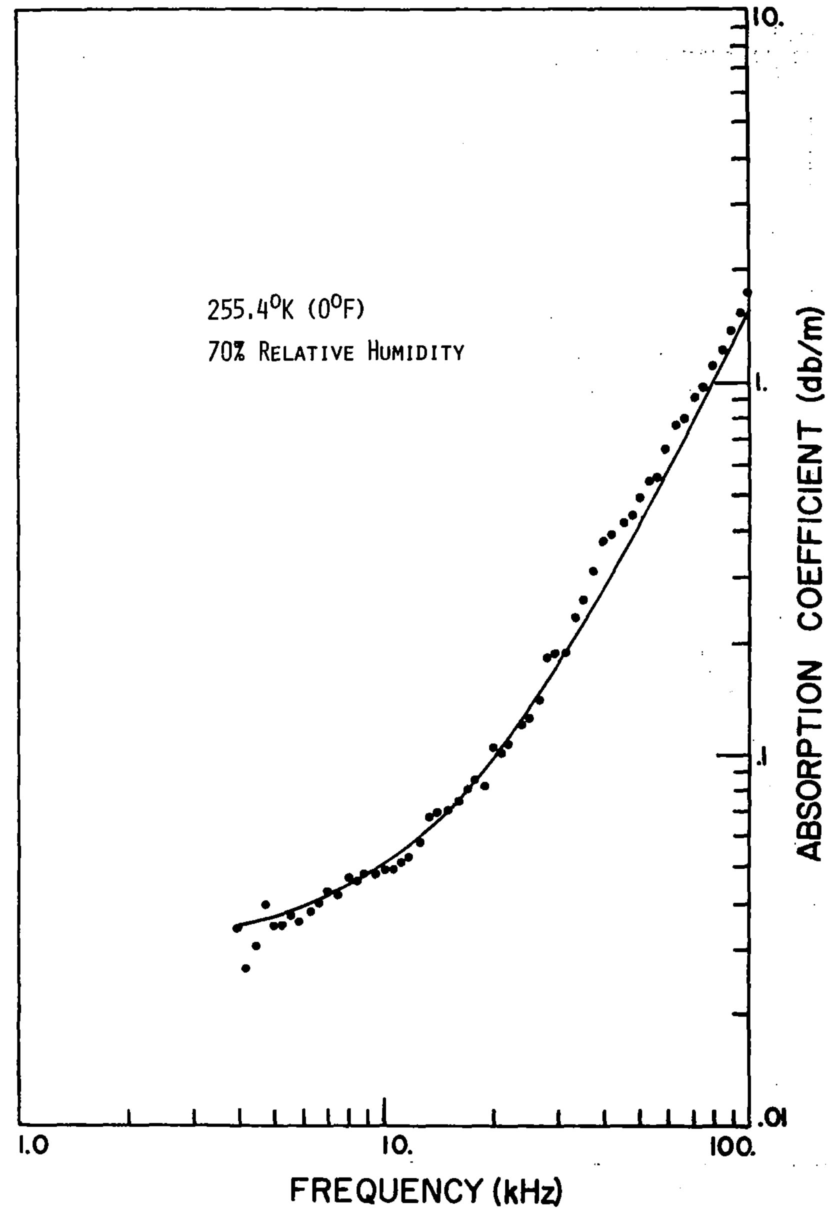
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	1.6364	1.5207
95.0	1.3911	1.3752
90.0	1.2613	1.2372
85.0	1.0854	1.1066
80.0	0.9857	0.9835
75.0	0.8299	0.8679
71.0	0.7704	0.7807
67.0	0.6632	0.6984
63.0	0.6631	0.6208
59.0	0.6048	0.5480
56.0	0.5222	0.4965
53.0	0.4915	0.4477
50.0	0.4544	0.4016
48.0	0.4003	0.3723
45.0	0.3833	0.3307
42.0	0.3650	0.2918
40.0	0.3431	0.2673
37.5	0.3188	0.2384
35.4	0.2652	0.2155
33.4	0.2193	0.1950
31.5	0.1874	0.1766
29.7	0.1882	0.1602
28.0	0.1560	0.1455
26.5	0.1324	0.1333
25.0	0.1151	0.1218
24.0	0.1161	0.1145
22.0	0.0923	0.1007
21.0	0.0984	0.0943
20.0	0.0929	0.0882
19.0	0.0719	0.0823
18.0	0.0871	0.0768
17.0	0.0789	0.0716
16.0	0.0663	0.0666
15.0	0.0617	0.0620
14.0	0.0624	0.0576
13.2	0.0599	0.0544
12.5	0.0504	0.0516
11.8	0.0469	0.0491
11.2	0.0450	0.0470
10.6	0.0449	0.0450
10.0	0.0444	0.0431
9.5	0.0377	0.0416
9.0	0.0379	0.0402
8.5	0.0383	0.0388
8.0	0.0357	0.0375
7.5	0.0359	0.0363
7.1	0.0363	0.0354
6.7	0.0336	0.0344
6.3	0.0311	0.0336
5.9	0.0289	0.0327
5.6	0.0289	0.0321
5.3	0.0299	0.0314
5.0	0.0281	0.0308
4.8	0.0315	0.0304
4.5	0.0307	0.0298
4.2	0.0306	0.0292
4.0	0.0280	0.0287



ABSORPTION OF SOUND IN AIR

TEMPERATURE =255.4 K RELATIVE HUMIDITY = 70.0 %

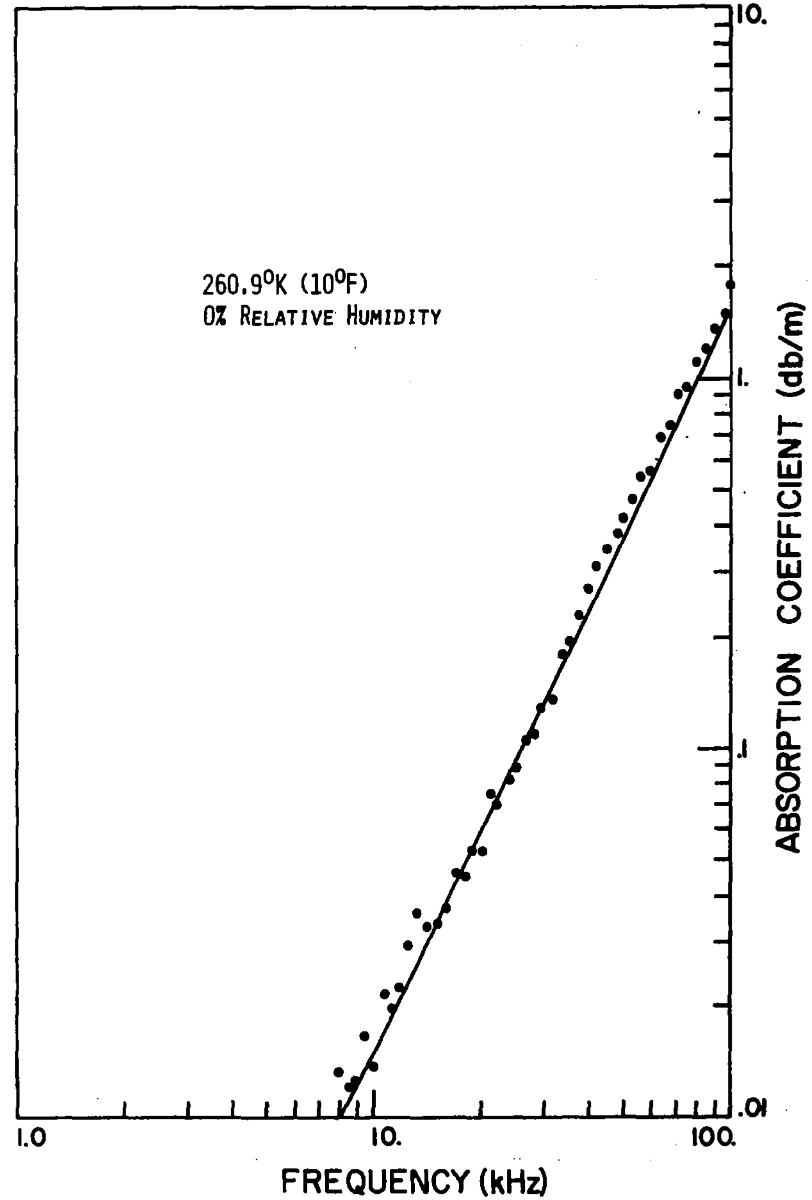
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	1.7765	1.5280
95.0	1.5405	1.3825
90.0	1.3911	1.2445
85.0	1.2182	1.1139
80.0	1.1033	0.9908
75.0	0.9633	0.8752
71.0	0.9132	0.7880
67.0	0.8007	0.7057
63.0	0.7734	0.6281
59.0	0.6556	0.5553
56.0	0.5624	0.5038
53.0	0.5410	0.4550
50.0	0.4919	0.4089
48.0	0.4432	0.3796
45.0	0.4229	0.3380
42.0	0.3889	0.2991
40.0	0.3751	0.2746
37.5	0.3144	0.2457
35.4	0.2634	0.2228
33.4	0.2363	0.2023
31.5	0.1887	0.1839
29.7	0.1888	0.1674
28.0	0.1813	0.1528
26.5	0.1399	0.1406
25.0	0.1268	0.1290
24.0	0.1205	0.1217
22.0	0.1089	0.1080
21.0	0.1006	0.1015
20.0	0.1039	0.0954
19.0	0.0825	0.0895
18.0	0.0860	0.0840
17.0	0.0811	0.0788
16.0	0.0753	0.0738
15.0	0.0709	0.0691
14.0	0.0699	0.0647
13.2	0.0677	0.0615
12.5	0.0588	0.0587
11.8	0.0533	0.0561
11.2	0.0518	0.0540
10.6	0.0496	0.0520
10.0	0.0489	0.0501
9.5	0.0478	0.0485
9.0	0.0483	0.0471
8.5	0.0459	0.0456
8.0	0.0467	0.0443
7.5	0.0416	0.0430
7.1	0.0429	0.0419
6.7	0.0405	0.0410
6.3	0.0380	0.0400
5.9	0.0364	0.0390
5.6	0.0372	0.0383
5.3	0.0348	0.0375
5.0	0.0349	0.0368
4.8	0.0398	0.0363
4.5	0.0308	0.0355
4.2	0.0270	0.0346
4.0	0.0342	0.0340



ABSORPTION OF SOUND IN AIR

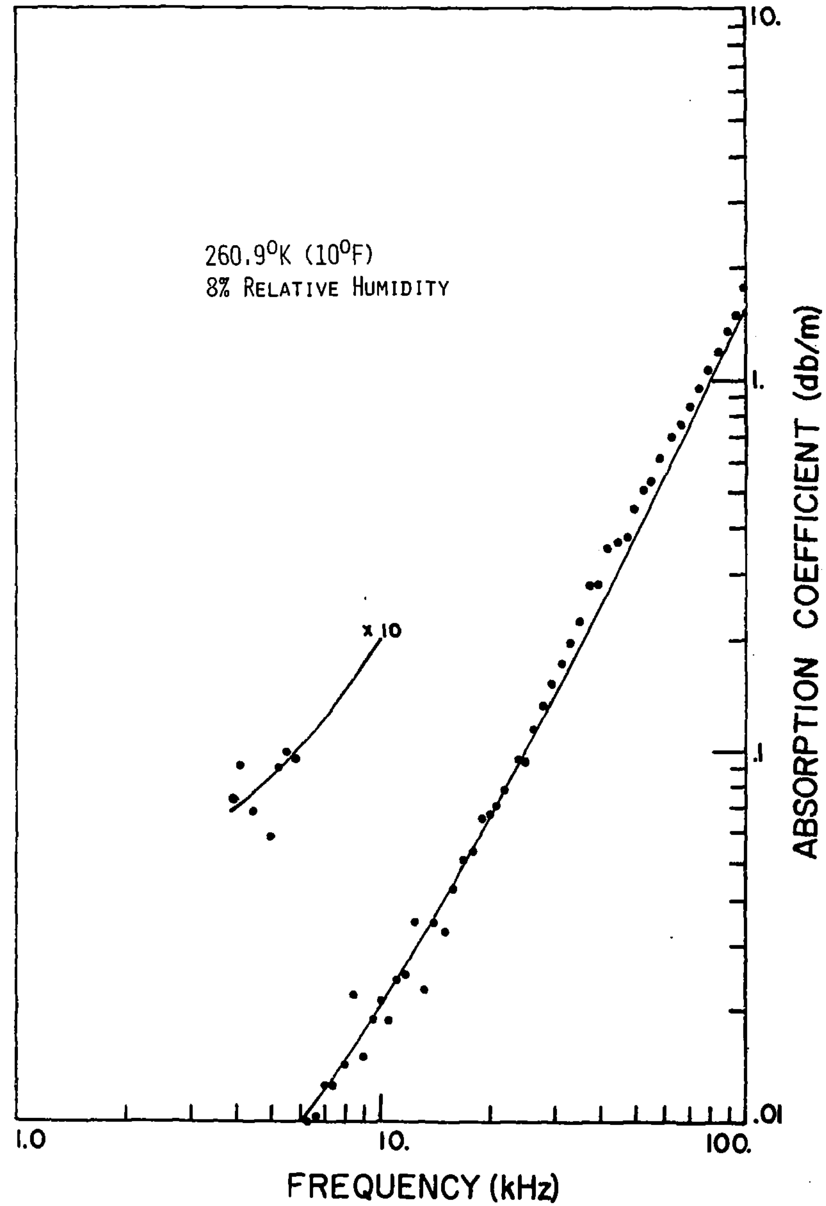
TEMPERATURE =260.9 K   RELATIVE HUMIDITY = 0.0 %

FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	1.7581	1.5089
95.0	1.4832	1.3619
90.0	1.3645	1.2224
85.0	1.1946	1.0904
80.0	1.0959	0.9660
75.0	0.9413	0.8491
71.0	0.9034	0.7610
67.0	0.7431	0.6778
63.0	0.6955	0.5993
59.0	0.5608	0.5257
56.0	0.5420	0.4737
53.0	0.4705	0.4244
50.0	0.4162	0.3778
48.0	0.3836	0.3482
45.0	0.3425	0.3061
42.0	0.3118	0.2668
40.0	0.2712	0.2420
37.5	0.2271	0.2128
35.4	0.1965	0.1897
33.4	0.1799	0.1690
31.5	0.1378	0.1504
29.7	0.1320	0.1337
28.0	0.1107	0.1189
26.5	0.1083	0.1066
25.0	0.0887	0.0950
24.0	0.0822	0.0876
22.0	0.0708	0.0737
21.0	0.0755	0.0672
20.0	0.0534	0.0610
19.0	0.0540	0.0551
18.0	0.0455	0.0496
17.0	0.0466	0.0443
16.0	0.0376	0.0393
15.0	0.0343	0.0346
14.0	0.0332	0.0303
13.2	0.0362	0.0270
12.5	0.0195	0.0243
11.8	0.0229	0.0217
11.2	0.0202	0.0196
10.6	0.0221	0.0176
10.0	0.0139	0.0158
9.5	0.0167	0.0143
9.0	0.0126	0.0129
8.5	0.0123	0.0116
8.0	0.0136	0.0104



ABSORPTION OF SOUND IN AIR
TEMPERATURE =260.9 K   RELATIVE HUMIDITY = 8.0 %

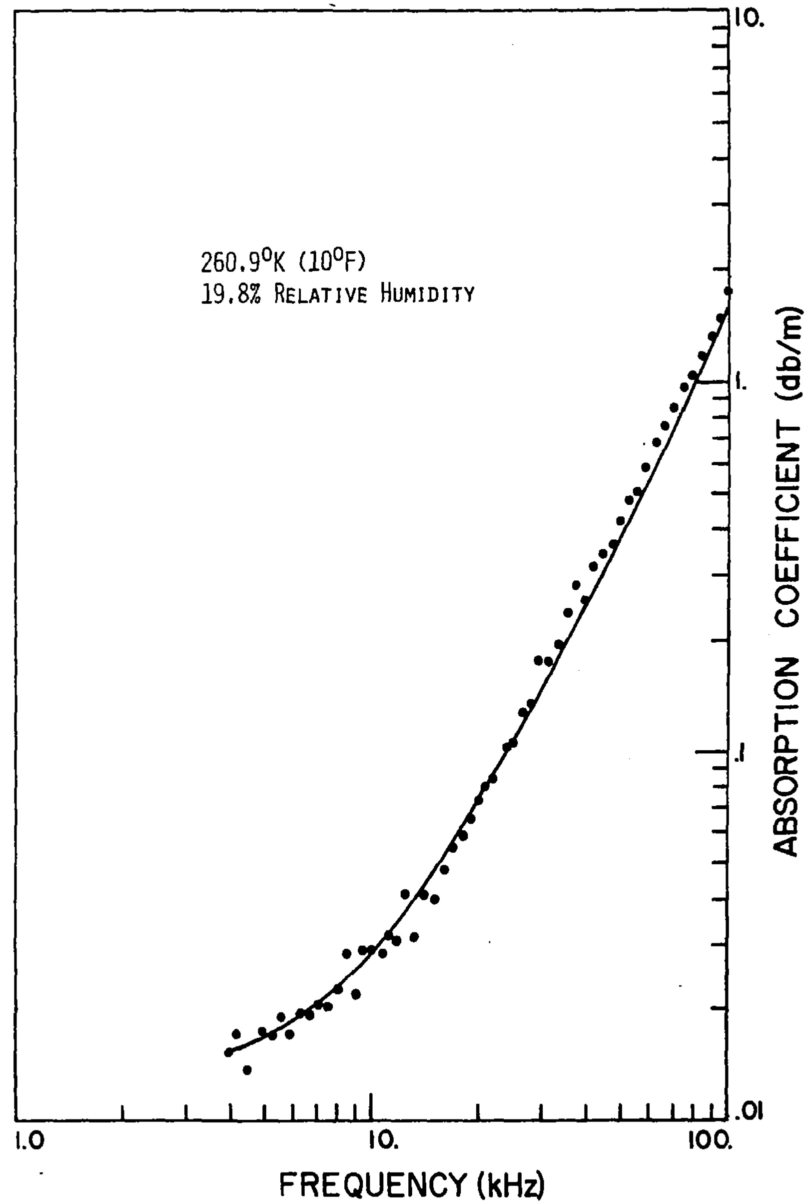
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	1.7736	1.5129
95.0	1.5109	1.3659
90.0	1.3514	1.2263
85.0	1.1885	1.0943
80.0	1.0579	0.9699
75.0	0.9481	0.8530
71.0	0.8513	0.7649
67.0	0.7577	0.6817
63.0	0.7026	0.6033
59.0	0.6213	0.5297
56.0	0.5380	0.4776
53.0	0.5116	0.4283
50.0	0.4479	0.3817
48.0	0.3841	0.3521
45.0	0.3653	0.3101
42.0	0.3505	0.2707
40.0	0.2800	0.2460
37.5	0.2799	0.2167
35.4	0.2248	0.1936
33.4	0.1982	0.1729
31.5	0.1724	0.1543
29.7	0.1621	0.1377
28.0	0.1323	0.1229
26.5	0.1163	0.1105
25.0	0.0937	0.0989
24.0	0.0950	0.0915
22.0	0.0788	0.0776
21.0	0.0715	0.0711
20.0	0.0680	0.0650
19.0	0.0660	0.0591
18.0	0.0544	0.0535
17.0	0.0511	0.0482
16.0	0.0432	0.0432
15.0	0.0333	0.0386
14.0	0.0349	0.0342
13.2	0.0233	0.0309
12.5	0.0352	0.0282
11.8	0.0253	0.0256
11.2	0.0246	0.0236
10.6	0.0191	0.0216
10.0	0.0216	0.0197
9.5	0.0195	0.0182
9.0	0.0152	0.0168
8.5	0.0223	0.0155
8.0	0.0146	0.0143
7.5	0.0128	0.0131
7.1	0.0129	0.0122
6.7	0.0106	0.0114
6.3	0.0101	0.0106
5.9	0.0095	0.0099
5.6	0.0100	0.0094
5.3	0.0091	0.0089
5.0	0.0060	0.0084
4.5	0.0069	0.0077
4.2	0.0092	0.0073
4.0	0.0065	0.0070



ABSORPTION OF SOUND IN AIR

TEMPERATURE =260.9 K   RELATIVE HUMIDITY = 19.8 %

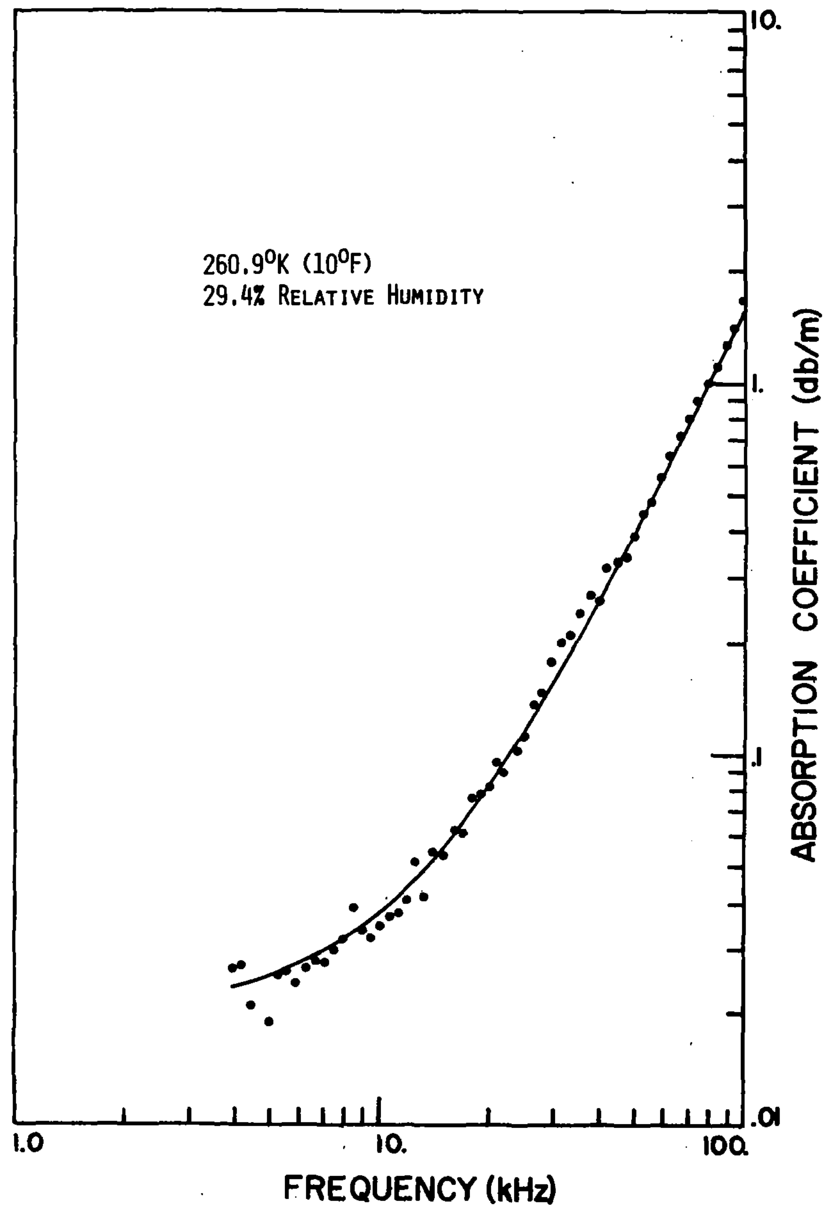
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	1.7394	1.5217
95.0	1.4887	1.3747
90.0	1.3352	1.2352
85.0	1.1758	1.1032
80.0	1.0385	0.9788
75.0	0.9686	0.8619
71.0	0.8559	0.7738
67.0	0.7628	0.6905
63.0	0.6831	0.6121
59.0	0.5888	0.5385
56.0	0.5049	0.4865
53.0	0.4775	0.4372
50.0	0.4183	0.3906
48.0	0.3606	0.3610
45.0	0.3424	0.3189
42.0	0.3165	0.2795
40.0	0.2577	0.2548
37.5	0.2821	0.2256
35.4	0.2387	0.2025
33.4	0.1995	0.1817
31.5	0.1750	0.1631
29.7	0.1750	0.1465
28.0	0.1368	0.1317
26.5	0.1272	0.1194
25.0	0.1055	0.1078
24.0	0.1042	0.1004
22.0	0.0851	0.0865
21.0	0.0813	0.0800
20.0	0.0746	0.0738
19.0	0.0667	0.0679
18.0	0.0598	0.0623
17.0	0.0555	0.0571
16.0	0.0489	0.0521
15.0	0.0401	0.0474
14.0	0.0414	0.0430
13.2	0.0316	0.0399
12.5	0.0412	0.0370
11.8	0.0314	0.0345
11.2	0.0321	0.0324
10.6	0.0286	0.0304
10.0	0.0297	0.0285
9.5	0.0293	0.0271
9.0	0.0224	0.0257
8.5	0.0286	0.0243
8.0	0.0232	0.0231
7.5	0.0209	0.0219
7.1	0.0211	0.0210
6.7	0.0196	0.0202
6.3	0.0199	0.0194
5.9	0.0173	0.0186
5.6	0.0193	0.0181
5.3	0.0173	0.0176
5.0	0.0177	0.0171
4.5	0.0140	0.0164
4.2	0.0173	0.0160
4.0	0.0154	0.0157



ABSORPTION OF SOUND IN AIR

TEMPERATURE =260.9 K   RELATIVE HUMIDITY = 29.4 %

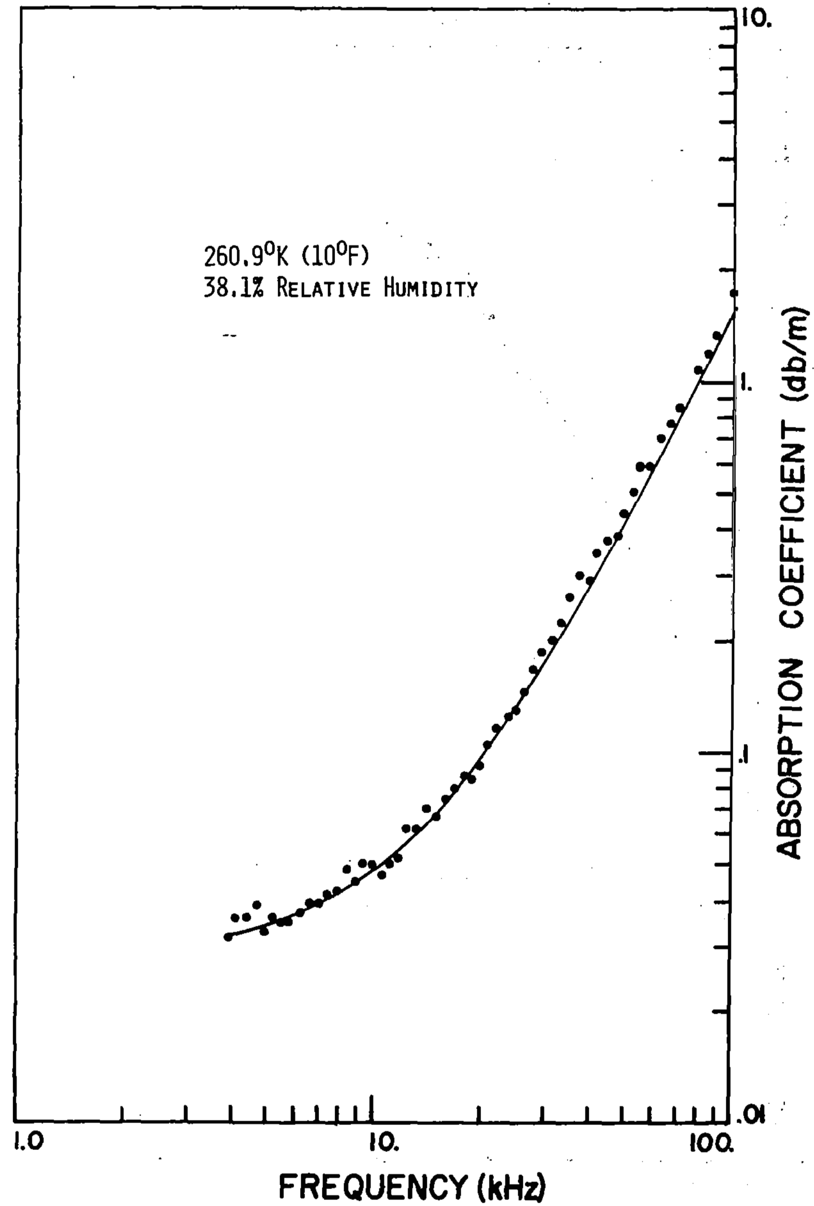
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	1.6669	1.5312
95.0	1.4115	1.3842
90.0	1.2683	1.2447
85.0	1.1048	1.1127
80.0	0.9943	0.9883
75.0	0.8855	0.8714
71.0	0.8030	0.7833
67.0	0.7152	0.7000
63.0	0.6420	0.6216
59.0	0.5569	0.5480
56.0	0.4795	0.4960
53.0	0.4488	0.4466
50.0	0.3925	0.4000
48.0	0.3424	0.3705
45.0	0.3310	0.3284
42.0	0.3185	0.2890
40.0	0.2620	0.2643
37.5	0.2724	0.2351
35.4	0.2440	0.2120
33.4	0.2147	0.1912
31.5	0.2025	0.1726
29.7	0.1762	0.1560
28.0	0.1476	0.1412
26.5	0.1368	0.1289
25.0	0.1120	0.1172
24.0	0.1044	0.1098
22.0	0.0895	0.0959
21.0	0.0964	0.0895
20.0	0.0834	0.0833
19.0	0.0791	0.0774
18.0	0.0770	0.0718
17.0	0.0617	0.0665
16.0	0.0627	0.0615
15.0	0.0537	0.0568
14.0	0.0555	0.0525
13.2	0.0417	0.0492
12.5	0.0521	0.0464
11.8	0.0409	0.0439
11.2	0.0380	0.0418
10.6	0.0374	0.0398
10.0	0.0349	0.0379
9.5	0.0325	0.0364
9.0	0.0344	0.0350
8.5	0.0389	0.0337
8.0	0.0316	0.0324
7.5	0.0297	0.0312
7.1	0.0278	0.0303
6.7	0.0281	0.0294
6.3	0.0267	0.0286
5.9	0.0244	0.0278
5.6	0.0261	0.0272
5.3	0.0256	0.0267
5.0	0.0191	0.0261
4.5	0.0213	0.0253
4.2	0.0273	0.0248
4.0	0.0267	0.0245



ABSORPTION OF SOUND IN AIR

TEMPERATURE =260.9 K   RELATIVE HUMIDITY = 38.1 %

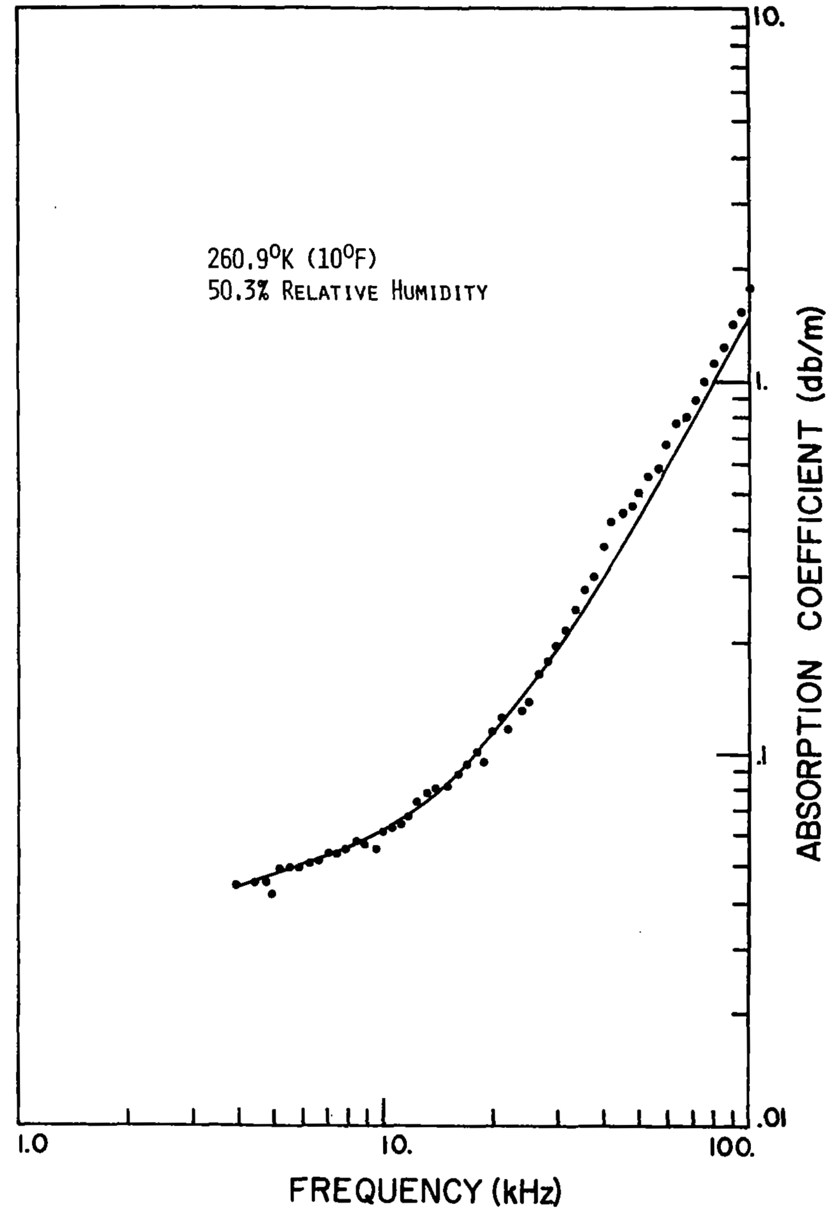
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	1.7084	1.5412
90.0	1.3328	1.2546
85.0	1.1777	1.1228
80.0	1.0734	0.9984
71.0	0.8517	0.7934
67.0	0.7685	0.7101
63.0	0.7011	0.6317
59.0	0.5906	0.5581
56.0	0.5936	0.5061
53.0	0.4976	0.4567
50.0	0.4446	0.4101
48.0	0.3834	0.3806
45.0	0.3675	0.3385
42.0	0.3450	0.2991
40.0	0.2907	0.2744
37.5	0.3020	0.2451
35.4	0.2597	0.2221
33.4	0.2226	0.2013
31.5	0.1988	0.1827
29.7	0.1857	0.1661
28.0	0.1676	0.1513
26.5	0.1452	0.1389
25.0	0.1297	0.1273
24.0	0.1241	0.1195
22.0	0.1164	0.1060
21.0	0.1053	0.0995
20.0	0.0922	0.0933
19.0	0.0850	0.0874
18.0	0.0858	0.0818
17.0	0.0799	0.0765
16.0	0.0746	0.0715
15.0	0.0674	0.0668
14.0	0.0710	0.0624
13.2	0.0622	0.0591
12.5	0.0620	0.0564
11.8	0.0521	0.0538
11.2	0.0504	0.0516
10.6	0.0475	0.0496
10.0	0.0501	0.0477
9.5	0.0504	0.0462
9.0	0.0453	0.0447
8.5	0.0480	0.0434
8.0	0.0419	0.0420
7.5	0.0412	0.0409
7.1	0.0388	0.0398
6.7	0.0389	0.03[illegible]
6.3	0.0369	0.0379
5.9	0.0351	0.0370
5.6	0.0339	0.0364
5.3	0.0356	0.0357
5.0	0.0328	0.0351
4.8	0.0393	0.0347
4.5	0.0357	0.0340
4.2	0.0356	0.0333
4.0	0.0323	0.0328



ABSORPTION OF SOUND IN AIR

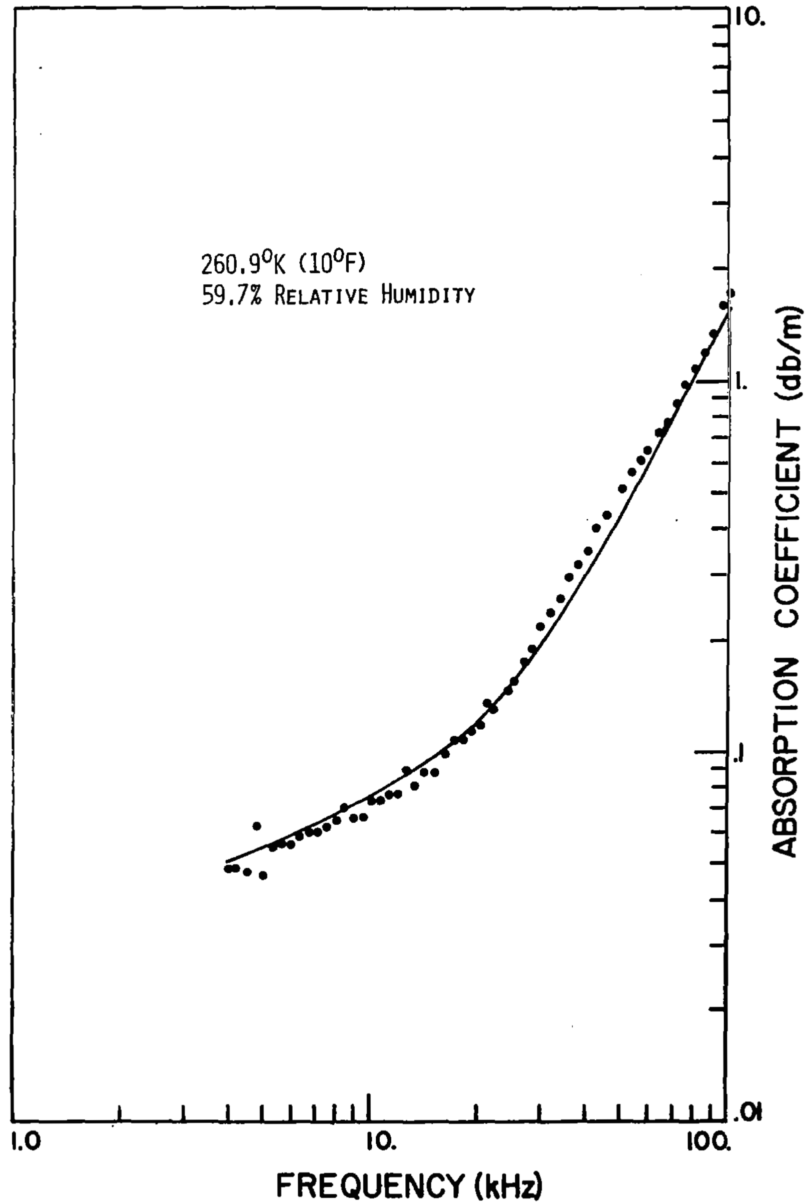
TEMPERATURE =260.9 K   RELATIVE HUMIDITY = 50.3 %

FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	1.7834	1.5576
95.0	1.5448	1.4105
90.0	1.4060	1.2710
85.0	1.2376	1.1390
80.0	1.1211	1.0146
75.0	0.9957	0.8977
71.0	0.8858	0.8096
67.0	0.8018	0.7263
63.0	0.7631	0.6479
59.0	0.6703	0.5743
56.0	0.5886	0.5223
53.0	0.5500	0.4729
50.0	0.5046	0.4263
48.0	0.4623	0.3968
45.0	0.4399	0.3547
42.0	0.4196	0.3153
40.0	0.3551	0.2906
37.5	0.2978	0.2613
35.4	0.2716	0.2382
33.4	0.2410	0.2174
31.5	0.2132	0.1989
29.7	0.1949	0.1822
28.0	0.1786	0.1674
26.5	0.1634	0.1550
25.0	0.1396	0.1434
24.0	0.1306	0.1359
22.0	0.1160	0.1220
21.0	0.1248	0.1155
20.0	0.1144	0.1093
19.0	0.0941	0.1034
18.0	0.0992	0.0977
17.0	0.0924	0.0924
16.0	0.0877	0.0873
15.0	0.0806	0.0826
14.0	0.0798	0.0781
13.2	0.0782	0.0747
12.5	0.0746	0.0719
11.8	0.0679	0.0693
11.2	0.0640	0.0671
10.6	0.0629	0.0649
10.0	0.0601	0.0629
9.5	0.0556	0.0613
9.0	0.0567	0.0597
8.5	0.0587	0.0582
8.0	0.0557	0.0567
7.5	0.0531	0.0552
7.1	0.0545	0.0541
6.7	0.0515	0.0529
6.3	0.0502	0.0517
5.9	0.0484	0.0505
5.6	0.0498	0.0496
5.3	0.0481	0.0486
5.0	0.0415	0.0476
4.8	0.0451	0.0469
4.5	0.0448	0.0458
4.0	0.0442	0.0437



ABSORPTION OF SOUND IN AIR
TEMPERATURE =260.9 K   RELATIVE HUMIDITY = 59.7 %

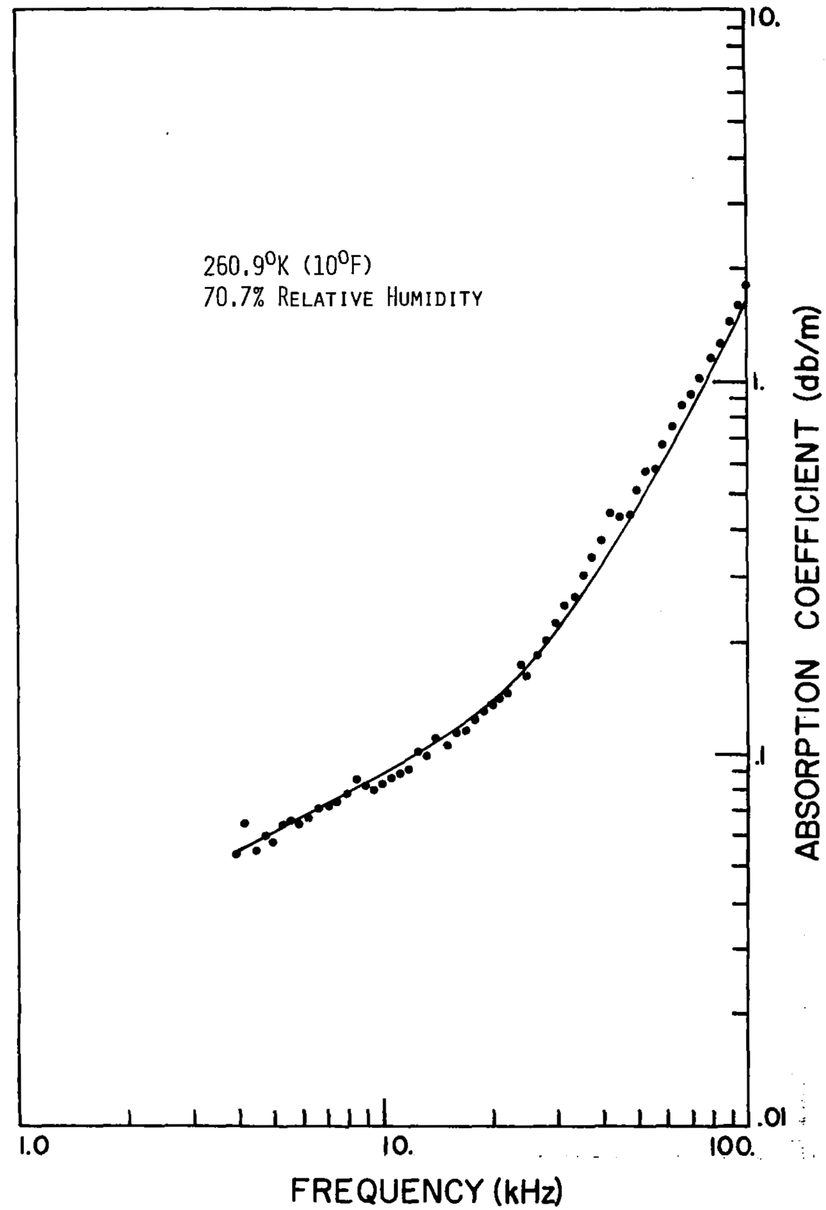
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	1.6957	1.5715
95.0	1.5714	1.4244
90.0	1.3270	1.2849
85.0	1.1731	1.1529
80.0	1.0603	1.0285
75.0	0.9532	0.9116
71.0	0.8530	0.8235
67.0	0.7659	0.7402
63.0	0.7195	0.6618
59.0	0.6420	0.5882
56.0	0.6009	0.5362
53.0	0.5635	0.4868
50.0	0.5003	0.4402
48.0	0.4533	0.4106
45.0	0.4262	0.3685
42.0	0.3998	0.3291
40.0	0.3422	0.3044
37.5	0.3167	0.2751
35.4	0.2919	0.2520
33.4	0.2556	0.2312
31.5	0.2373	0.2126
29.7	0.2147	0.1959
28.0	0.1878	0.1811
26.5	0.1737	0.1687
25.0	0.1545	0.1570
24.0	0.1468	0.1496
22.0	0.1300	0.1356
21.0	0.1348	0.1291
20.0	0.1163	0.1228
19.0	0.1132	0.1168
18.0	0.1085	0.1112
17.0	0.1074	0.1058
16.0	0.0984	0.1006
15.0	0.0879	0.0959
14.0	0.0894	0.0912
13.2	0.0805	0.0877
12.5	0.0880	0.0848
11.8	0.0764	0.0820
11.2	0.0760	0.0797
10.6	0.0749	0.0775
10.0	0.0737	0.0753
9.5	0.0665	0.0735
9.0	0.0666	0.0717
8.5	0.0702	0.0700
8.0	0.0659	0.0682
7.5	0.0622	0.0665
7.1	0.0609	0.0650
6.7	0.0610	0.0636
6.3	0.0591	0.0620
5.9	0.0562	0.0604
5.6	0.0563	0.0591
5.3	0.0556	0.0578
5.0	0.0464	0.0563
4.8	0.0638	0.0553
4.5	0.0479	0.0536
4.2	0.0484	0.0517
4.0	0.0486	0.0504



ABSORPTION OF SOUND IN AIR

TEMPERATURE =260.9 K   RELATIVE HUMIDITY = 70.7 %

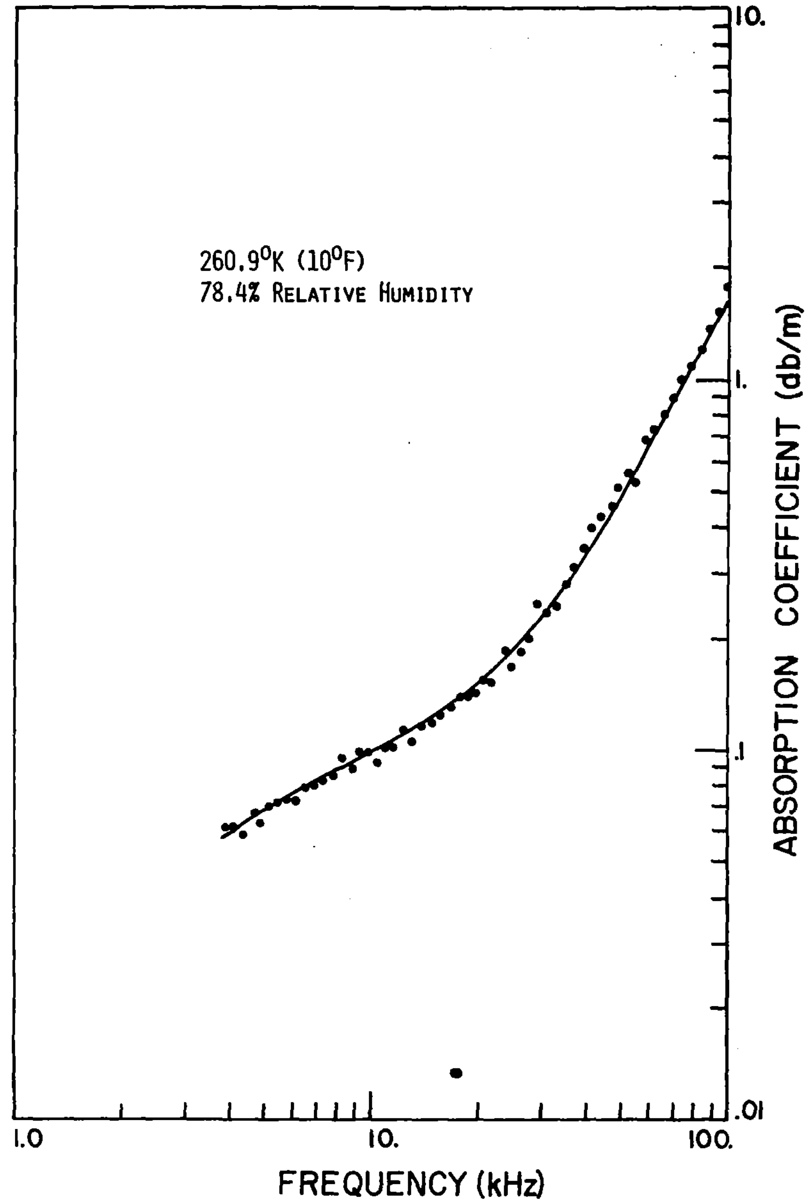
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	1.8278	1.5891
95.0	1.5902	1.4421
90.0	1.4436	1.3025
85.0	1.2718	1.1706
80.0	1.1528	1.0461
75.0	1.0382	0.9292
71.0	0.9281	0.8411
67.0	0.8622	0.7579
63.0	0.7639	0.6794
59.0	0.6710	0.6058
56.0	0.5848	0.5537
53.0	0.5750	0.5044
50.0	0.5104	0.4577
48.0	0.4472	0.4282
45.0	0.4307	0.3860
42.0	0.4409	0.3466
40.0	0.3790	0.3218
37.5	0.3371	0.2926
35.4	0.3091	0.2694
33.4	0.2647	0.2486
31.5	0.2502	0.2299
29.7	0.2249	0.2132
28.0	0.2031	0.1983
26.5	0.1865	0.1859
25.0	0.1634	0.1741
24.0	0.1747	0.1667
22.0	0.1479	0.1526
21.0	0.1426	0.1460
20.0	0.1369	0.1396
19.0	0.1303	0.1336
18.0	0.1240	0.1279
17.0	0.1160	0.1223
16.0	0.1144	0.1170
15.0	0.1068	0.1120
14.0	0.1120	0.1072
13.2	0.0991	0.1035
12.5	0.1023	0.1004
11.8	0.0920	0.0974
11.2	0.0891	0.0949
10.6	0.0880	0.0923
10.0	0.0837	0.0898
9.5	0.0800	0.0877
9.0	0.0828	0.0856
8.5	0.0850	0.0834
8.0	0.0784	0.0812
7.5	0.0746	0.0789
7.1	0.0721	0.0770
6.7	0.0713	0.0750
6.3	0.0676	0.0728
5.9	0.0657	0.0705
5.6	0.0660	0.0686
5.3	0.0646	0.0666
5.0	0.0581	0.0644
4.8	0.0604	0.0629
4.5	0.0553	0.0603
4.2	0.0657	0.0576
4.0	0.0548	0.0556



ABSORPTION OF SOUND IN AIR

TEMPERATURE =260.9 K   RELATIVE HUMIDITY = 78.4 %

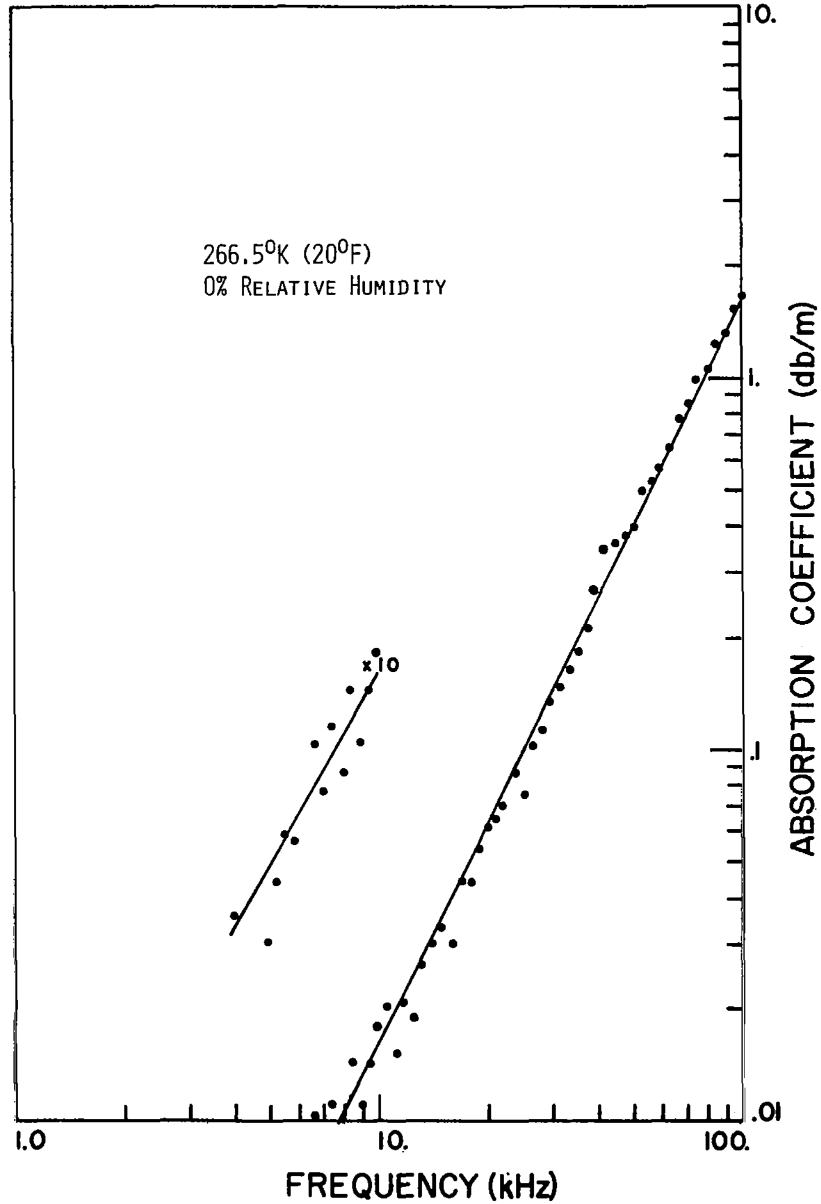
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	1.7404	1.6022
95.0	1.4996	1.4552
90.0	1.3522	1.3156
85.0	1.1978	1.1836
80.0	1.0899	1.0592
75.0	0.9864	0.9423
71.0	0.8831	0.8542
67.0	0.7891	0.7709
63.0	0.7244	0.6924
59.0	0.6731	0.6188
56.0	0.5298	0.5667
53.0	0.5572	0.5174
50.0	0.5037	0.4707
48.0	0.4523	0.4411
45.0	0.4203	0.3990
42.0	0.3986	0.3595
40.0	0.3431	0.3347
37.5	0.3072	0.3054
35.4	0.2776	0.2823
33.4	0.2421	0.2614
31.5	0.2317	0.2427
29.7	0.2453	0.2259
28.0	0.1955	0.2110
26.5	0.1832	0.1985
25.0	0.1667	0.1867
24.0	0.1826	0.1792
22.0	0.1524	0.1649
21.0	0.1534	0.1582
20.0	0.1418	0.1518
19.0	0.1383	0.1457
18.0	0.1380	0.1398
17.0	0.1291	0.1341
16.0	0.1240	0.1287
15.0	0.1162	0.1235
14.0	0.1157	0.1185
13.2	0.1048	0.1146
12.5	0.1139	0.1113
11.8	0.1002	0.1080
11.2	0.1003	0.1052
10.6	0.0920	0.1024
10.0	0.0972	0.0998
9.5	0.0977	0.0972
9.0	0.0886	0.0949
8.5	0.0935	0.0922
8.0	0.0842	0.0896
7.5	0.0819	0.0868
7.1	0.0799	0.0844
6.7	0.0784	0.0819
6.3	0.0733	0.0792
5.9	0.0721	0.0763
5.6	0.0719	0.0739
5.3	0.0695	0.0713
5.0	0.0633	0.0686
4.8	0.0676	0.0666
4.5	0.0587	0.0635
4.2	0.0618	0.0600
4.0	0.0602	0.0576



ABSORPTION OF SOUND IN AIR

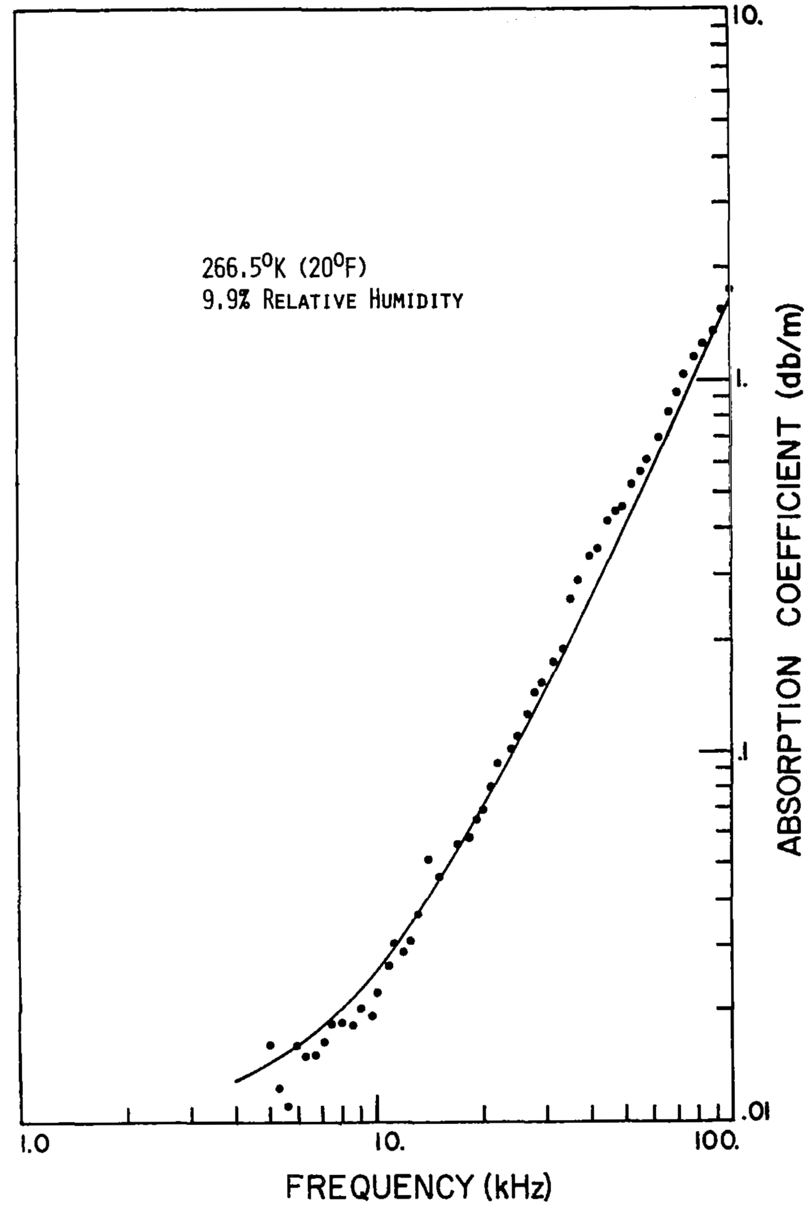
TEMPERATURE =266.5 K   RELATIVE HUMIDITY = 0.0 %

FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	1.6816	1.5250
95.0	1.5070	1.3764
90.0	1.3031	1.2354
85.0	1.2295	1.1020
80.0	1.0585	0.9763
75.0	0.9961	0.8582
71.0	0.8392	0.7692
67.0	0.7734	0.6850
63.0	0.6456	0.6058
59.0	0.5737	0.5314
56.0	0.5277	0.4788
53.0	0.4922	0.4289
50.0	0.3937	0.3819
48.0	0.3840	0.3520
45.0	0.3606	0.3095
42.0	0.3468	0.2697
40.0	0.2625	0.2447
37.5	0.2114	0.2151
35.4	0.1824	0.1918
33.4	0.1659	0.1708
31.5	0.1475	0.1520
29.7	0.1363	0.1352
28.0	0.1110	0.1203
26.5	0.1047	0.1078
25.0	0.0765	0.0961
24.0	0.0877	0.0886
22.0	0.0703	0.0746
21.0	0.0660	0.0680
20.0	0.0622	0.0618
19.0	0.0541	0.0558
18.0	0.0440	0.0502
17.0	0.0450	0.0448
16.0	0.0302	0.0398
15.0	0.0339	0.0351
14.0	0.0309	0.0307
13.2	0.0264	0.0274
12.5	0.0184	0.0246
11.8	0.0213	0.0220
11.2	0.0157	0.0199
10.6	0.0202	0.0179
10.0	0.0180	0.0160
9.5	0.0147	0.0146
9.0	0.0114	0.0131
8.5	0.0143	0.0118
8.0	0.0086	0.0106
7.5	0.0113	0.0094
7.1	0.0077	0.0085
6.7	0.0104	0.0076
6.3	0.0006	0.0068
5.9	0.0057	0.0061
5.6	0.0059	0.0056
5.3	0.0045	0.0051
5.0	0.0031	0.0046
4.5	0.0081	0.0039
4.0	0.0035	0.0032



ABSORPTION OF SOUND IN AIR
TEMPERATURE =266.5 K RELATIVE HUMIDITY = 9.9 %

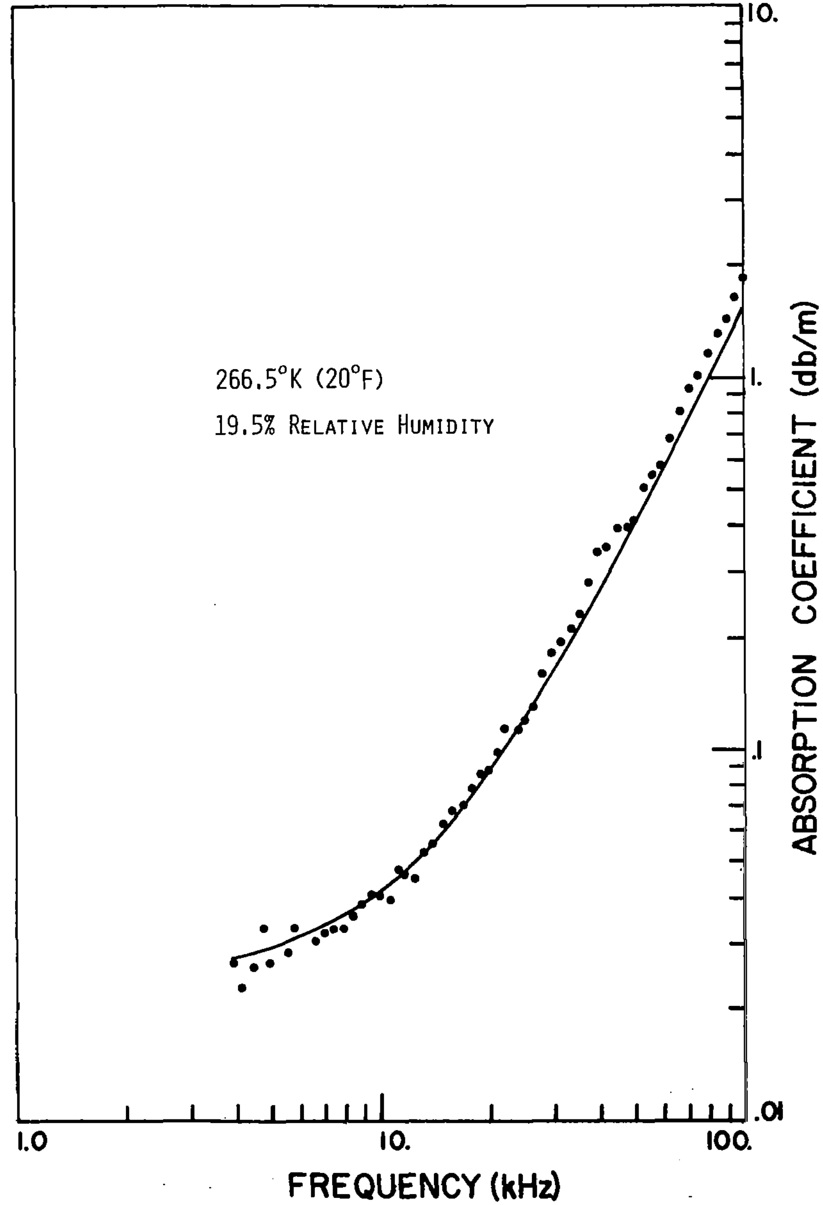
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	1.7409	1.5353
95.0	1.5440	1.3867
90.0	1.3795	1.2457
85.0	1.2757	1.1123
80.0	1.1512	0.9866
75.0	1.0303	0.8684
71.0	0.9313	0.7794
67.0	0.8269	0.6953
63.0	0.7044	0.6160
59.0	0.6120	0.5416
56.0	0.5718	0.4891
53.0	0.5135	0.4392
50.0	0.4659	0.3921
48.0	0.4328	0.3622
45.0	0.4178	0.3197
42.0	0.3510	0.2799
40.0	0.3364	0.2540
37.5	0.2873	0.2254
35.4	0.2586	0.2071
33.4	0.1924	0.1811
31.5	0.1767	0.1623
29.7	0.1547	0.1455
28.0	0.1467	0.1306
26.5	0.1258	0.1181
25.0	0.1119	0.1063
24.0	0.1033	0.0989
22.0	0.0933	0.0848
21.0	0.0817	0.0783
20.0	0.0703	0.0720
19.0	0.0663	0.0661
18.0	0.0591	0.0604
17.0	0.0573	0.0551
16.0	0.0500	0.0501
15.0	0.0474	0.0453
14.0	0.0527	0.0409
13.2	0.0370	0.0376
12.5	0.0318	0.0349
11.8	0.0298	0.0323
11.2	0.0311	0.0302
10.6	0.0269	0.0282
10.0	0.0228	0.0263
9.5	0.0194	0.0249
9.0	0.0206	0.0234
8.5	0.0189	0.0221
8.0	0.0191	0.0208
7.5	0.0190	0.0196
7.1	0.0169	0.0187
6.7	0.0155	0.0179
6.3	0.0156	0.0171
5.9	0.0165	0.0163
5.6	0.0114	0.0158
5.3	0.0127	0.0153
5.0	0.0168	0.0148



ABSORPTION OF SOUND IN AIR

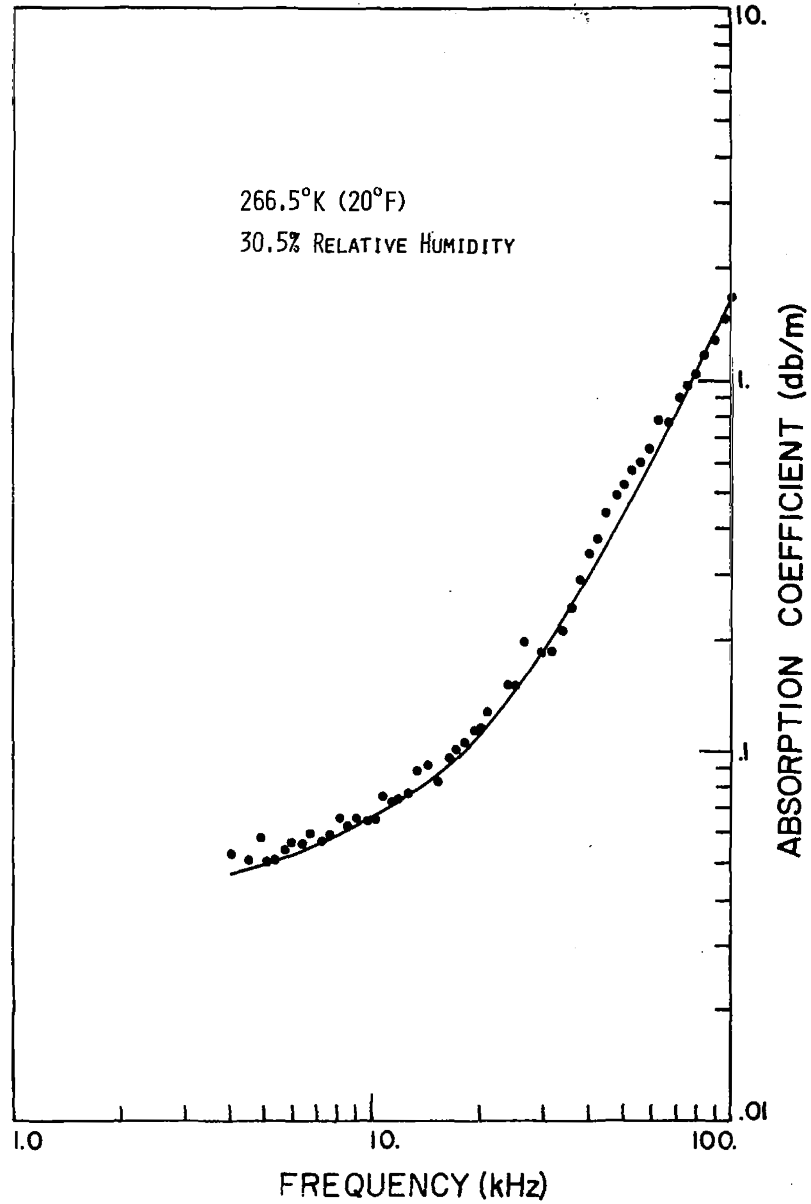
TEMPERATURE =266.5 K RELATIVE HUMIDITY = 19.5 %

FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	1.8502	1.5513
95.0	1.6425	1.4027
90.0	1.4480	1.2617
85.0	1.3136	1.1283
80.0	1.1627	1.0026
75.0	1.0290	0.8844
71.0	0.9216	0.7954
67.0	0.8042	0.7113
63.0	0.6847	0.6320
59.0	0.5819	0.5576
56.0	0.5493	0.5050
53.0	0.5022	0.4552
50.0	0.4158	0.4081
48.0	0.3971	0.3782
45.0	0.3978	0.3357
42.0	0.3503	0.2959
40.0	0.3414	0.2709
37.5	0.2823	0.2414
35.4	0.2308	0.2181
33.4	0.2129	0.1971
31.5	0.1958	0.1783
29.7	0.1837	0.1615
28.0	0.1618	0.1465
26.5	0.1301	0.1341
25.0	0.1220	0.1223
24.0	0.1139	0.1148
22.0	0.1142	0.1008
21.0	0.0994	0.0942
20.0	0.0888	0.0880
19.0	0.0865	0.0820
18.0	0.0791	0.0764
17.0	0.0712	0.0710
16.0	0.0689	0.0660
15.0	0.0636	0.0613
14.0	0.0569	0.0568
13.2	0.0518	0.0535
12.5	0.0460	0.0507
11.8	0.0466	0.0481
11.2	0.0484	0.0460
10.6	0.0399	0.0440
10.0	0.0414	0.0421
9.5	0.0419	0.0406
9.0	0.0381	0.0392
8.5	0.0362	0.0378
8.0	0.0338	0.0365
7.5	0.0337	0.0353
7.1	0.0324	0.0344
6.7	0.0309	0.0335
6.3	0.0316	0.0326
5.9	0.0331	0.0318
5.6	0.0285	0.0312
5.3	0.0298	0.0307
5.0	0.0270	0.0301
4.8	0.0334	0.0297
4.5	0.0268	0.0292
4.2	0.0236	0.0287
4.0	0.0269	0.0283



ABSORPTION OF SOUND IN AIR
TEMPERATURE =266.5 K   RELATIVE HUMIDITY = 30.5 %

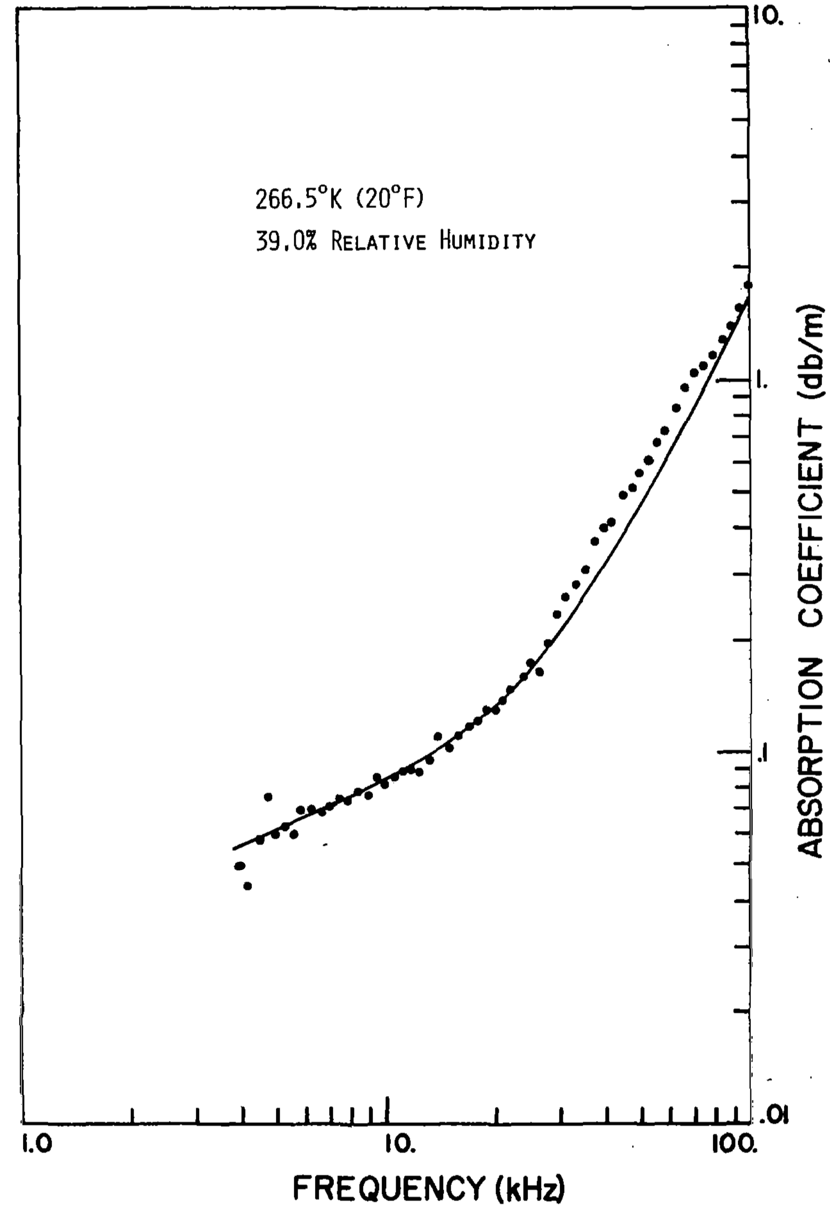
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	1.6564	1.5753
95.0	1.4397	1.4267
90.0	1.2856	1.2857
85.0	1.1670	1.1523
80.0	1.0395	1.0266
75.0	0.9618	0.9084
71.0	0.8993	0.8194
67.0	0.7682	0.7353
63.0	0.7764	0.6560
59.0	0.6475	0.5816
56.0	0.6020	0.5290
53.0	0.5692	0.4792
50.0	0.5213	0.4321
48.0	0.4773	0.4022
45.0	0.4443	0.3597
42.0	0.3759	0.3199
40.0	0.3417	0.2949
37.5	0.2919	0.2653
35.4	0.2386	0.2420
33.4	0.2102	0.2210
31.5	0.1837	0.2022
29.7	0.1837	0.1854
26.0	0.1951	0.1536
25.0	0.1481	0.1461
24.0	0.1504	0.1387
22.0	0.1273	0.1246
21.0	0.1276	0.1180
20.0	0.1151	0.1117
19.0	0.1167	0.1057
18.0	0.1060	0.1001
17.0	0.1010	0.0947
16.0	0.0961	0.0896
15.0	0.0827	0.0848
14.0	0.0925	0.0803
13.2	0.0893	0.0769
12.5	0.0767	0.0741
11.8	0.0760	0.0714
11.2	0.0737	0.0692
10.6	0.0863	0.0671
10.0	0.0772	0.0650
9.5	0.0746	0.0634
9.0	0.0666	0.0619
8.5	0.0620	0.0603
8.0	0.0662	0.0589
7.5	0.0593	0.0574
7.1	0.0570	0.0563
6.7	0.0606	0.0551
6.3	0.0564	0.0540
5.9	0.0573	0.0529
5.6	0.0542	0.0520
5.3	0.0505	0.0511
5.0	0.0500	0.0501
4.8	0.0583	0.0494
4.5	0.0502	0.0484
4.0	0.0523	0.0464



ABSORPITON OF SOUND IN AIR

TEMPERATURE =266.5 K RELATIVE HUMIDITY = 39.0 %

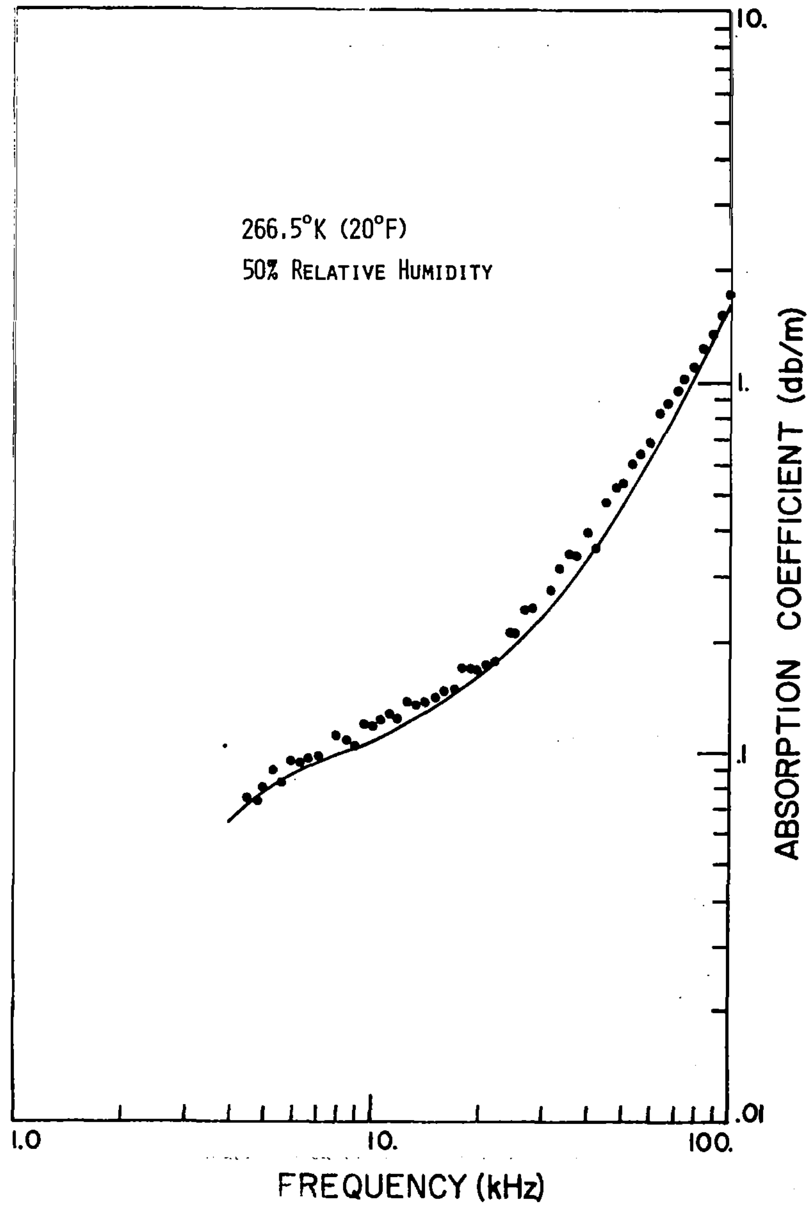
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	1.7710	1.5972
95.0	1.5476	1.4485
90.0	1.3769	1.3076
85.0	1.2786	1.1742
80.0	1.1744	1.0484
75.0	1.0937	0.9303
71.0	1.0354	0.8413
67.0	0.9521	0.7571
63.0	0.8352	0.6779
59.0	0.7316	0.6035
56.0	0.6788	0.5509
53.0	0.6126	0.5010
50.0	0.5571	0.4539
48.0	0.5082	0.4240
45.0	0.4862	0.3815
42.0	0.4150	0.3416
40.0	0.3993	0.3166
37.5	0.3692	0.2871
35.4	0.3052	0.2637
33.4	0.2864	0.2427
31.5	0.2624	0.2238
29.7	0.2322	0.2070
28.0	0.1981	0.1920
26.5	0.1645	0.1795
25.0	0.1748	0.1676
24.0	0.1602	0.1601
22.0	0.1489	0.1460
21.0	0.1393	0.1393
20.0	0.1311	0.1330
19.0	0.1308	0.1270
18.0	0.1219	0.1212
17.0	0.1178	0.1157
16.0	0.1112	0.1105
15.0	0.1029	0.1056
14.0	0.1112	0.1009
13.2	0.0957	0.0974
12.5	0.0894	0.0944
11.8	0.0900	0.0915
11.2	0.0890	0.0892
10.6	0.0864	0.0868
10.0	0.0822	0.0846
9.5	0.0861	0.0827
9.0	0.0772	0.0809
8.5	0.0795	0.0790
8.0	0.0741	0.0772
7.5	0.0753	0.0753
7.1	0.0719	0.0738
6.7	0.0695	0.0721
6.3	0.0699	0.0705
5.9	0.0701	0.0687
5.6	0.0599	0.0672
5.3	0.0638	0.0657
5.0	0.0611	0.0641
4.8	0.0761	0.0629
4.5	0.0586	0.0610
4.2	0.0440	0.0589
4.0	0.0499	0.0573



ABSORPTION OF SOUND IN AIR

TEMPERATURE =266.5 K   RELATIVE HUMIDITY = 50.0 %

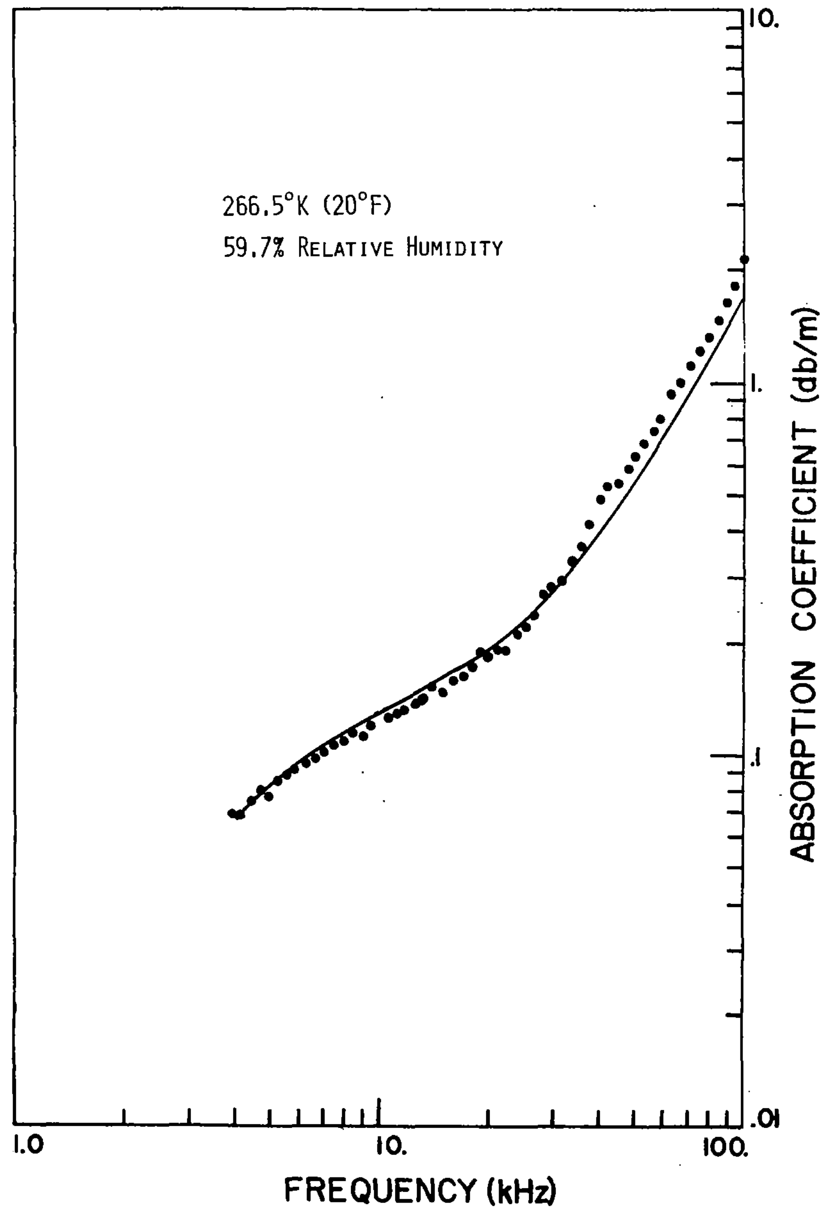
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	1.7335	1.6289
95.0	1.5105	1.4803
90.0	1.3419	1.3393
85.0	1.2342	1.2059
80.0	1.1053	1.0801
75.0	1.0173	0.9620
71.0	0.9544	0.8729
67.0	0.8796	0.7888
63.0	0.8201	0.7095
59.0	0.6921	0.6351
56.0	0.6423	0.5824
53.0	0.6064	0.5326
50.0	0.5294	0.4854
48.0	0.5182	0.4555
45.0	0.4724	0.4129
42.0	0.3567	0.3730
40.0	0.3886	0.3480
37.5	0.3342	0.3183
35.4	0.3475	0.2949
33.4	0.3121	0.2738
31.5	0.2749	0.2549
28.0	0.2466	0.2229
26.5	0.2466	0.2102
25.0	0.2131	0.1983
24.0	0.2116	0.1907
22.0	0.1764	0.1763
21.0	0.1713	0.1695
20.0	0.1679	0.1630
19.0	0.1706	0.1568
18.0	0.1708	0.1508
17.0	0.1471	0.1450
16.0	0.1455	0.1395
15.0	0.1391	0.1343
14.0	0.1362	0.1292
13.2	0.1339	0.1252
12.5	0.1354	0.1218
11.8	0.1216	0.1184
11.2	0.1241	0.1155
10.6	0.1212	0.1127
10.0	0.1189	0.1097
9.5	0.1205	0.1073
9.0	0.1027	0.1047
8.5	0.1082	0.1021
8.0	0.1119	0.0993
7.1	0.0968	0.0938
6.7	0.0966	0.0912
6.3	0.0938	0.0883
5.9	0.0956	0.0851
5.6	0.0838	0.0826
5.3	0.0896	0.0798
5.0	0.0808	0.0768
4.8	0.0742	0.0747
4.5	0.0767	0.0713



ABSORPTION OF SOUND IN AIR

TEMPERATURE =266.5 K   RELATIVE HUMIDITY = 59.7 %

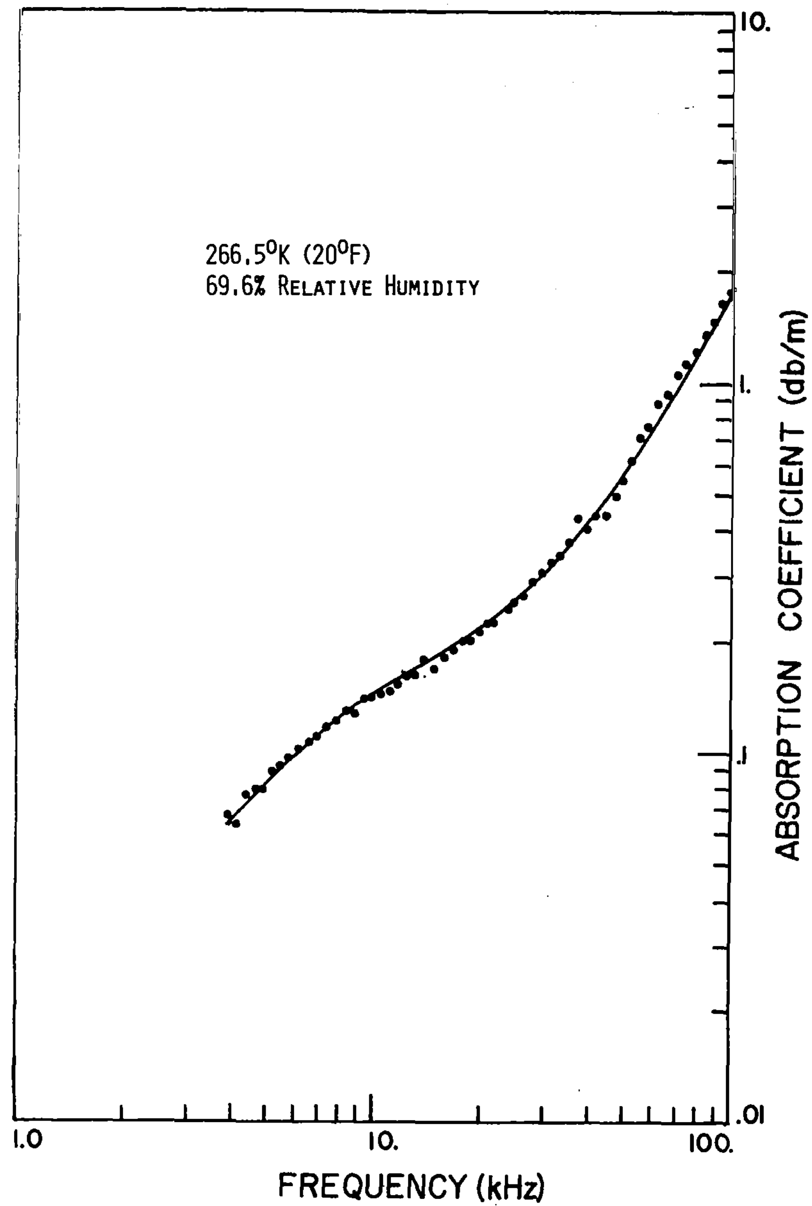
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	2.0123	1.6555
95.0	1.7846	1.5109
90.0	1.6096	1.3699
85.0	1.4684	1.2364
80.0	1.3180	1.1107
75.0	1.2075	0.9925
71.0	1.1254	0.9034
67.0	0.9917	0.8192
63.0	0.9258	0.7399
59.0	0.7984	0.6654
56.0	0.7346	0.6128
53.0	0.6861	0.5628
50.0	0.6384	0.5156
48.0	0.5879	0.4857
45.0	0.5330	0.4430
42.0	0.5245	0.4030
40.0	0.4811	0.3779
37.5	0.4168	0.3482
35.4	0.3621	0.3246
33.4	0.3253	0.3034
31.5	0.2917	0.2843
29.7	0.2824	0.2672
28.0	0.2691	0.2520
26.5	0.2354	0.2392
25.0	0.2178	0.2270
24.0	0.2105	0.2192
22.0	0.1898	0.2044
21.0	0.1928	0.1974
20.0	0.1813	0.1906
19.0	0.1879	0.1840
18.0	0.1701	0.1777
17.0	0.1633	0.1715
16.0	0.1570	0.1655
15.0	0.1450	0.1597
14.0	0.1524	0.1539
13.2	0.1412	0.1493
12.5	0.1352	0.1452
11.8	0.1316	0.1411
11.2	0.1288	0.1375
10.6	0.1259	0.1337
10.0	0.1235	0.1299
9.5	0.1192	0.1265
9.0	0.1110	0.1230
8.5	0.1145	0.1192
8.0	0.1072	0.1152
7.5	0.1055	0.1109
7.1	0.1016	0.1072
6.7	0.0976	0.1032
6.3	0.0948	0.0989
5.9	0.0910	0.0943
5.6	0.0879	0.0905
5.3	0.0843	0.0865
5.0	0.0776	0.0822
4.8	0.0804	0.0792
4.5	0.0746	0.0745
4.2	0.0695	0.0694
4.0	0.0683	0.0659



ABSORPTION OF SOUND IN AIR

TEMPERATURE =266.5 K   RELATIVE HUMIDITY = 69.6 %

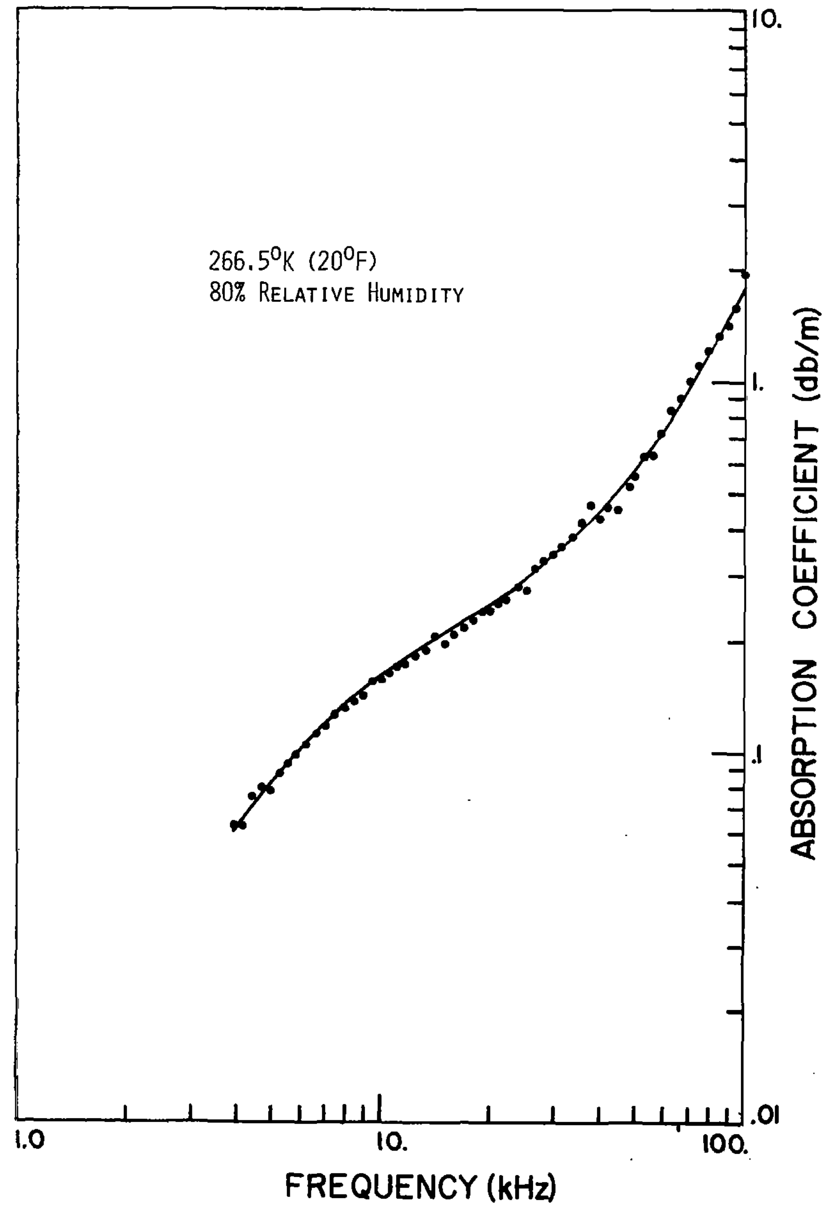
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	1.7578	1.6928
95.0	1.6272	1.5441
90.0	1.4586	1.4031
85.0	1.3438	1.2696
80.0	1.2085	1.1438
75.0	1.1191	1.0256
71.0	1.0601	0.9365
67.0	0.9330	0.8522
63.0	0.8825	0.7728
59.0	0.7591	0.6983
56.0	0.7124	0.6455
53.0	0.6225	0.5955
50.0	0.5504	0.5482
48.0	0.5024	0.5182
45.0	0.4433	0.4754
42.0	0.4384	0.4353
40.0	0.3990	0.4100
37.5	0.4290	0.3801
35.4	0.3707	0.3563
33.4	0.3430	0.3349
31.5	0.3267	0.3156
29.7	0.3076	0.2982
28.0	0.2892	0.2826
26.5	0.2657	0.2695
25.0	0.2535	0.2570
24.0	0.2460	0.2489
22.0	0.2260	0.2335
21.0	0.2248	0.2260
20.0	0.2130	0.2188
19.0	0.2013	0.2118
18.0	0.2007	0.2048
17.0	0.1906	0.1980
16.0	0.1806	0.1912
15.0	0.1690	0.1844
14.0	0.1798	0.1775
13.2	0.1618	0.1719
12.5	0.1611	0.1669
11.8	0.1536	0.1616
11.2	0.1483	0.1570
10.6	0.1460	0.1521
10.0	0.1411	0.1469
9.5	0.1399	0.1424
9.0	0.1270	0.1375
8.5	0.1293	0.1324
8.0	0.1221	0.1269
7.5	0.1182	0.1209
7.1	0.1113	0.1158
6.7	0.1076	0.1104
6.3	0.1023	0.1046
5.9	0.0965	0.0985
5.6	0.0925	0.0936
5.3	0.0887	0.0885
5.0	0.0797	0.0831
4.8	0.0800	0.0794
4.5	0.0779	0.0736
4.2	0.0637	0.0676
4.0	0.0679	0.0636



ABSORPTION OF SOUND IN AIR

TEMPERATURE =266.5 K RELATIVE HUMIDITY = 80.0 %

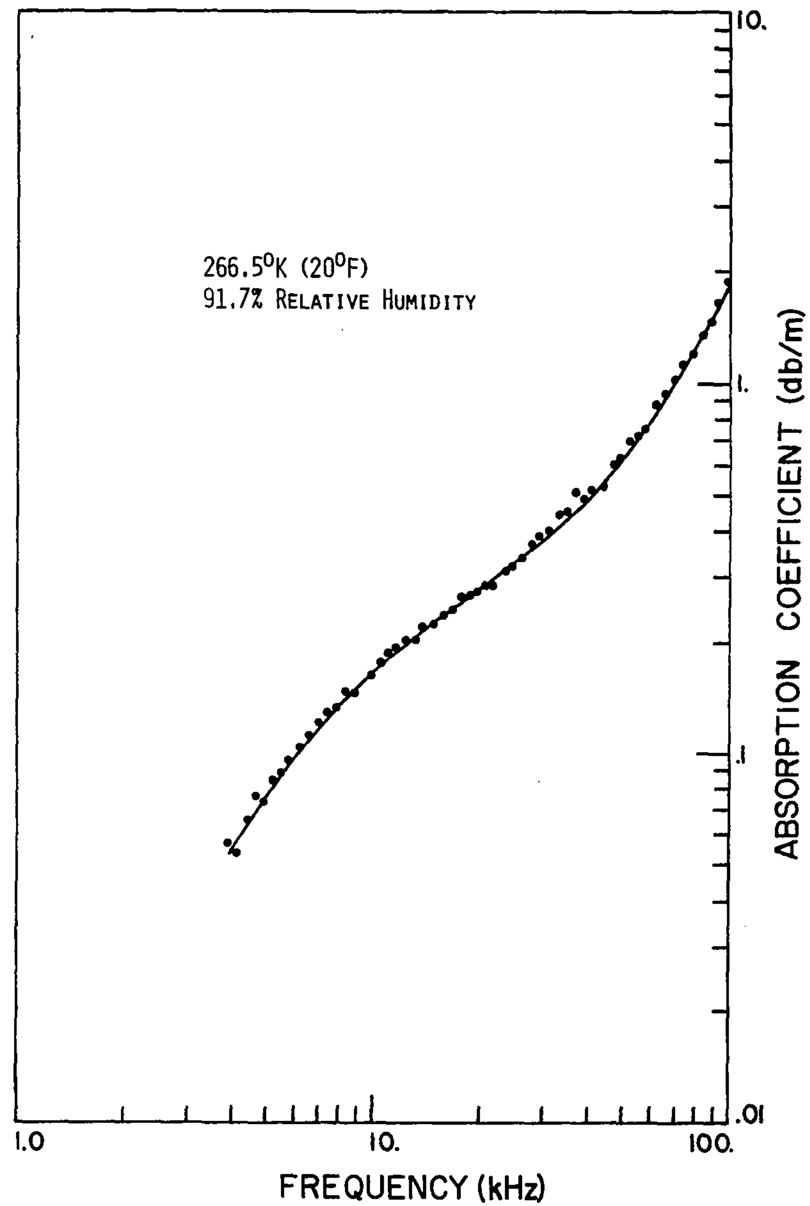
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	1.9848	1.7296
95.0	1.5870	1.5809
90.0	1.4250	1.4398
85.0	1.3294	1.3063
80.0	1.2060	1.1804
75.0	1.1067	1.0621
71.0	1.0286	0.9729
67.0	0.8922	0.8885
63.0	0.8399	0.8090
59.0	0.7290	0.7342
56.0	0.6351	0.6815
53.0	0.6171	0.6313
50.0	0.5583	0.5839
48.0	0.5165	0.5537
45.0	0.4561	0.5107
42.0	0.4588	0.4703
40.0	0.4250	0.4448
37.5	0.4648	0.4145
35.4	0.4174	0.3905
33.4	0.3803	0.3687
31.5	0.3595	0.3490
29.7	0.3413	0.3312
28.0	0.3244	0.3152
26.5	0.3126	0.3015
25.0	0.2716	0.2884
24.0	0.2756	0.2799
22.0	0.2572	0.2634
21.0	0.2515	0.2554
20.0	0.2395	0.2475
19.0	0.2368	0.2396
18.0	0.2288	0.2319
17.0	0.2182	0.2240
16.0	0.2084	0.2160
15.0	0.1957	0.2079
14.0	0.2056	0.1995
13.2	0.1869	0.1925
12.5	0.1830	0.1861
11.8	0.1737	0.1794
11.2	0.1707	0.1734
10.6	0.1624	0.1670
10.0	0.1583	0.1602
9.5	0.1551	0.1542
9.0	0.1402	0.1479
8.5	0.1389	0.1411
8.0	0.1311	0.1340
7.5	0.1251	0.1264
7.1	0.1178	0.1199
6.7	0.1121	0.1131
6.3	0.1053	0.1060
5.9	0.0978	0.0985
5.6	0.0937	0.0927
5.3	0.0879	0.0867
5.0	0.0786	0.0806
4.8	0.0803	0.0764
4.5	0.0752	0.0700
4.2	0.0620	0.0636
4.0	0.0636	0.0592



ABSORPTION OF SOUND IN AIR

TEMPERATURE =266.5 K   RELATIVE HUMIDITY = 91.7 %

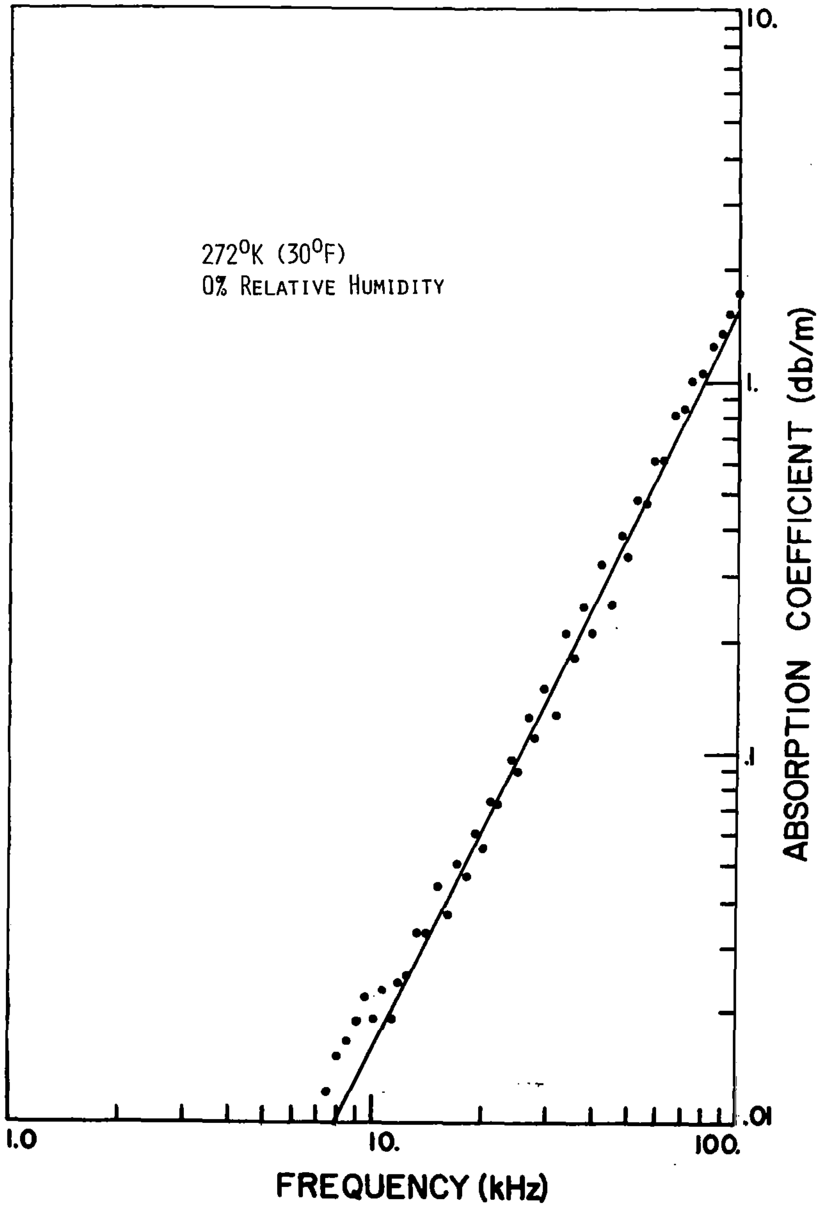
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	1.8468	1.7727
95.0	1.6013	1.6239
90.0	1.4269	1.4828
85.0	1.3147	1.3492
80.0	1.1789	1.2231
75.0	1.1025	1.1047
71.0	1.0111	1.0154
67.0	0.9166	0.9308
63.0	0.8700	0.8511
59.0	0.7436	0.7762
56.0	0.7186	0.7232
53.0	0.6875	0.6728
50.0	0.6177	0.6250
48.0	0.5925	0.5947
45.0	0.5183	0.5512
42.0	0.5086	0.5104
40.0	0.4811	0.4846
37.5	0.5062	0.4538
35.4	0.4488	0.4292
33.4	0.4321	0.4069
31.5	0.3939	0.3865
29.7	0.3807	0.3680
28.0	0.3633	0.3512
26.5	0.3331	0.3367
25.0	0.3169	0.3227
24.0	0.3079	0.3135
22.0	0.2825	0.2953
21.0	0.2845	0.2864
20.0	0.2724	0.2774
19.0	0.2651	0.2683
18.0	0.2619	0.2592
17.0	0.2406	0.2498
16.0	0.2354	0.2402
15.0	0.2226	0.2302
14.0	0.2174	0.2197
13.2	0.2026	0.2108
12.5	0.2001	0.2027
11.8	0.1905	0.1941
11.2	0.1875	0.1863
10.6	0.1734	0.1781
10.0	0.1635	0.1695
9.5	0.1638	0.1618
9.0	0.1461	0.1539
8.5	0.1465	0.1455
8.0	0.1328	0.1367
7.5	0.1295	0.1274
7.1	0.1213	0.1197
6.7	0.1122	0.1118
6.3	0.1036	0.1036
5.9	0.0963	0.0952
5.6	0.0889	0.0888
5.3	0.0846	0.0823
5.0	0.0749	0.0757
4.8	0.0772	0.0713
4.5	0.0662	0.0647
4.2	0.0545	0.0582
4.0	0.0572	0.0539



ABSORPTION OF SOUND IN AIR

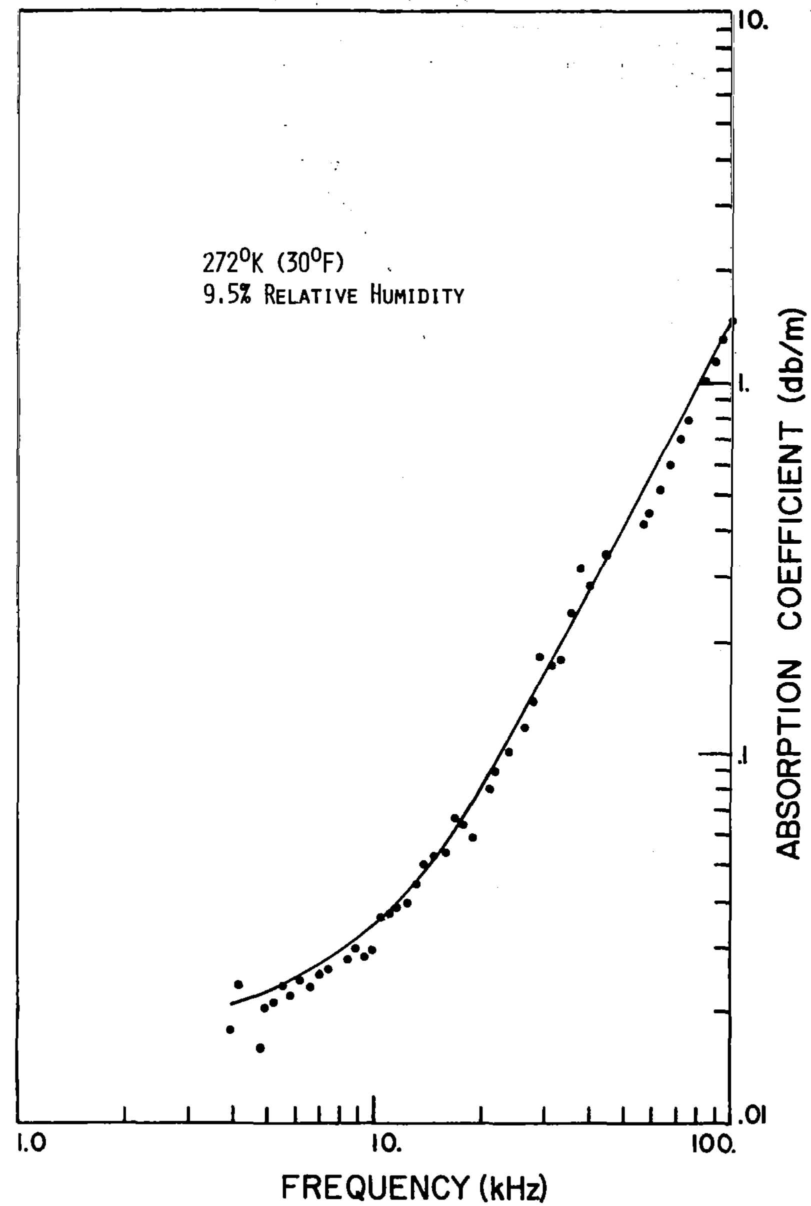
TEMPERATURE =272.0 K RELATIVE HUMIDITY = 0.0 %

FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	1.7388	1.5409
95.0	1.5441	1.3908
90.0	1.3554	1.2483
85.0	1.2550	1.1136
80.0	1.0570	0.9865
75.0	1.1013	0.8672
71.0	0.8415	0.7772
67.0	0.8171	0.6922
63.0	0.6134	0.6121
59.0	0.6178	0.5370
56.0	0.4727	0.4839
53.0	0.4892	0.4335
50.0	0.3364	0.3859
48.0	0.3870	0.3557
45.0	0.2505	0.3128
42.0	0.3211	0.2726
40.0	0.2116	0.2473
37.5	0.2520	0.2175
35.4	0.1837	0.1939
33.4	0.2129	0.1727
31.5	0.1279	0.1537
29.7	0.1495	0.1367
28.0	0.1102	0.1216
26.5	0.1251	0.1090
25.0	0.0895	0.0972
24.0	0.0965	0.0896
22.0	0.0733	0.0754
21.0	0.0758	0.0688
20.0	0.0567	0.0625
19.0	0.0610	0.0565
18.0	0.0474	0.0508
17.0	0.0517	0.0454
16.0	0.0371	0.0403
15.0	0.0450	0.0356
14.0	0.0332	0.0311
13.2	0.0331	0.0277
12.5	0.0258	0.0250
11.8	0.0249	0.0223
11.2	0.0195	0.0202
10.6	0.0232	0.0182
10.0	0.0195	0.0163
9.5	0.0225	0.0148
9.0	0.0192	0.0134
8.5	0.0174	0.0120
8.0	0.0155	0.0108
7.5	0.0124	0.0096
7.1	0.0111	0.0087



ABSORPTION OF SOUND IN AIR
TEMPERATURE =272.0 K RELATIVE HUMIDITY = 9.5 %

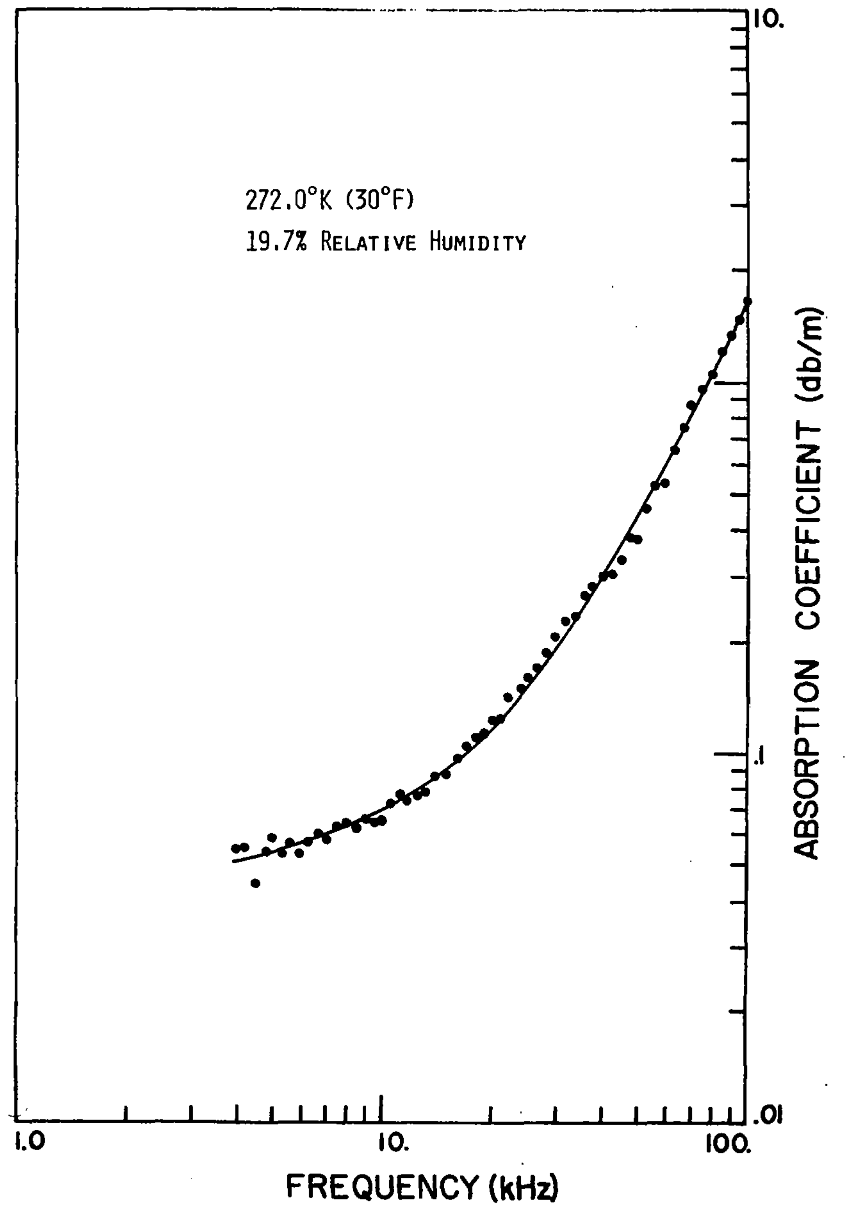
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	1.4841	1.5602
95.0	1.3074	1.4101
90.0	1.1420	1.2676
85.0	1.0242	1.1329
80.0	1.0074	1.0058
75.0	0.7911	0.8865
71.0	0.7041	0.7965
67.0	0.6026	0.7115
63.0	0.5119	0.6315
59.0	0.4468	0.5563
56.0	0.4175	0.5032
45.0	0.3427	0.3321
40.0	0.2864	0.2666
37.5	0.3160	0.2368
35.4	0.2424	0.2132
33.4	0.1808	0.1920
31.5	0.1716	0.1730
29.7	0.1838	0.1561
28.0	0.1407	0.1410
26.5	0.1181	0.1284
25.0	0.1158	0.1165
24.0	0.1024	0.1089
22.0	0.0900	0.0948
21.6	0.0805	0.0881
20.0	0.0802	0.0818
19.0	0.0598	0.0758
18.0	0.0649	0.0701
17.0	0.0679	0.0647
16.0	0.0542	0.0596
15.0	0.0532	0.0548
14.0	0.0503	0.0504
13.2	0.0449	0.0470
12.5	0.0401	0.0442
11.8	0.0389	0.0416
11.2	0.0375	0.0395
10.6	0.0363	0.0375
10.0	0.0299	0.0356
9.5	0.0283	0.0341
9.0	0.0298	0.0326
8.5	0.0286	0.0313
8.0	0.0301	0.0300
7.5	0.0262	0.0288
7.1	0.0258	0.0279
6.7	0.0236	0.0270
6.3	0.0246	0.0262
5.9	0.0225	0.0254
5.6	0.0236	0.0249
5.3	0.0215	0.0243
5.0	0.0207	0.0238
4.8	0.0164	0.0235
4.2	0.0238	0.0226
4.0	0.0181	0.0223



ABSORPTION OF SOUND IN AIR

TEMPERATURE =272.0 K   RELATIVE HUMIDITY = 19.7 %

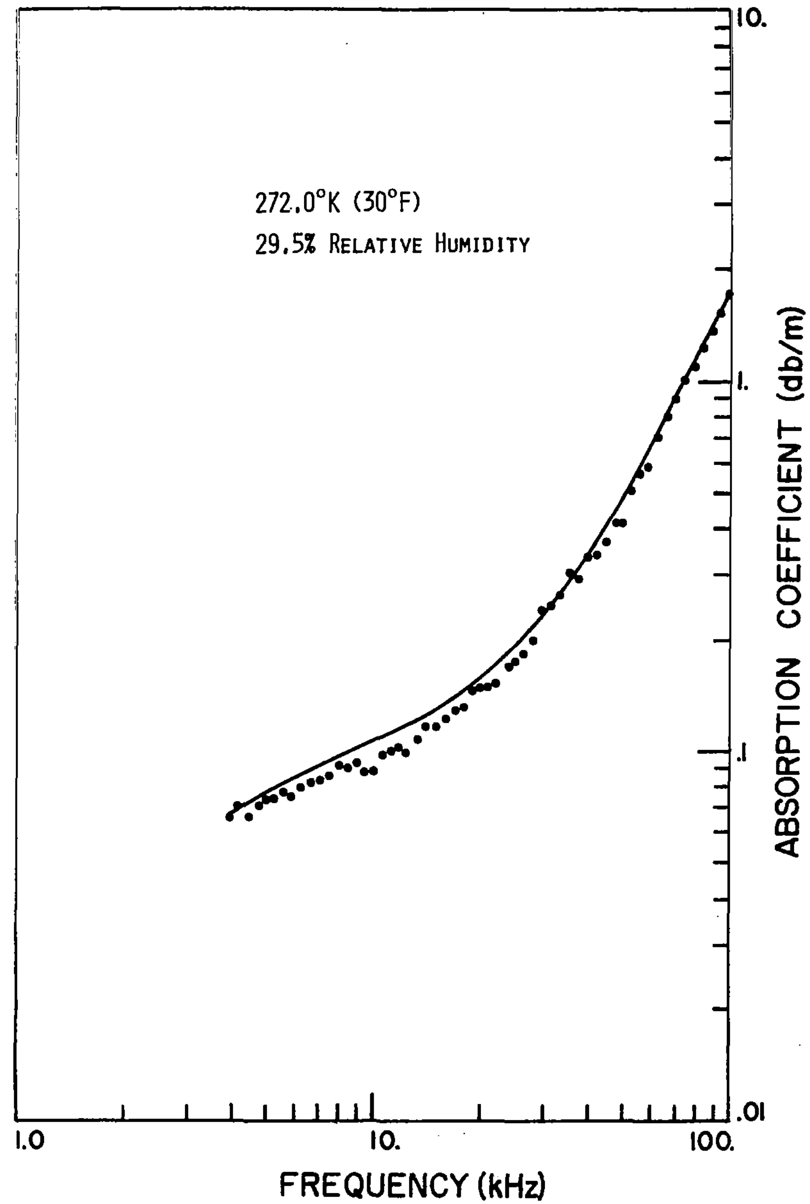
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	1.6515	1.5960
95.0	1.4880	1.4459
90.0	1.3182	1.3034
85.0	1.1891	1.1686
80.0	1.0551	1.0416
75.0	0.9486	0.9222
71.0	0.8607	0.8323
67.0	0.7489	0.7473
63.0	0.6563	0.6672
59.0	0.5301	0.5920
56.0	0.5300	0.5379
53.0	0.4547	0.4885
50.0	0.3745	0.4409
48.0	0.3801	0.4107
45.0	0.3280	0.3678
42.0	0.3010	0.3276
40.0	0.3021	0.3023
37.5	0.2827	0.2724
35.4	0.2644	0.2489
33.4	0.2328	0.2276
31.5	0.2232	0.2086
29.7	0.2039	0.1917
28.0	0.1838	0.1765
26.5	0.1688	0.1639
25.0	0.1596	0.1520
24.0	0.1502	0.1444
22.0	0.1417	0.1302
21.0	0.1240	0.1236
20.0	0.1234	0.1172
19.0	0.1136	0.1112
18.0	0.1099	0.1054
17.0	0.1036	0.1000
16.0	0.0971	0.0949
15.0	0.0867	0.0900
14.0	0.0859	0.0855
13.2	0.0796	0.0820
12.5	0.0759	0.0792
11.8	0.0741	0.0765
11.2	0.0772	0.0742
10.6	0.0734	0.0721
10.0	0.0646	0.0700
9.5	0.0644	0.0684
9.0	0.0657	0.0668
8.5	0.0624	0.0653
8.0	0.0643	0.0638
7.5	0.0626	0.0623
7.1	0.0580	0.0612
6.7	0.0598	0.0600
6.3	0.0568	0.0588
5.9	0.0531	0.0577
5.6	0.0571	0.0568
5.3	0.0530	0.0558
5.0	0.0587	0.0548
4.8	0.0538	0.0542
4.5	0.0440	0.0531
4.2	0.0549	0.0519
4.0	0.0547	0.0510



ABSORPTION OF SOUND IN AIR

TEMPERATURE =272.0 K   RELATIVE HUMIDITY = 29.5 %

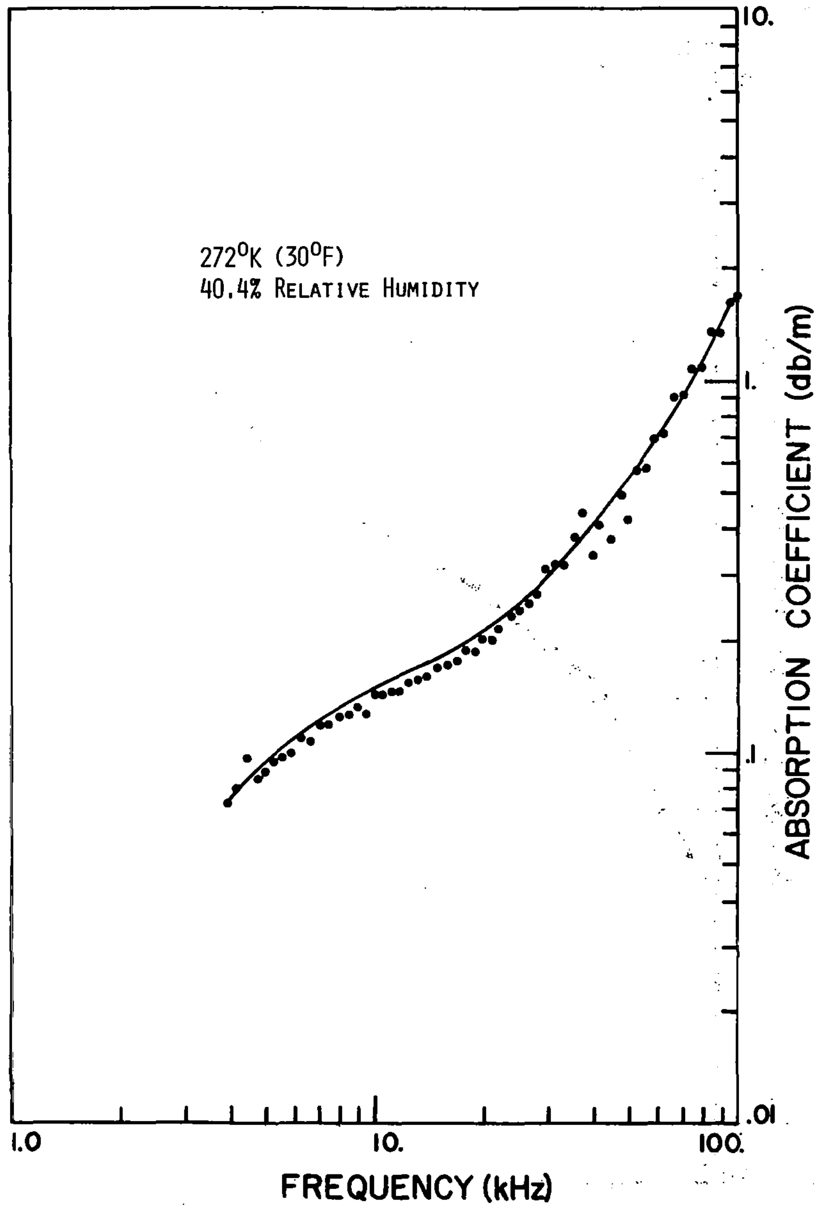
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	1.7100	1.6406
95.0	1.5335	1.4904
90.0	1.3625	1.3479
85.0	1.2361	1.2132
80.0	1.1001	1.0861
75.0	1.0114	0.9667
71.0	0.9139	0.8769
67.0	0.8166	0.7918
63.0	0.7097	0.7117
59.0	0.5935	0.6365
56.0	0.5718	0.5833
53.0	0.5132	0.5329
50.0	0.4233	0.4853
48.0	0.4208	0.4551
45.0	0.3732	0.4121
42.0	0.3436	0.3718
40.0	0.3442	0.3465
37.5	0.2977	0.3166
35.4	0.3176	0.2930
33.4	0.2693	0.2717
31.5	0.2526	0.2526
29.7	0.2431	0.2356
28.0	0.2035	0.2204
26.5	0.1876	0.2076
25.0	0.1782	0.1956
24.0	0.1733	0.1880
22.0	0.1568	0.1735
21.0	0.1536	0.1668
20.0	0.1523	0.1603
19.0	0.1501	0.1541
18.0	0.1335	0.1481
17.0	0.1328	0.1424
16.0	0.1252	0.1370
15.0	0.1209	0.1319
14.0	0.1204	0.1269
13.2	0.1100	0.1231
12.5	0.1035	0.1198
11.8	0.1041	0.1167
11.2	0.1032	0.1140
10.6	0.1001	0.1113
10.0	0.0908	0.1087
9.5	0.0907	0.1064
9.0	0.0954	0.1042
8.5	0.0918	0.1018
8.0	0.0936	0.0994
7.5	0.0876	0.0969
7.1	0.0853	0.0948
6.7	0.0841	0.0925
6.3	0.0826	0.0900
5.9	0.0776	0.0874
5.6	0.0792	0.0852
5.3	0.0761	0.0829
5.0	0.0752	0.0803
4.8	0.0736	0.0785
4.5	0.0683	0.0755
4.2	0.0727	0.0723
4.0	0.0668	0.0699



ABSORPTION OF SOUND IN AIR

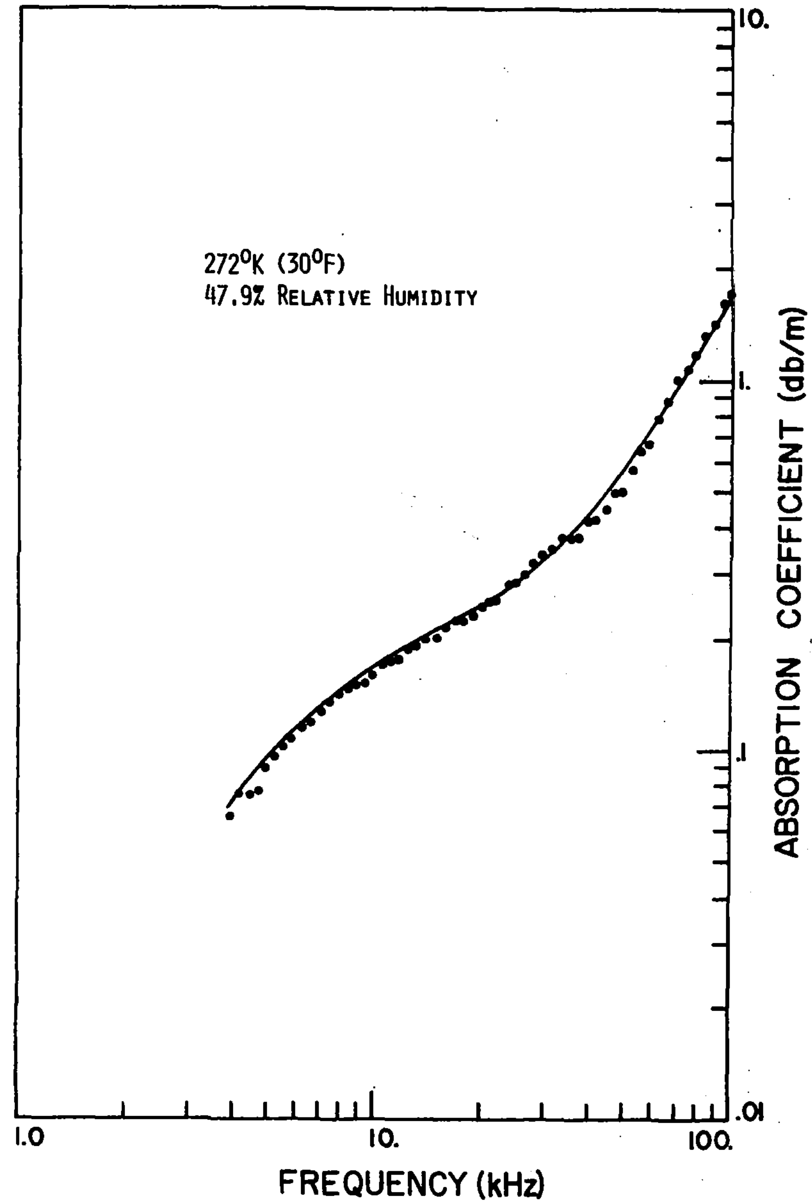
TEMPERATURE =272.0 K RELATIVE HUMIDITY = 40.4 %

FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	1.6602	1.6985
95.0	1.6050	1.5483
90.0	1.3297	1.4059
85.0	1.3203	1.2711
80.0	1.0791	1.1439
75.0	1.0835	1.0245
71.0	0.9026	0.9345
67.0	0.8810	0.8494
63.0	0.7039	0.7693
59.0	0.6863	0.6940
56.0	0.5704	0.6408
53.0	0.5701	0.5903
50.0	0.4186	0.5426
48.0	0.4887	0.5123
45.0	0.3702	0.4691
42.0	0.4088	0.4287
40.0	0.3362	0.4033
37.5	0.4367	0.3732
35.4	0.3786	0.3494
33.4	0.3163	0.3279
31.5	0.3180	0.3085
29.7	0.3066	0.2912
28.0	0.2646	0.2757
26.5	0.2475	0.2626
25.0	0.2345	0.2502
24.0	0.2309	0.2423
22.0	0.2129	0.2271
21.0	0.2005	0.2199
20.0	0.1986	0.2130
19.0	0.1861	0.2062
18.0	0.1870	0.1996
17.0	0.1735	0.1932
16.0	0.1705	0.1869
15.0	0.1665	0.1807
14.0	0.1584	0.1745
13.2	0.1561	0.1695
12.5	0.1519	0.1651
11.8	0.1442	0.1606
11.2	0.1438	0.1566
10.6	0.1410	0.1524
10.0	0.1401	0.1481
9.5	0.1251	0.1443
9.0	0.1301	0.1402
8.5	0.1252	0.1359
8.0	0.1238	0.1313
7.5	0.1191	0.1263
7.1	0.1167	0.1220
6.7	0.1074	0.1173
6.3	0.1090	0.1123
5.9	0.0997	0.1068
5.6	0.0974	0.1024
5.3	0.0931	0.0977
5.0	0.0883	0.0927
4.8	0.0838	0.0892
4.5	0.0955	0.0837
4.2	0.0799	0.0778
4.0	0.0725	0.0738



ABSORPTION OF SOUND IN AIR
TEMPERATURE =272.0 K   RELATIVE HUMIDITY = 47.9 %

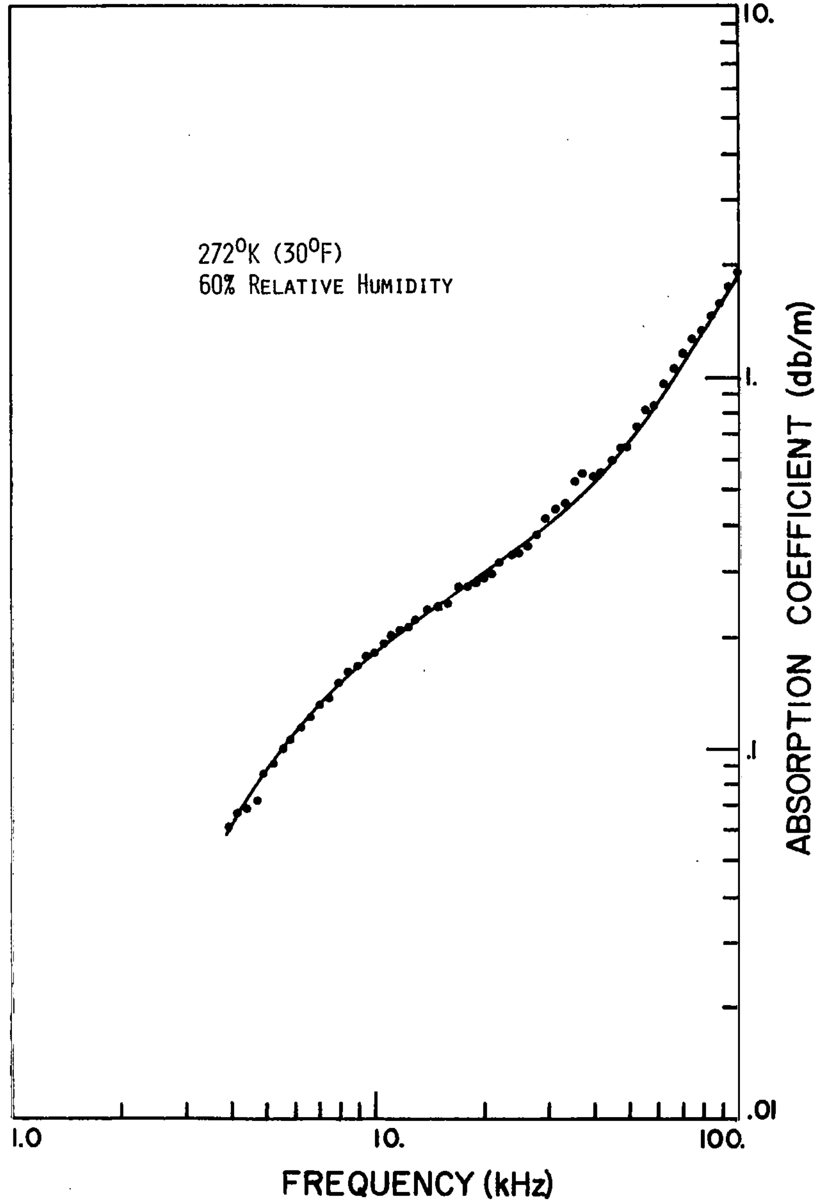
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	1.7923	1.7422
95.0	1.6238	1.5920
90.0	1.4372	1.4495
85.0	1.3186	1.3146
80.0	1.1822	1.1875
75.0	1.0870	1.0680
71.0	1.0048	0.9779
67.0	0.8890	0.8927
63.0	0.7932	0.8125
59.0	0.6713	0.7371
56.0	0.6413	0.6837
53.0	0.5766	0.6332
50.0	0.5043	0.5853
48.0	0.5028	0.5549
45.0	0.4522	0.5115
42.0	0.4227	0.4709
40.0	0.4193	0.4453
37.5	0.3768	0.4149
35.4	0.3802	0.3908
33.4	0.3720	0.3690
31.5	0.3514	0.3493
29.7	0.3447	0.3315
28.0	0.3230	0.3156
26.5	0.2972	0.3021
25.0	0.2836	0.2892
24.0	0.2805	0.2808
22.0	0.2567	0.2648
21.0	0.2500	0.2570
20.0	0.2466	0.2494
19.0	0.2301	0.2419
18.0	0.2250	0.2344
17.0	0.2269	0.2271
16.0	0.2154	0.2196
15.0	0.2011	0.2121
14.0	0.2038	0.2045
13.2	0.1925	0.1981
12.5	0.1880	0.1923
11.8	0.1770	0.1862
11.2	0.1759	0.1808
10.6	0.1719	0.1750
10.0	0.1609	0.1689
9.5	0.1523	0.1635
9.0	0.1526	0.1577
8.5	0.1470	0.1515
8.0	0.1440	0.1449
7.5	0.1351	0.1378
7.1	0.1271	0.1317
6.7	0.1200	0.1252
6.3	0.1156	0.1183
5.9	0.1090	0.1109
5.6	0.1033	0.1051
5.3	0.0966	0.0990
5.0	0.0906	0.0927
4.8	0.0782	0.0884
4.5	0.0762	0.0817
4.2	0.0776	0.0748
4.0	0.0677	0.0701



ABSORPTION OF SOUND IN AIR

TEMPERATURE =272.0 K   RELATIVE HUMIDITY = 60.0 %

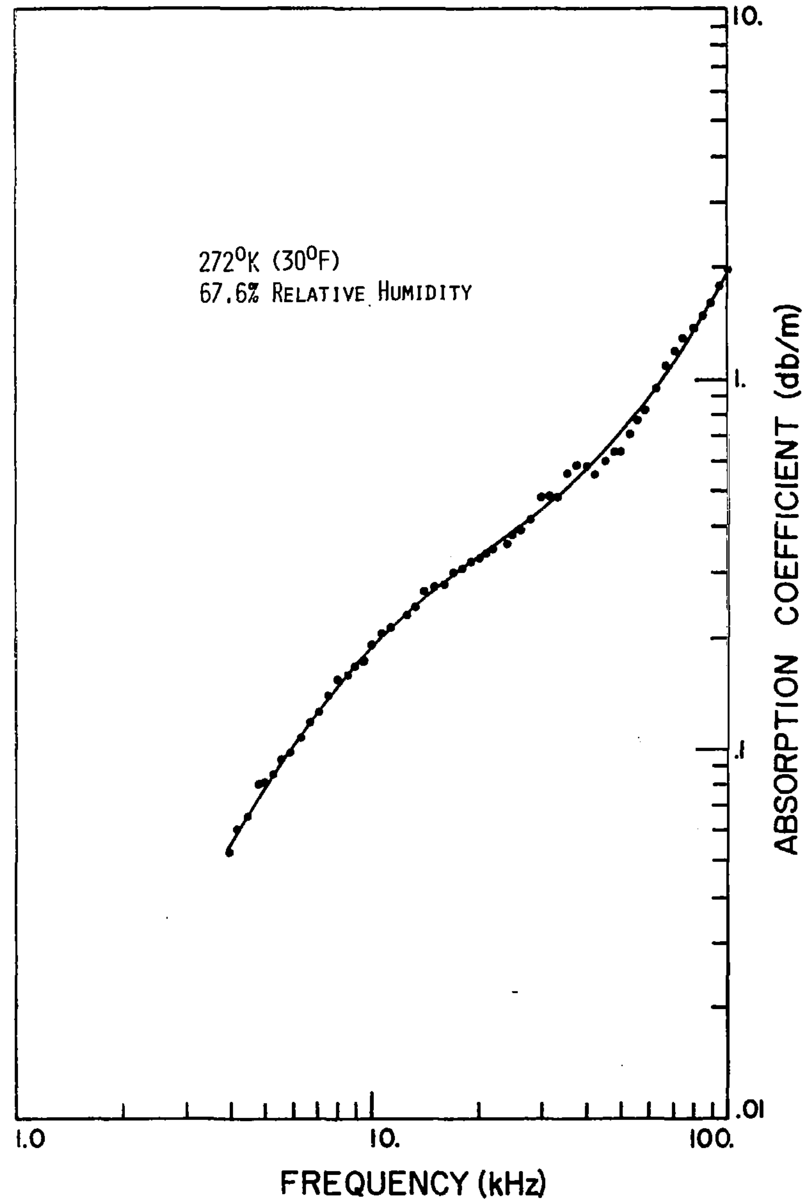
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	1.8967	1.8175
95.0	1.7366	1.6671
90.0	1.5668	1.5245
85.0	1.4540	1.3895
80.0	1.3212	1.2621
75.0	1.2352	1.1424
71.0	1.1501	1.0521
67.0	1.0385	0.9667
63.0	0.9479	0.8862
59.0	0.8371	0.8104
56.0	0.8172	0.7568
53.0	0.7317	0.7058
50.0	0.6408	0.6575
48.0	0.6405	0.6268
45.0	0.5868	0.5828
42.0	0.5487	0.5415
40.0	0.5384	0.5153
37.5	0.5454	0.4841
35.4	0.5184	0.4592
33.4	0.4558	0.4365
31.5	0.4388	0.4158
29.7	0.4183	0.3969
28.0	0.3765	0.3797
26.5	0.3504	0.3650
25.0	0.3337	0.3506
24.0	0.3322	0.3411
22.0	0.3144	0.3225
21.0	0.2987	0.3132
20.0	0.2881	0.3038
19.0	0.2767	0.2944
18.0	0.2728	0.2849
17.0	0.2707	0.2750
16.0	0.2443	0.2649
15.0	0.2396	0.2543
14.0	0.2381	0.2431
13.2	0.2219	0.2337
12.5	0.2144	0.2249
11.8	0.2070	0.2156
11.2	0.2038	0.2072
10.6	0.1907	0.1983
10.0	0.1807	0.1889
9.5	0.1783	0.1806
9.0	0.1678	0.1719
8.5	0.1606	0.1627
8.0	0.1516	0.1530
7.5	0.1383	0.1428
7.1	0.1312	0.1343
6.7	0.1223	0.1255
6.3	0.1151	0.1164
5.9	0.1063	0.1071
5.6	0.1004	0.0959
5.3	0.0914	0.0927
5.0	0.0854	0.0853
4.8	0.0722	0.0804
4.5	0.0689	0.0730
4.2	0.0682	0.0657
4.0	0.0611	0.0609



ABSORPTION OF SOUND IN AIR

TEMPERATURE =272.0 K   RELATIVE HUMIDITY = 67.6 %

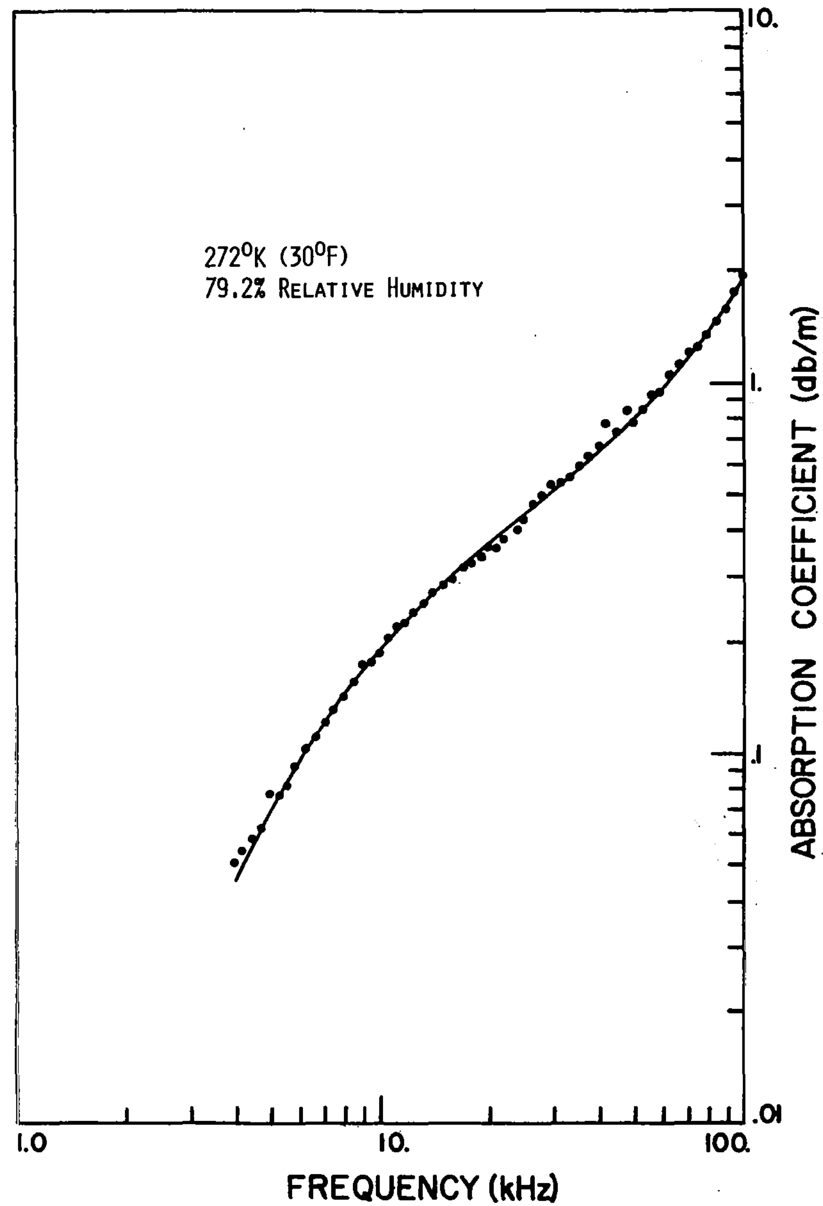
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	1.9513	1.8669
95.0	1.7702	1.7165
90.0	1.5875	1.5737
85.0	1.4774	1.4385
80.0	1.3619	1.3110
75.0	1.2662	1.1911
71.0	1.1884	1.1006
67.0	1.0708	1.0149
63.0	0.9385	0.9340
59.0	0.8177	0.8579
56.0	0.7740	0.8040
53.0	0.7043	0.7526
50.0	0.6341	0.7039
48.0	0.6358	0.6728
45.0	0.5978	0.6283
42.0	0.5525	0.5862
40.0	0.5771	0.5595
37.5	0.5800	0.5275
35.4	0.5527	0.5017
33.4	0.4828	0.4782
31.5	0.4843	0.4565
29.7	0.4809	0.4366
28.0	0.4161	0.4182
26.5	0.3893	0.4022
25.0	0.3776	0.3865
24.0	0.3601	0.3760
22.0	0.3474	0.3550
21.0	0.3379	0.3443
20.0	0.3270	0.3335
19.0	0.3163	0.3225
18.0	0.3060	0.3111
17.0	0.2962	0.2993
16.0	0.2801	0.2869
15.0	0.2745	0.2740
14.0	0.2661	0.2602
13.2	0.2419	0.2485
12.5	0.2307	0.2376
11.2	0.2120	0.2159
10.6	0.2057	0.2051
10.0	0.1910	0.1937
9.5	0.1718	0.1838
9.0	0.1693	0.1735
8.5	0.1591	0.1627
8.0	0.1542	0.1516
7.5	0.1394	0.1401
7.1	0.1276	0.1307
6.7	0.1192	0.1211
6.3	0.1076	0.1113
5.9	0.0968	0.1014
5.6	0.0941	0.0940
5.3	0.0860	0.0865
5.0	0.0816	0.0791
4.8	0.0798	0.0742
4.5	0.0662	0.0669
4.2	0.0612	0.0598
4.0	0.0527	0.0551



ABSORPTION OF SOUND IN AIR

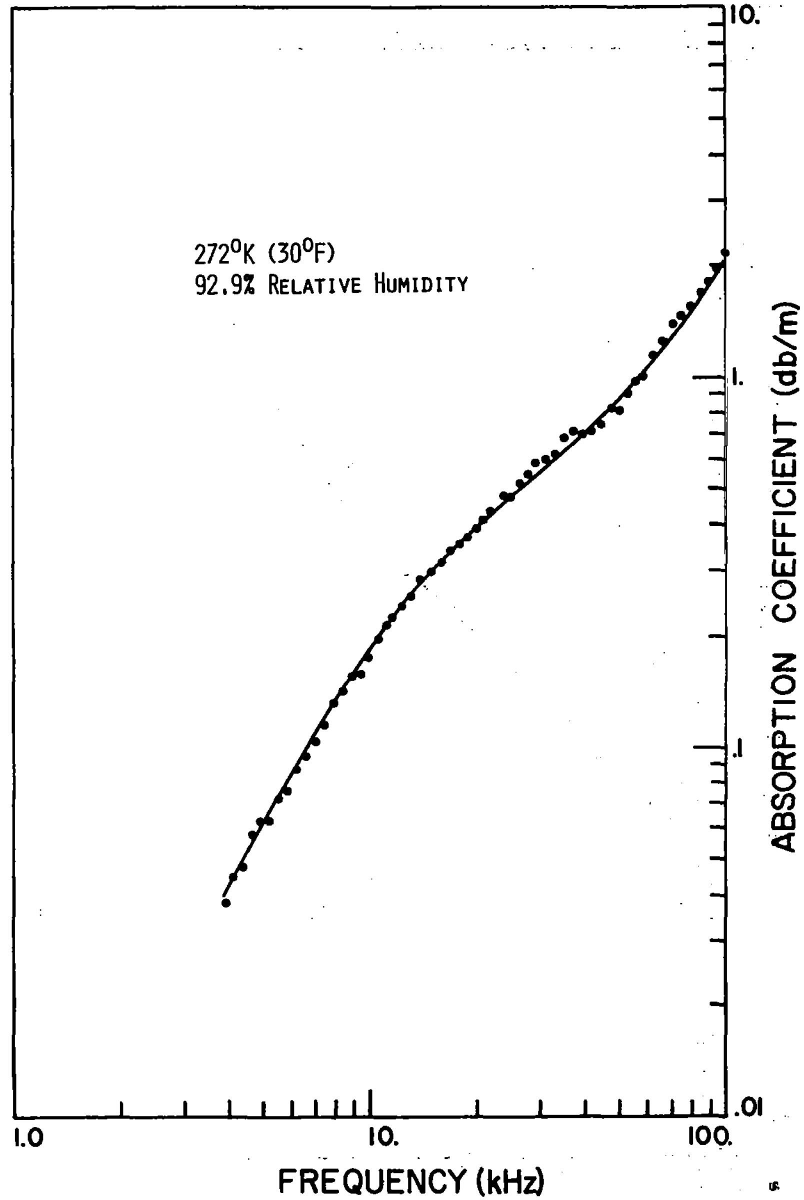
TEMPERATURE =272.0 K   RELATIVE HUMIDITY = 79.2 %

FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	1.9487	1.9447
95.0	1.7567	1.7940
90.0	1.5859	1.6509
85.0	1.4676	1.5153
80.0	1.3441	1.3874
75.0	1.2494	1.2669
71.0	1.2058	1.1759
67.0	1.1215	1.0897
63.0	1.0459	1.0081
59.0	0.9375	0.9312
56.0	0.9313	0.8765
53.0	0.8488	0.8243
50.0	0.7752	0.7745
48.0	0.8306	0.7427
45.0	0.7296	0.6969
42.0	0.7746	0.6532
40.0	0.6710	0.6253
37.5	0.6377	0.5915
35.4	0.5963	0.5640
33.4	0.5445	0.5386
31.5	0.5387	0.5148
29.7	0.5244	0.4926
28.0	0.4954	0.4718
26.5	0.4672	0.4535
25.0	0.4318	0.4350
24.0	0.4023	0.4225
22.0	0.3804	0.3969
21.0	0.3645	0.3837
20.0	0.3616	0.3702
19.0	0.3378	0.3561
18.0	0.3247	0.3415
17.0	0.3166	0.3263
16.0	0.2972	0.3103
15.0	0.2841	0.2935
14.0	0.2708	0.2756
13.2	0.2543	0.2606
12.5	0.2390	0.2468
11.8	0.2258	0.2324
11.2	0.2203	0.2196
10.6	0.2039	0.2064
10.0	0.1875	0.1927
9.5	0.1777	0.1810
9.0	0.1720	0.1690
8.5	0.1564	0.1568
8.0	0.1424	0.1443
7.5	0.1314	0.1318
7.1	0.1214	0.1217
6.7	0.1107	0.1116
6.3	0.1020	0.1015
5.9	0.0923	0.0916
5.6	0.0824	0.0842
5.3	0.0768	0.0769
5.0	0.0777	0.0698
4.8	0.0633	0.0652
4.5	0.0595	0.0583
4.2	0.0552	0.0517
4.0	0.0508	0.0475



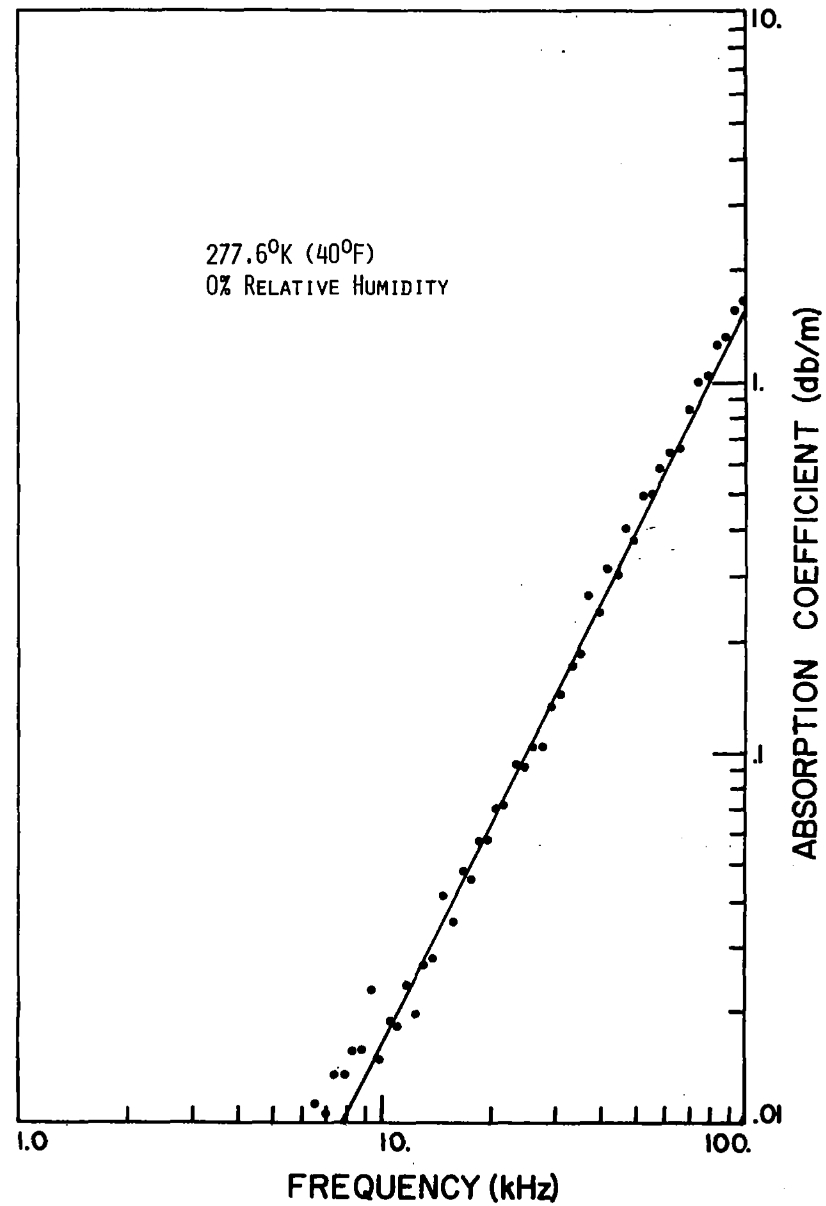
ABSORPTION OF SOUND IN AIR
TEMPERATURE =272,0 K   RELATIVE HUMIDITY = 92,9 %

FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100,0	2,1824	2.0387
95,0	1,9849	1.8874
90,0	1,8073	1.7437
85,0	1,7007	1.6[illegible]5
80,0	1,5565	1.47[illegible]7
75,0	1,4715	1.3573
71,0	1,3952	1.2654
67,0	1,2532	1.1781
63,0	1,1394	1.0953
59,0	1,0137	1.0168
56,0	0,9768	0.9608
53,0	0,8961	0.9071
50,0	0,8239	0.8556
48,0	0,8200	0.8224
45,0	0,7480	0.7743
42,0	0,7237	0.7280
40,0	0,7144	0.6980
37,5	0,7184	0.6612
35,4	0,6931	0.6309
33,4	0,6246	0.6023
31,5	0,6014	0.5753
29,7	0,5845	0.5496
28,0	0,5456	0.5250
26,5	0,5151	0.5030
25,0	0,4750	0.4805
24,0	0,4766	0.4651
22,0	0,4354	0.4332
21,0	0,4128	0.4166
20,0	0,3865	0.3994
19,0	0,3679	0.3815
18,0	0,3571	0.3630
17,0	0,3386	0.3437
16,0	0,3157	0.3235
15,0	0,2985	0.3025
14,0	0,2833	0.2805
13,2	0,2572	0.2623
12,5	0,2429	0.2458
11,8	0,2259	0.2289
11,2	0,2146	0.2141
10,6	0,1976	0.1991
10,0	0,1767	0.1839
9,5	0,1577	0.1711
9,0	0,1568	0.1582
8,5	0,1418	0.1453
8,0	0,1321	0.1324
7,5	0,1163	0.1197
7,1	0,1053	0.1096
6,7	0,0962	0.0997
6,3	0,0878	0.0900
5,9	0,0772	0.0805
5,6	0,0729	0.0736
5,3	0,0640	0.0669
5,0	0,0644	0.0604
4,8	0,0589	0,0562
4,5	0,0483	0.0500
4,2	0,0454	0.0442
4,0	0,0383	0.0404



ABSORPTION OF SOUND IN AIR
TEMPERATURE =277.6 K RELATIVE HUMIDITY = 0.0 %

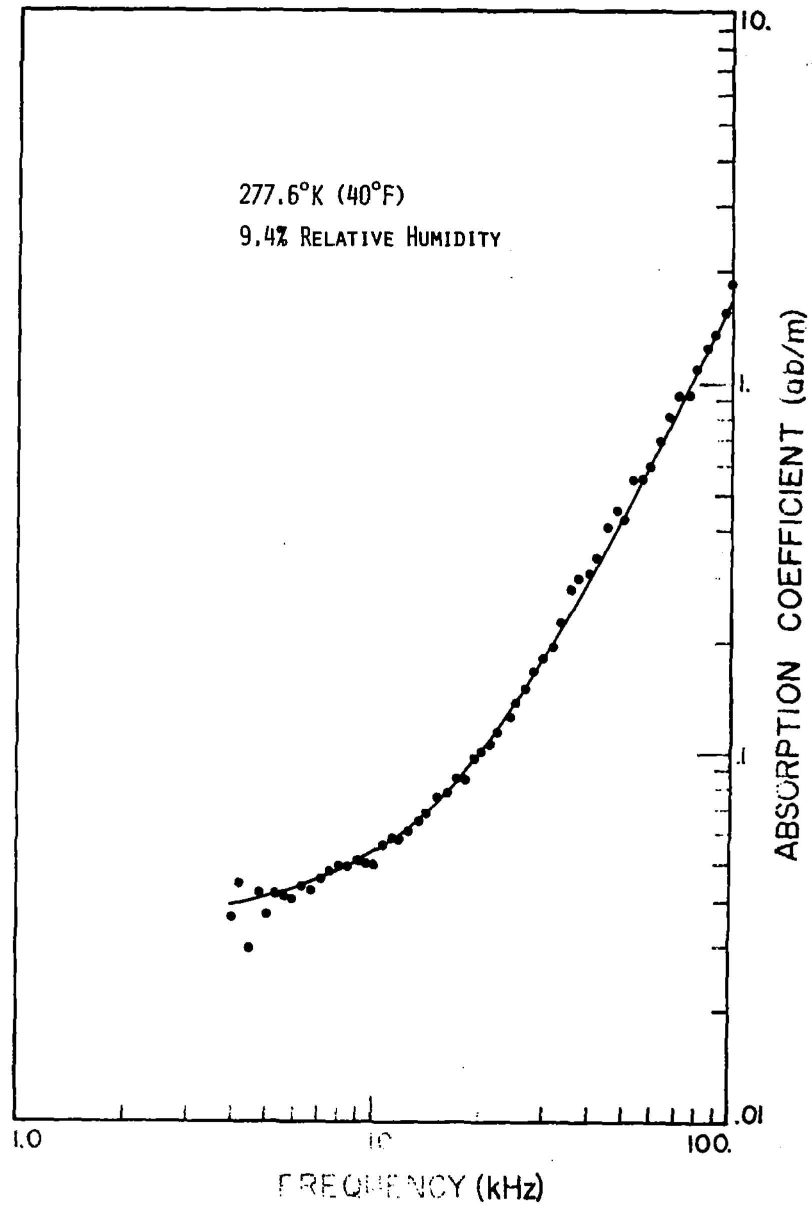
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	1.6640	1.5567
95.0	1.5784	1.4050
90.0	1.3327	1.2611
85.0	1.2695	1.1250
80.0	1.0534	0.9966
75.0	1.0094	0.8761
71.0	0.8470	0.7852
67.0	0.6772	0.6994
63.0	0.6518	0.6185
59.0	0.5944	0.5425
56.0	0.5010	0.4889
53.0	0.4940	0.4380
50.0	0.3761	0.3899
48.0	0.4062	0.3594
45.0	0.3035	0.3160
42.0	0.3166	0.2754
40.0	0.2435	0.2499
37.5	0.2697	0.2198
35.4	0.1874	0.1960
33.4	0.1758	0.1746
31.5	0.1468	0.1554
29.7	0.1363	0.1382
28.0	0.1068	0.1230
26.5	0.1067	0.1103
25.0	0.0920	0.0982
24.0	0.0946	0.0906
22.0	0.0734	0.0763
21.0	0.0722	0.0696
20.0	0.0596	0.0632
19.0	0.0591	0.0572
18.0	0.0463	0.0514
17.0	0.0485	0.0460
16.0	0.0357	0.0408
15.0	0.0418	0.0360
14.0	0.0281	0.0315
13.2	0.0271	0.0281
12.5	0.0209	0.0253
11.8	0.0243	0.0227
11.2	0.0186	0.0205
10.6	0.0194	0.0185
10.0	0.0152	0.0166
9.5	0.0231	0.0151
9.0	0.0159	0.0136
8.5	0.0159	0.0123
8.0	0.0137	0.0110
7.5	0.0139	0.0098
7.1	0.0106	0.0089
6.7	0.0115	0.0080
6.3	0.0069	0.0072
5.9	0.0086	0.0064



ABSORPTION OF SOUND IN AIR

TEMPERATURE =277.6 K   RELATIVE HUMIDITY = 9.4 %

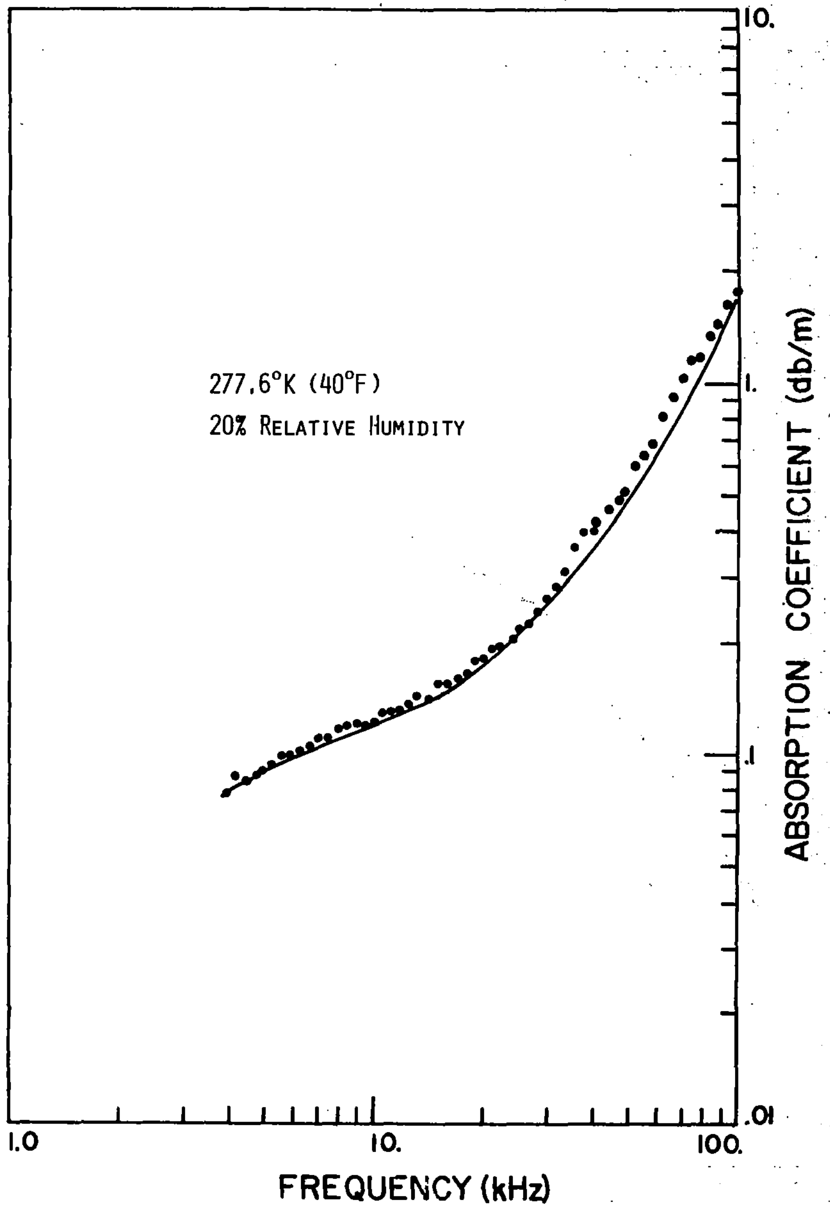
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	1.8038	1.5942
95.0	1.5190	1.4426
90.0	1.3409	1.2987
85.0	1.2155	1.1625
80.0	1.0934	1.0342
75.0	0.9027	0.9136
71.0	0.9094	0.8228
67.0	0.8098	0.7369
63.0	0.6987	0.6560
59.0	0.5974	0.5801
56.0	0.5442	0.5264
53.0	0.5485	0.4755
50.0	0.4214	0.4275
48.0	0.4587	0.3970
45.0	0.4090	0.3536
42.0	0.3379	0.3130
40.0	0.3033	0.2875
37.5	0.2987	0.2573
35.4	0.2734	0.2335
33.4	0.2209	0.2121
31.5	0.1910	0.1929
29.7	0.1782	0.1758
28.0	0.1641	0.1605
26.5	0.1472	0.1478
25.0	0.1349	0.1357
24.0	0.1227	0.1281
22.0	0.1137	0.1138
21.0	0.1047	0.1071
20.0	0.1000	0.1007
19.0	0.0963	0.0946
18.0	0.0835	0.0889
17.0	0.0850	0.0834
16.0	0.0774	0.0783
15.0	0.0752	0.0734
14.0	0.0679	0.0689
13.2	0.0651	0.0655
12.5	0.0613	0.0627
11.8	0.0579	0.0600
11.2	0.0583	0.0578
10.6	0.0564	0.0557
10.0	0.0496	0.0538
9.5	0.0501	0.0522
9.0	0.0505	0.0507
8.5	0.0492	0.0493
8.0	0.0494	0.0480
7.5	0.0476	0.0467
7.1	0.0455	0.0457
6.7	0.0426	0.0448
6.3	0.0431	0.0439
5.9	0.0403	0.0430
5.6	0.0411	0.0424
5.3	0.0412	0.0417
5.0	0.0364	0.0411
4.8	0.0422	0.0407
4.5	0.0294	0.0401
4.2	0.0445	0.0394
4.0	0.0356	0.0390



ABSORPTION OF SOUND IN AIR

TEMPERATURE =277.6 K   RELATIVE HUMIDITY = 20.0 %

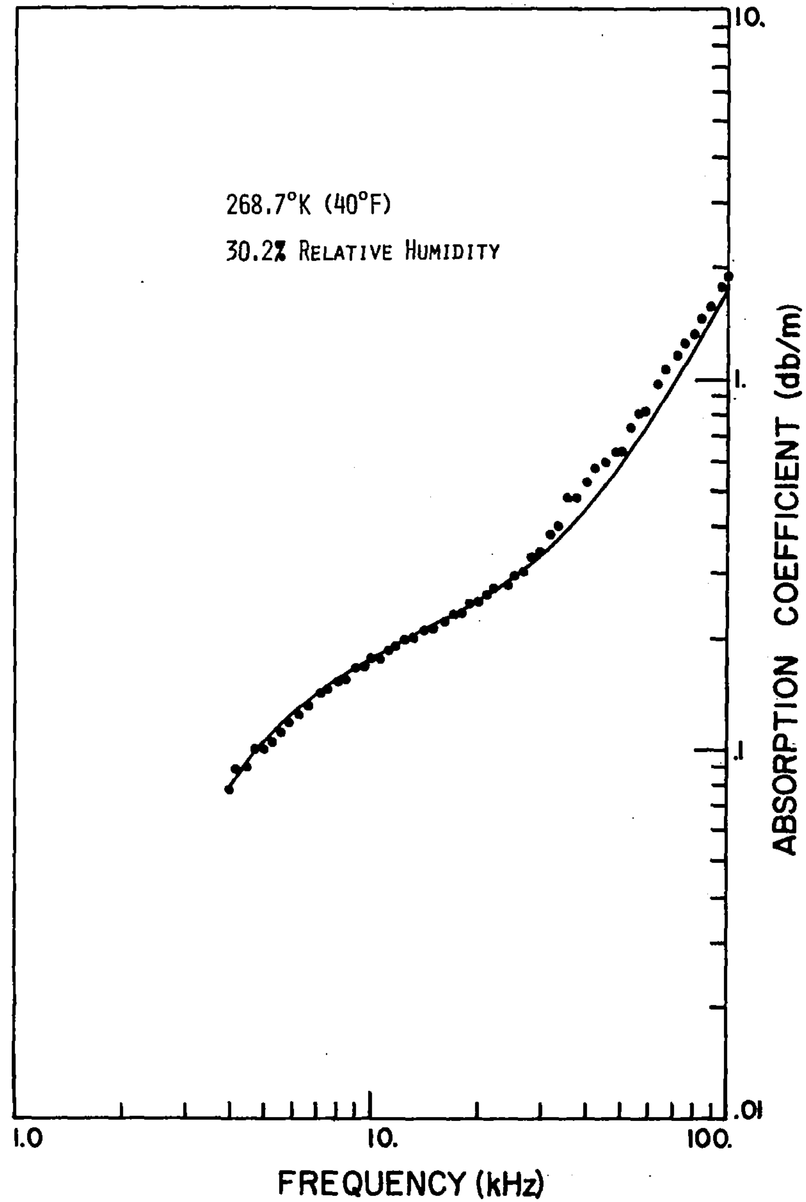
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	2.1944	1.6700
95.0	1.9806	1.5183
90.0	1.7946	1.3744
85.0	1.6201	1.2382
80.0	1.2564	1.1099
75.0	1.4089	0.9893
71.0	1.3353	0.8984
67.0	1.2023	0.8125
63.0	1.0154	0.7316
59.0	0.8768	0.6557
56.0	0.8098	0.6020
53.0	0.7514	0.5511
50.0	0.6610	0.5030
48.0	0.5990	0.4724
45.0	0.5311	0.4290
42.0	0.4960	0.3883
40.0	0.4081	0.3627
37.5	0.4030	0.3325
35.4	0.3686	0.3086
33.4	0.3138	0.2871
31.5	0.2903	0.2678
29.7	0.2675	0.2506
28.0	0.2429	0.2352
26.5	0.2250	0.2223
25.0	0.2214	0.2102
24.0	0.2084	0.2024
22.0	0.1989	0.1878
21.0	0.1932	0.1809
20.0	0.1838	0.1744
19.0	0.1806	0.1681
18.0	0.1662	0.1620
17.0	0.1611	0.1562
16.0	0.1561	0.1507
15.0	0.1552	0.1454
14.0	0.1420	0.1403
13.2	0.1437	0.1364
12.5	0.1386	0.1331
11.8	0.1330	0.1298
11.2	0.1321	0.1270
10.6	0.1302	0.1242
10.0	0.1234	0.1214
9.5	0.1209	0.1190
9.0	0.1211	0.1166
8.5	0.1213	0.1141
8.0	0.1172	0.1115
7.5	0.1121	0.1087
7.1	0.1123	0.1064
6.7	0.1064	0.1039
6.3	0.1035	0.1012
5.9	0.1014	0.0982
5.6	0.0993	0.0958
5.3	0.0957	0.0931
5.0	0.0914	0.0903
4.8	0.0882	0.0882
4.5	0.0856	0.0849
4.2	0.0886	0.0811
4.0	0.0781	0.0784



ABSORPTION OF SOUND IN AIR

TEMPERATURE =277.6 K   RELATIVE HUMIDITY = 30.2 %

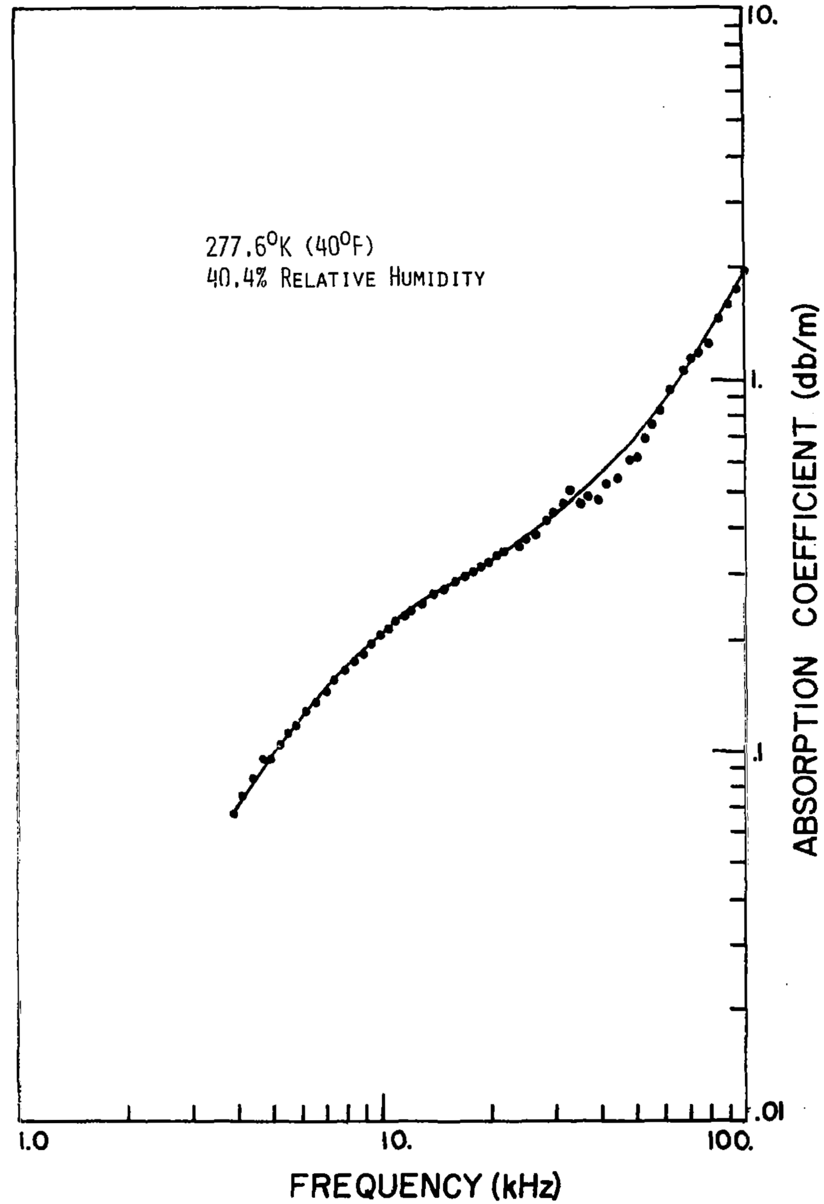
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	1.2556	1.7629
95.0	1.1134	1.6112
90.0	0.9856	1.4672
85.0	0.9074	1.3310
80.0	0.8693	1.2026
75.0	0.7564	1.0819
71.0	0.6988	0.9909
67.0	0.6316	0.9049
63.0	0.5463	0.8239
59.0	0.5739	0.7477
56.0	0.5396	0.6939
53.0	0.5022	0.6428
50.0	0.4392	0.5945
48.0	0.4380	0.5638
45.0	0.3929	0.5201
42.0	0.3889	0.4791
40.0	0.4220	0.4533
37.5	0.4847	0.4227
35.4	0.4311	0.3984
33.4	0.3756	0.3765
31.5	0.3637	0.3567
29.7	0.3437	0.3389
28.0	0.3333	0.3229
26.5	0.2992	0.3094
25.0	0.2906	0.2965
24.0	0.2791	0.2882
22.0	0.2693	0.2722
21.0	0.2588	0.2645
20.0	0.2521	0.2570
19.0	0.2503	0.2496
18.0	0.2346	0.2423
17.0	0.2348	0.2351
16.0	0.2223	0.2279
15.0	0.2132	0.2207
14.0	0.2108	0.2133
13.2	0.2015	0.2072
12.5	0.1994	0.2017
11.8	0.1903	0.1959
11.2	0.1874	0.1907
10.6	0.1783	0.1852
10.0	0.1752	0.1794
9.5	0.1679	0.1742
9.0	0.1655	0.1687
8.5	0.1579	0.1628
8.0	0.1522	0.1564
7.5	0.1447	0.1495
7.1	0.1417	0.1435
6.7	0.1326	0.1371
6.3	0.1253	0.1302
5.9	0.1193	0.1229
5.6	0.1138	0.1170
5.3	0.1066	0.1108
5.0	0.1012	0.1043
4.8	0.1000	0.0997
4.5	0.0896	0.0927
4.2	0.0890	0.0854
4.0	0.0772	0.0803



ABSORPTION OF SOUND IN AIR

TEMPERATURE =277.6 K   RELATIVE HUMIDITY = 40.4 %

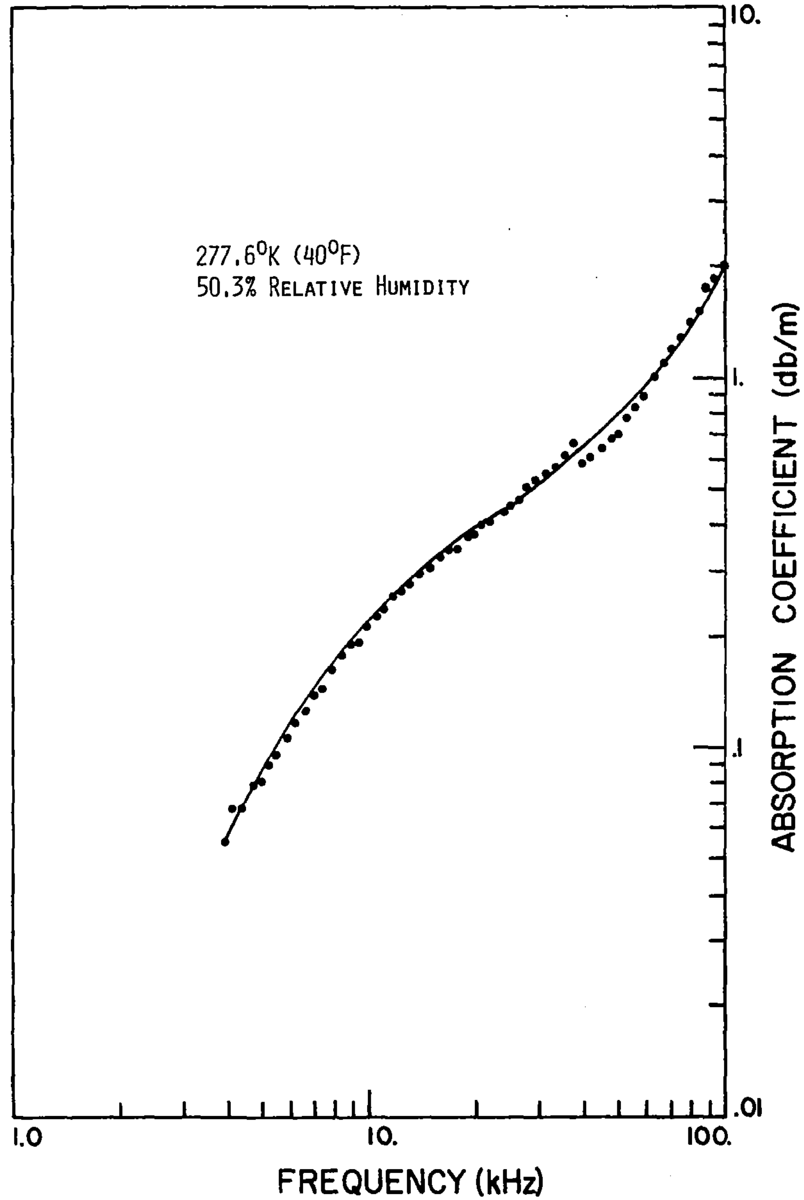
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	1.9168	1.8679
95.0	1.7400	1.7160
90.0	1.5742	1.5719
85.0	1.4359	1.4355
80.0	1.2339	1.3068
75.0	1.1859	1.1858
71.0	1.1347	1.0946
67.0	1.0271	1.0083
63.0	0.9304	0.9268
59.0	0.8060	0.8502
56.0	0.7421	0.7960
53.0	0.6991	0.7444
50.0	0.6057	0.6956
48.0	0.6028	0.6644
45.0	0.5463	0.6199
42.0	0.5208	0.5780
40.0	0.4727	0.5515
37.5	0.4708	0.5198
35.4	0.4638	0.4944
33.4	0.4946	0.4713
31.5	0.4612	0.4502
29.7	0.4391	0.4309
28.0	0.4104	0.4133
26.5	0.3774	0.3982
25.0	0.3715	0.3833
24.0	0.3569	0.3735
22.0	0.3479	0.3541
21.0	0.3370	0.3444
20.0	0.3214	0.3346
19.0	0.3173	0.3247
18.0	0.3002	0.3145
17.0	0.2950	0.3041
16.0	0.2844	0.2932
15.0	0.2709	0.2818
14.0	0.2652	0.2698
13.2	0.2495	0.2595
12.5	0.2462	0.2499
11.8	0.2365	0.2398
11.2	0.2242	0.2305
10.6	0.2140	0.2207
10.0	0.2055	0.2103
9.5	0.1971	0.2011
9.0	0.1860	0.1914
8.5	0.1767	0.1812
8.0	0.1675	0.1705
7.5	0.1553	0.1591
7.1	0.1449	0.1497
6.7	0.1368	0.1399
6.3	0.1271	0.1298
5.9	0.1178	0.1194
5.6	0.1113	0.1114
5.3	0.1029	0.1033
5.0	0.0952	0.0952
4.8	0.0955	0.0897
4.5	0.0822	0.0815
4.2	0.0789	0.0733
4.0	0.0682	0.0679



ABSORPTION OF SOUND IN AIR

TEMPERATURE =277.6 K   RELATIVE HUMIDITY = 50.3 %

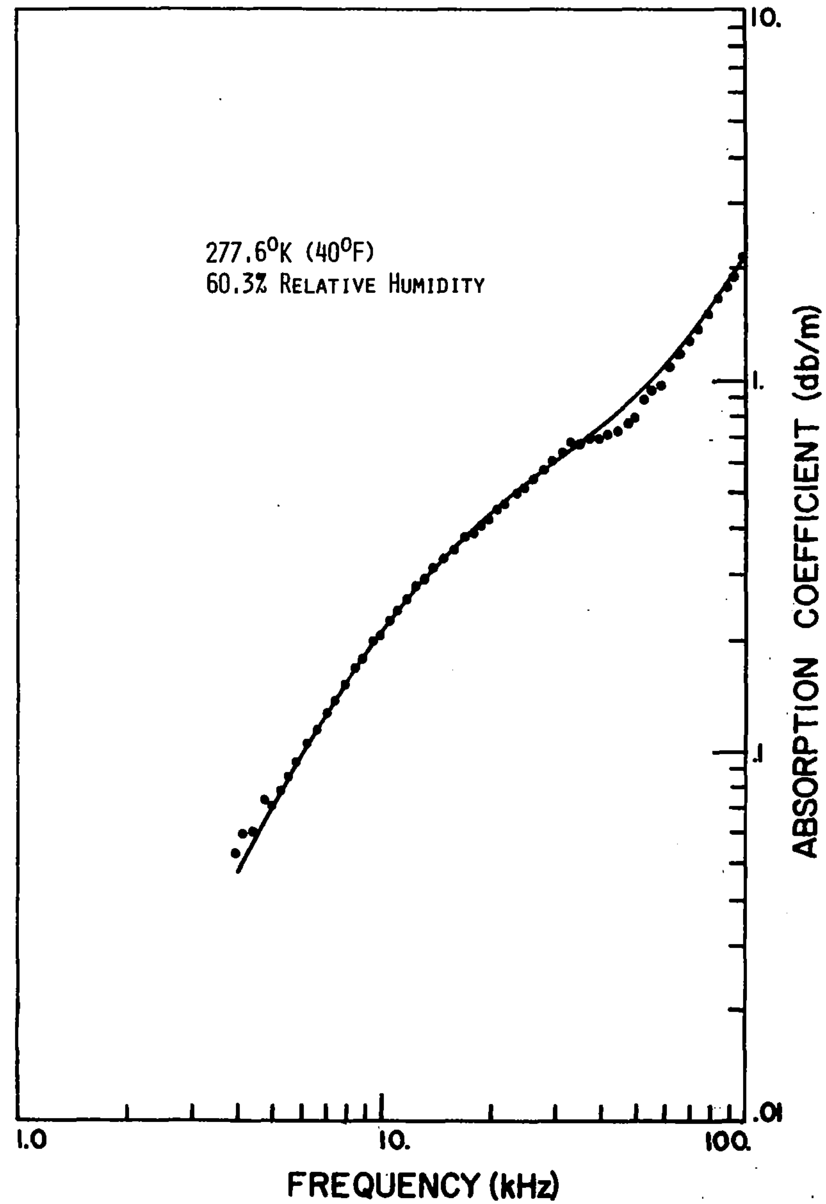
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	2.0338	1.9768
95.0	1.8224	1.8247
90.0	1.7045	1.6802
85.0	1.5085	1.5433
80.0	1.4168	1.4142
75.0	1.2824	1.2926
71.0	1.2144	1.2008
67.0	1.1064	1.1138
63.0	1.0105	1.0316
59.0	0.8849	0.9541
56.0	0.8300	0.8990
53.0	0.7855	0.8465
50.0	0.7098	0.7964
48.0	0.6949	0.7645
45.0	0.6411	0.7185
42.0	0.6162	0.6747
40.0	0.5977	0.6468
37.5	0.6679	0.6130
35.4	0.6290	0.5857
33.4	0.5752	0.5603
31.5	0.5537	0.5368
29.7	0.5239	0.5140
28.0	0.5047	0.4943
26.5	0.4709	0.4762
25.0	0.4537	0.4580
24.0	0.4361	0.4457
22.0	0.4074	0.4207
21.0	0.3982	0.4077
20.0	0.3806	0.3944
19.0	0.3708	0.3806
18.0	0.3458	0.3663
17.0	0.3435	0.3513
16.0	0.3270	0.3355
15.0	0.3085	0.3187
14.0	0.2960	0.3008
13.2	0.2791	0.2857
12.5	0.2689	0.2717
11.8	0.2513	0.2570
11.2	0.2395	0.2439
10.6	0.2262	0.2301
10.0	0.2105	0.2158
9.5	0.1938	0.2035
9.0	0.1871	0.1908
8.5	0.1749	0.1777
8.0	0.1632	0.1644
7.5	0.1449	0.1508
7.1	0.1377	0.1397
6.7	0.1259	0.1286
6.3	0.1156	0.1174
5.9	0.1058	0.1063
5.6	0.0969	0.0980
5.3	0.0888	0.0898
5.0	0.0818	0.0817
4.8	0.0781	0.0764
4.5	0.0697	0.0685
4.2	0.0682	0.0609
4.0	0.0556	0.0560



ABSORPTION OF SOUND IN AIR

TEMPERATURE =277.6 K RELATIVE HUMIDITY = 60.3 %

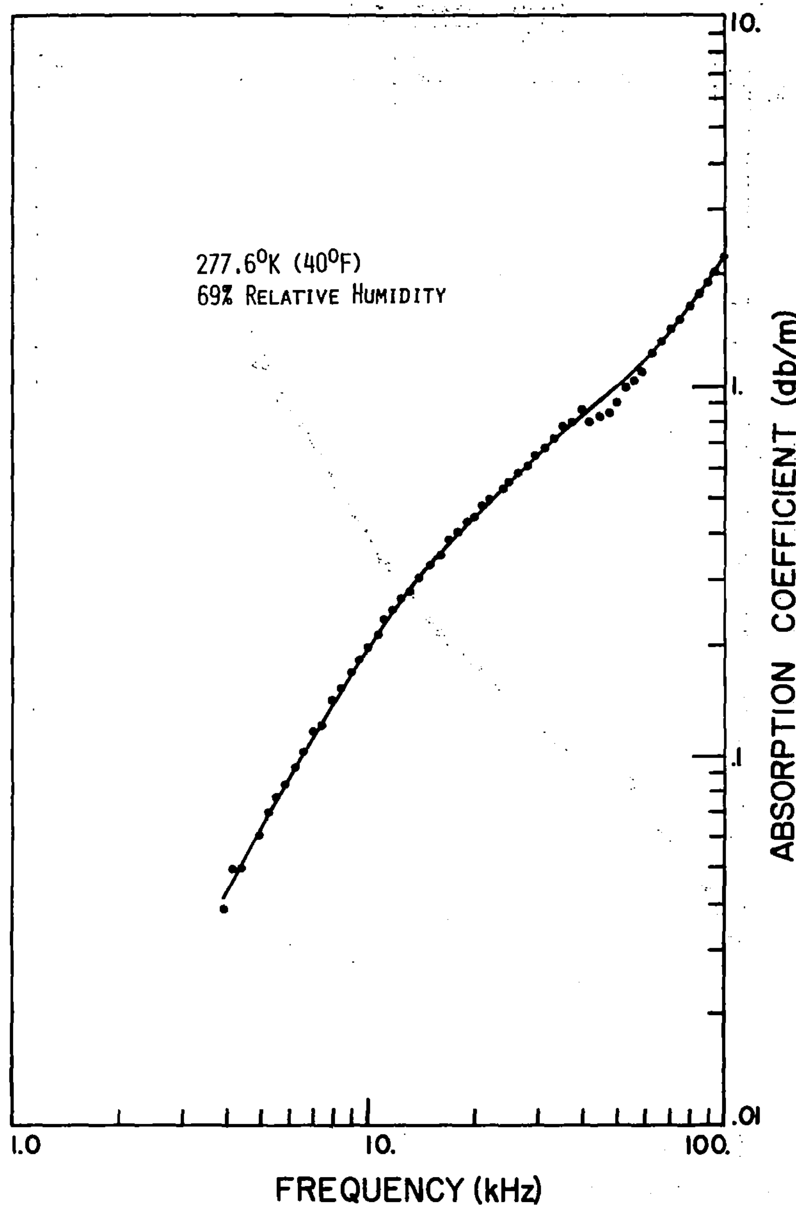
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	2.1002	2.0907
95.0	1.8857	1.9380
90.0	1.7376	1.7929
85.0	1.6036	1.6553
80.0	1.4862	1.5253
75.0	1.3489	1.4027
71.0	1.2624	1.3099
67.0	1.1618	1.2217
63.0	1.0662	1.1381
59.0	0.9591	1.0590
56.0	0.9136	1.0025
53.0	0.8668	0.9483
50.0	0.7797	0.8963
48.0	0.7693	0.8629
45.0	0.7071	0.8144
42.0	0.6942	0.7677
40.0	0.6816	0.7374
37.5	0.6787	0.7004
35.4	0.6620	0.6698
33.4	0.6611	0.6410
31.5	0.6244	0.6137
29.7	0.5921	0.5878
28.0	0.5675	0.5629
26.5	0.5320	0.5406
25.0	0.5058	0.5178
24.0	0.4863	0.5022
22.0	0.4593	0.4697
21.0	0.4448	0.4526
20.0	0.4127	0.4350
19.0	0.4024	0.4166
18.0	0.3780	0.3975
17.0	0.3725	0.3774
16.0	0.3472	0.3564
15.0	0.3297	0.3343
14.0	0.3092	0.3111
13.2	0.2827	0.2917
12.5	0.2778	0.2742
11.8	0.2548	0.2561
11.2	0.2382	0.2401
10.6	0.2234	0.2238
10.0	0.2013	0.2072
9.5	0.1960	0.1932
9.0	0.1763	0.1791
8.5	0.1670	0.1649
8.0	0.1508	0.1506
7.5	0.1373	0.1364
7.1	0.1276	0.1252
6.7	0.1143	0.1141
6.3	0.1046	0.1032
5.9	0.0940	0.0925
5.6	0.0847	0.0846
5.3	0.0773	0.0770
5.0	0.0710	0.0696
4.8	0.0748	0.0648
4.5	0.0603	0.0578
4.2	0.0594	0.0511
4.0	0.0524	0.0467



ABSORPTION OF SOUND IN AIR

TEMPERATURE =277.6 K   RELATIVE HUMIDITY = 69.0 %

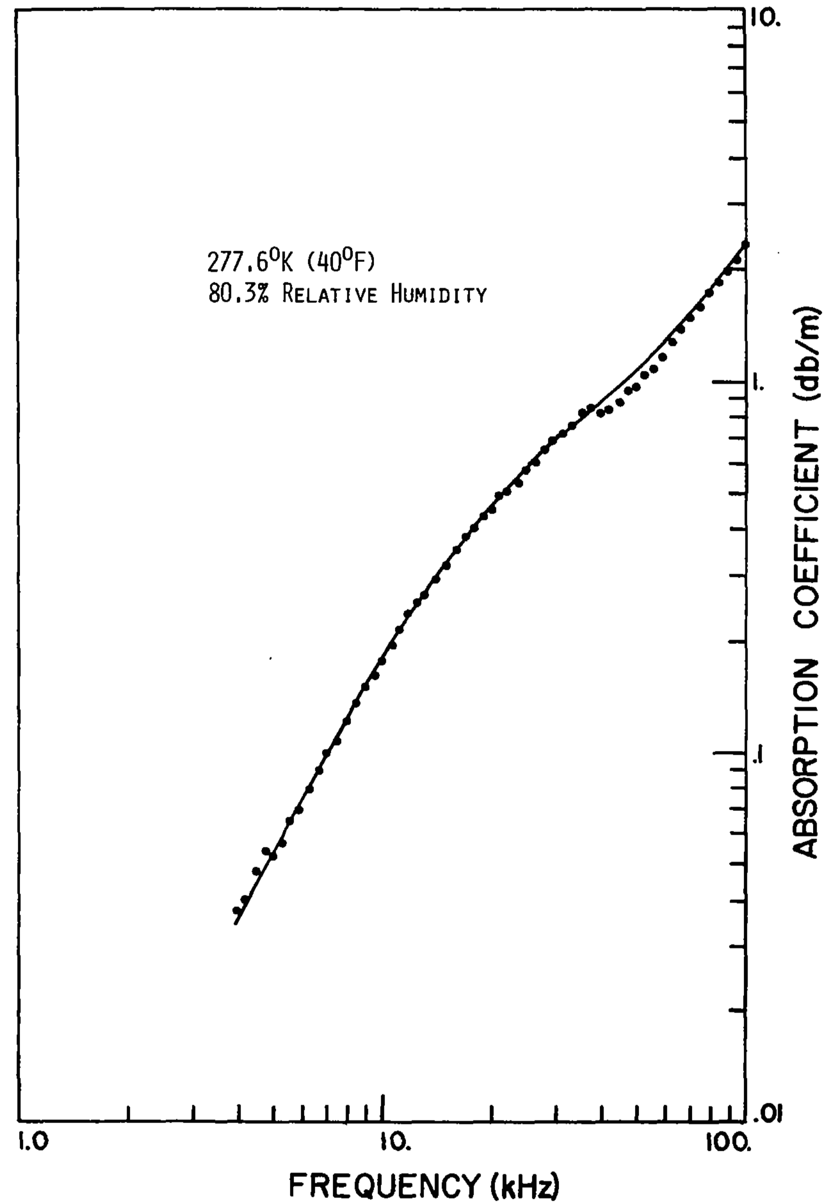
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	2.2131	2.1911
95.0	2.0226	2.0377
90.0	1.8674	1.8917
85.0	1.7517	1.7532
80.0	1.6102	1.6220
75.0	1.4754	1.4980
71.0	1.3969	1.4039
67.0	1.2926	1.3143
63.0	1.2102	1.2289
59.0	1.0753	1.1477
56.0	1.0213	1.0893
53.0	0.9771	1.0331
50.0	0.8941	0.9787
48.0	0.8305	0.9434
45.0	0.8143	0.8918
42.0	0.7809	0.8415
40.0	0.8528	0.8085
37.5	0.7853	0.7677
35.4	0.7721	0.7334
33.4	0.7125	0.7007
31.5	0.6750	0.6692
29.7	0.6404	0.6389
28.0	0.6021	0.6095
26.5	0.5669	0.5829
25.0	0.5372	0.5554
24.0	0.5229	0.5365
22.0	0.4854	0.4969
21.0	0.4731	0.4762
20.0	0.4377	0.4547
19.0	0.4282	0.4325
18.0	0.3977	0.4094
17.0	0.3806	0.3855
16.0	0.3468	0.3606
15.0	0.3274	0.3348
14.0	0.3007	0.3082
13.2	0.2785	0.2863
12.5	0.2640	0.2667
11.8	0.2451	0.2468
11.2	0.2327	0.2296
10.6	0.2106	0.2122
10.0	0.1936	0.1949
9.5	0.1773	0.1804
9.0	0.1670	0.1660
8.5	0.1517	0.1517
8.0	0.1409	0.1376
7.5	0.1214	0.1237
7.1	0.1156	0.1129
6.7	0.1017	0.1023
6.3	0.0937	0.0920
5.9	0.0838	0.0820
5.6	0.0766	0.0748
5.3	0.0700	0.0678
5.0	0.0611	0.0611
4.5	0.0500	0.0505
4.2	0.0494	0.0445
4.0	0.0385	0.0407



ABSORPTION OF SOUND IN AIR

TEMPERATURE =277.6 K   RELATIVE HUMIDITY = 80.3 %

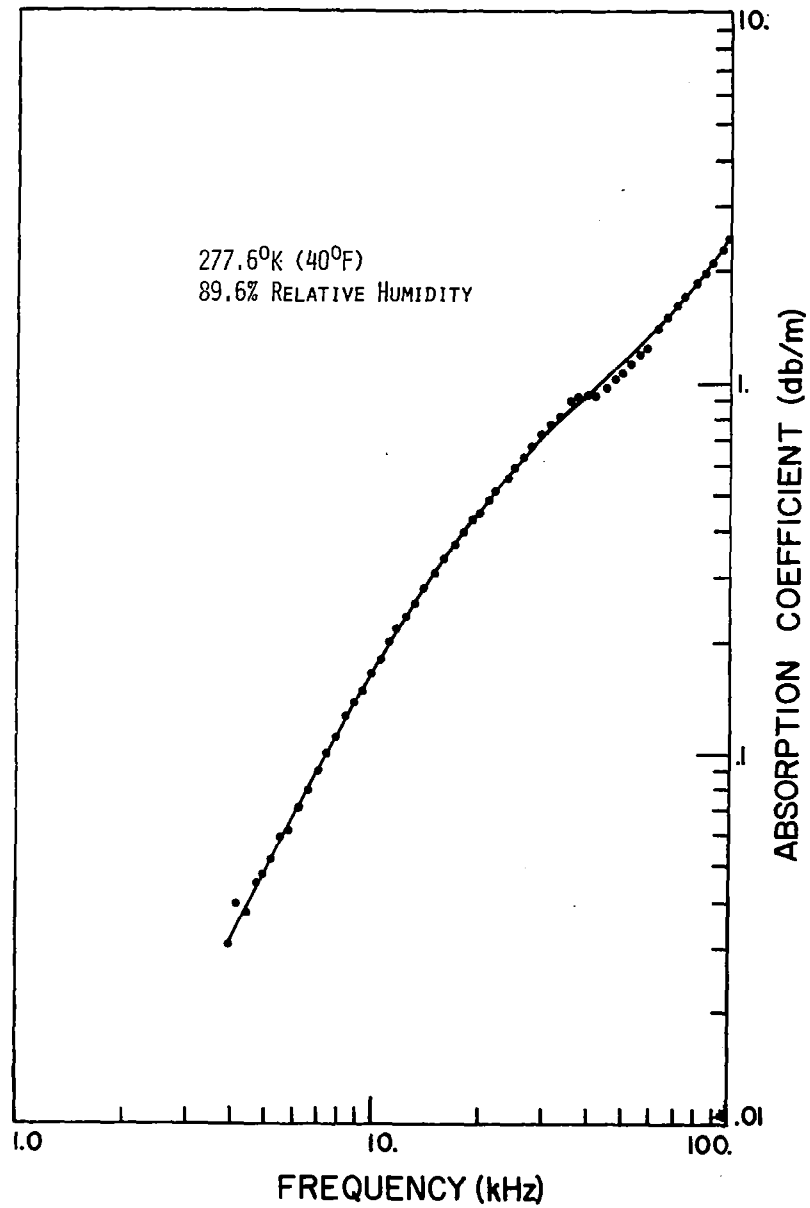
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	2.3317	2.3212
95.0	2.1363	2.1664
90.0	1.9720	2.0189
85.0	1.8444	1.8785
80.0	1.7282	1.7452
75.0	1.5857	1.6187
71.0	1.4991	1.5222
67.0	1.3823	1.4298
63.0	1.2855	1.3413
59.0	1.1515	1.2563
56.0	1.0897	1.1947
53.0	1.0406	1.1348
50.0	0.9607	1.0762
48.0	0.9418	1.0379
45.0	0.8785	0.9811
42.0	0.8366	0.9248
40.0	0.8183	0.8873
37.5	0.8440	0.8402
35.4	0.8321	0.8002
33.4	0.7622	0.7615
31.5	0.7389	0.7238
29.7	0.6801	0.6872
28.0	0.6551	0.6515
26.5	0.6027	0.6189
25.0	0.5702	0.5852
24.0	0.5374	0.5621
22.0	0.5051	0.5139
21.0	0.4934	0.4889
20.0	0.4486	0.4632
19.0	0.4368	0.4367
18.0	0.4037	0.4096
17.0	0.3796	0.3818
16.0	0.3505	0.3534
15.0	0.3188	0.3245
14.0	0.2932	0.2952
13.2	0.2675	0.2715
12.5	0.2550	0.2507
11.8	0.2334	0.2300
11.2	0.2196	0.2122
10.6	0.1975	0.1947
10.0	0.1788	0.1773
9.5	0.1617	0.1631
9.0	0.1510	0.1491
8.5	0.1377	0.1354
8.0	0.1213	0.1220
7.5	0.1097	0.1091
7.1	0.1017	0.0990
6.7	0.0912	0.0894
6.3	0.0802	0.0800
5.9	0.0703	0.0711
5.6	0.0666	0.0646
5.3	0.0579	0.0584
5.0	0.0538	0.0525
4.8	0.0555	0.0487
4.5	0.0484	0.0432
4.2	0.0410	0.0380
4.0	0.0382	0.0347



ABSORPTION OF SOUND IN AIR

TEMPERATURE =277.6 K   RELATIVE HUMIDITY = 89.6 %

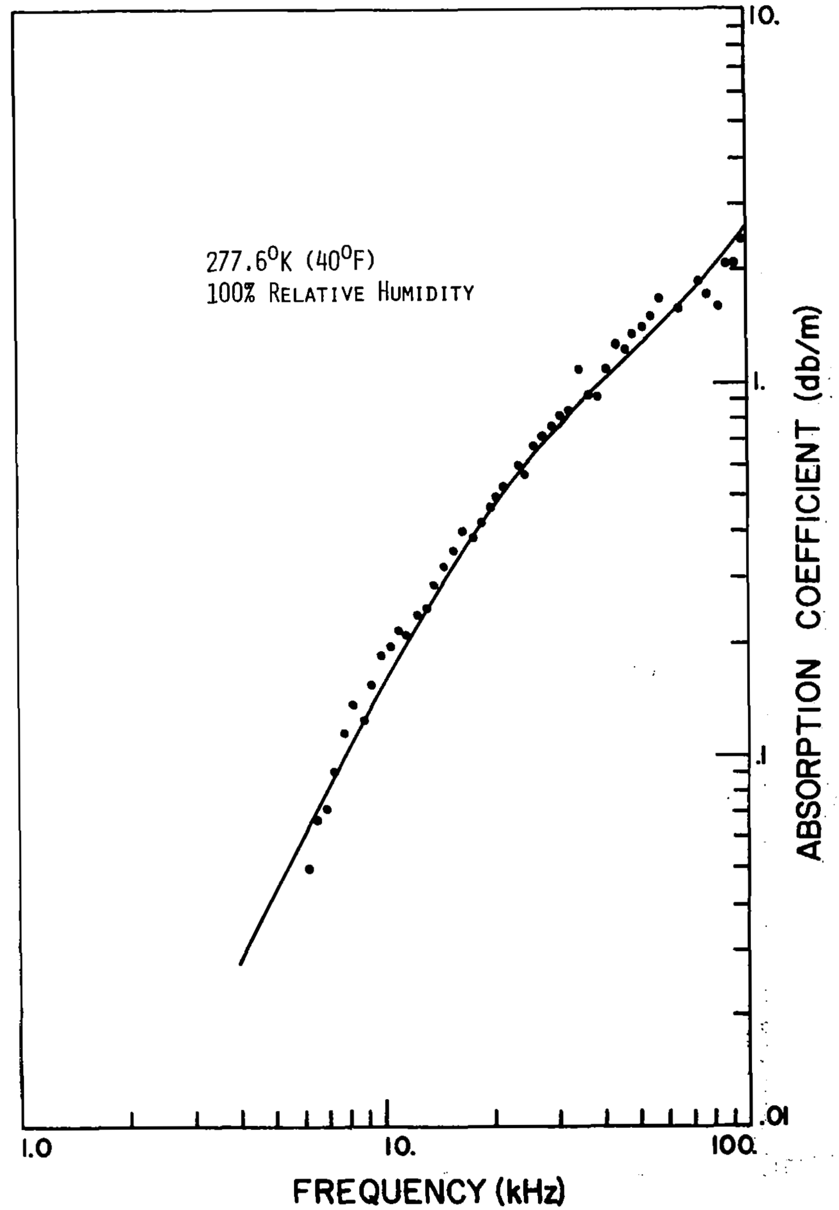
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	2.4546	2.4266
95.0	2.2738	2.2703
90.0	2.1078	2.1210
85.0	1.9656	1.9786
80.0	1.8556	1.8429
75.0	1.6991	1.7136
71.0	1.6241	1.6145
67.0	1.5019	1.5151
63.0	1.3960	1.4272
59.0	1.2435	1.3383
56.0	1.1944	1.2733
53.0	1.1365	1.2096
50.0	1.0604	1.1468
48.0	1.0345	1.1053
45.0	0.9622	1.0433
42.0	0.9168	0.9813
40.0	0.9260	0.9396
37.5	0.9188	0.8868
35.4	0.8853	0.8415
33.4	0.8114	0.7975
31.5	0.7796	0.7545
29.7	0.7227	0.7126
28.0	0.6749	0.6718
26.5	0.6311	0.6346
25.0	0.5881	0.5963
24.0	0.5569	0.5701
22.0	0.5090	0.5160
21.0	0.4900	0.4891
20.0	0.4479	0.4597
19.0	0.4301	0.4307
18.0	0.3987	0.4014
17.0	0.3690	0.3716
16.0	0.3394	0.3415
15.0	0.3072	0.3112
14.0	0.2804	0.2809
13.2	0.2552	0.2568
12.5	0.2388	0.2359
11.8	0.2189	0.2151
11.2	0.2015	0.1976
10.6	0.1817	0.1804
10.0	0.1645	0.1636
9.5	0.1486	0.1499
9.0	0.1384	0.1365
8.5	0.1260	0.1235
8.0	0.1115	0.1110
7.5	0.1012	0.0989
7.1	0.0905	0.0896
6.7	0.0800	0.0806
6.3	0.0705	0.0721
5.9	0.0627	0.0639
5.6	0.0602	0.0580
5.3	0.0521	0.0524
5.0	0.0480	0.0470
4.8	0.0453	0.0436
4.5	0.0379	0.0387
4.2	0.0408	0.0340
4.0	0.0311	0.0311



ABSORPTION OF SOUND IN AIR

TEMPERATURE =277.6 K   RELATIVE HUMIDITY =100.0 %

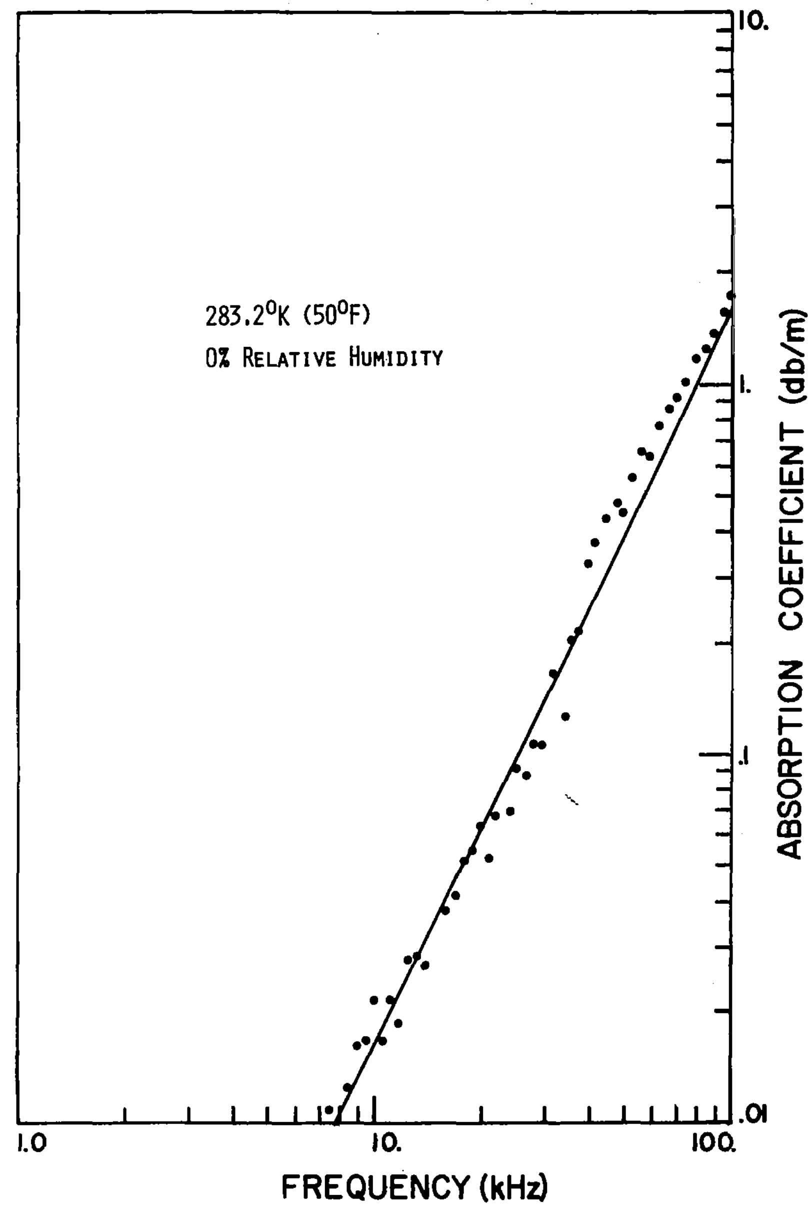
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	2.4032	2.5412
95.0	2.0386	2.3827
90.0	2.0570	2.2309
85.0	1.5655	2.0957
80.0	1.6998	1.9466
75.0	1.8280	1.8134
67.0	1.5388	1.6114
63.0	1.4975	1.5148
59.0	1.6464	1.4206
56.0	1.4876	1.3512
53.0	1.3907	1.2825
50.0	1.3089	1.2142
48.0	1.2028	1.1689
45.0	1.2431	1.1005
42.0	1.0735	1.0314
40.0	0.8998	0.9846
37.5	0.9049	0.9251
35.4	1.0822	0.8740
33.4	0.8265	0.8241
31.5	0.8041	0.7754
29.7	0.7556	0.7290
28.0	0.7095	0.6820
26.5	0.6634	0.6403
25.0	0.5600	0.5977
24.0	0.5879	0.5697
22.0	0.5120	0.5055
21.0	0.4867	0.4793
20.0	0.4667	0.4488
19.0	0.4193	0.4191
18.0	0.3806	0.3872
17.0	0.3944	0.3562
16.0	0.3511	0.3252
15.0	0.3158	0.2945
14.0	0.2817	0.2640
13.2	0.2444	0.2401
12.5	0.2351	0.2195
11.8	0.2073	0.1993
11.2	0.2136	0.1824
10.6	0.1929	0.1659
10.0	0.1820	0.1498
9.5	0.1521	0.1369
9.0	0.1222	0.1243
8.5	0.1361	0.1122
8.0	0.1143	0.1005
7.5	0.0905	0.0894
7.1	0.0718	0.0808
6.7	0.0677	0.0726
6.3	0.0502	0.0648



ABSORPTION OF SOUND IN AIR

TEMPERATURE =283.2 K   RELATIVE HUMIDITY = 0.0 %

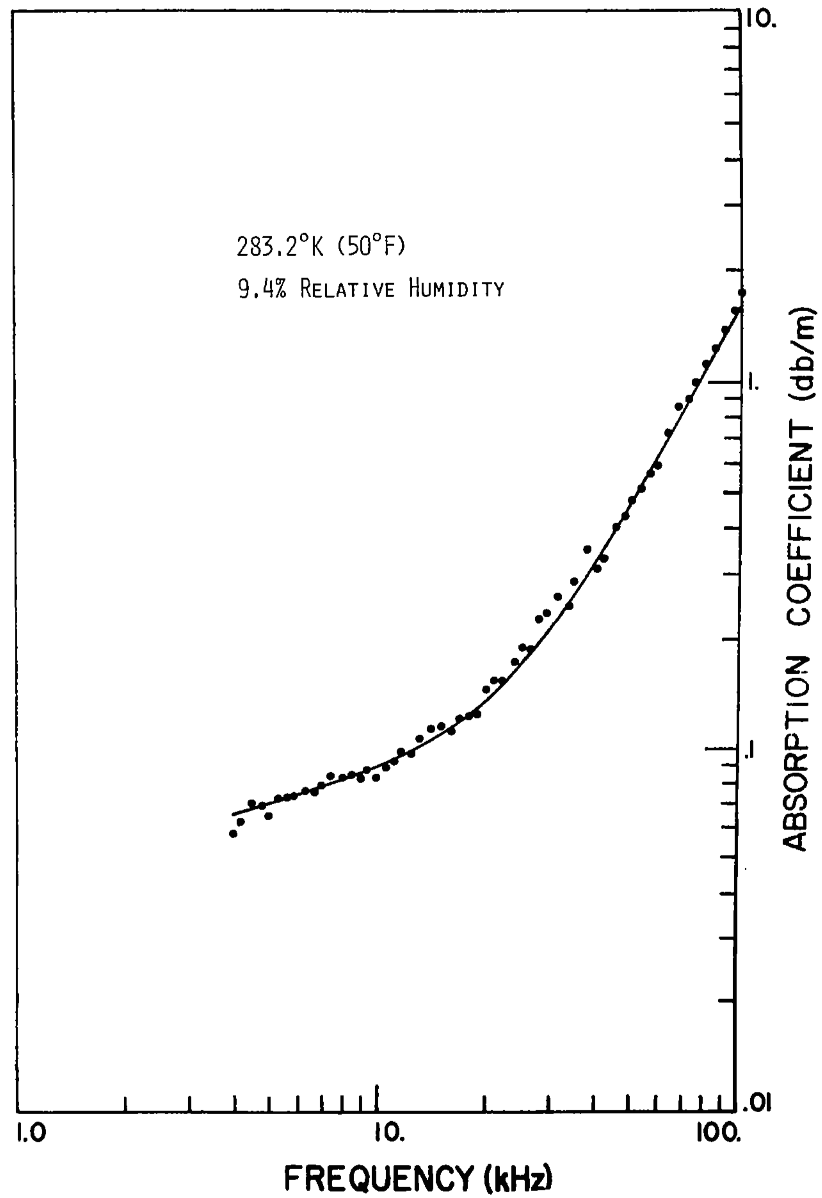
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	1.7246	1.5723
95.0	1.5611	1.4191
90.0	1.3620	1.2739
85.0	1.2596	1.1363
80.0	1.1817	1.0067
75.0	1.0120	0.8849
71.0	0.9290	0.7932
67.0	0.8692	0.7064
63.0	0.7788	0.6247
59.0	0.6437	0.5481
56.0	0.6610	0.4938
53.0	0.5644	0.4425
50.0	0.4488	0.3939
48.0	0.4761	0.3631
45.0	0.4364	0.3193
42.0	0.3774	0.2783
40.0	0.3289	0.2525
37.5	0.2199	0.2221
35.4	0.2068	0.1989
33.4	0.1284	0.1764
31.5	0.1682	0.1570
29.7	0.1069	0.1397
28.0	0.1099	0.1243
26.5	0.0891	0.1115
25.0	0.0928	0.0993
24.0	0.0709	0.0916
22.0	0.0697	0.0772
21.0	0.0533	0.0704
20.0	0.0656	0.0640
19.0	0.0556	0.0579
18.0	0.0521	0.0520
17.0	0.0426	0.0465
16.0	0.0381	0.0414
14.0	0.0274	0.0319
13.2	0.0290	0.0285
12.5	0.0285	0.0257
11.8	0.0193	0.0230
11.2	0.0220	0.0209
10.6	0.0171	0.0188
10.0	0.0221	0.0166
9.5	0.0170	0.0153
9.0	0.0165	0.0139
8.5	0.0128	0.0125
8.0	0.0071	0.0112
7.5	0.0117	0.0100
7.1	0.0091	0.0091
6.7	0.0087	0.0082



ABSORPTION OF SOUND IN AIR

TEMPERATURE =283.2 K RELATIVE HUMIDITY = 9.4 %

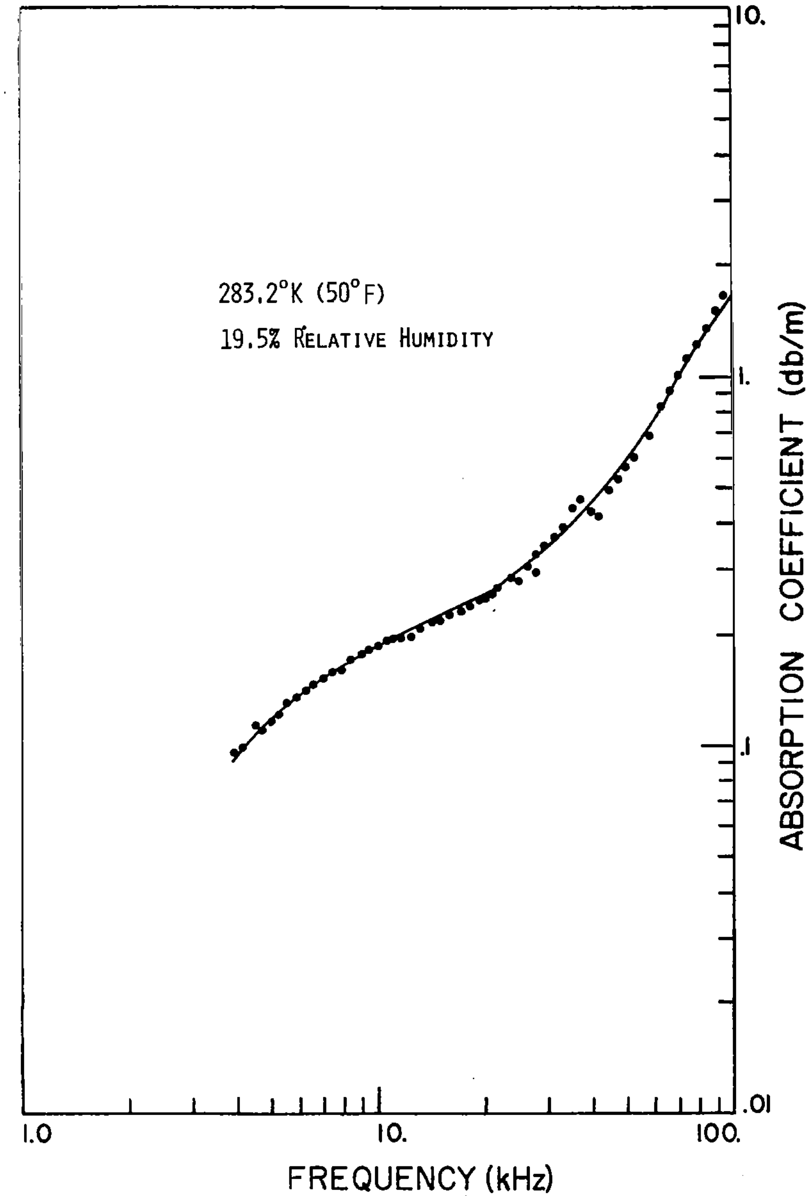
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	1.7447	1.6452
95.0	1.5503	1.4920
90.1	1.3826	1.3467
85.0	1.2338	1.2092
80.0	1.1050	1.0796
75.0	0.9959	0.9578
71.0	0.8885	0.8660
67.0	0.8511	0.7793
63.0	0.7244	0.6976
59.0	0.5971	0.6209
56.0	0.5623	0.5667
53.0	0.5163	0.5153
50.0	0.4713	0.4668
48.0	0.4333	0.4360
45.0	0.4046	0.3921
42.0	0.3319	0.3511
40.0	0.3187	0.3253
37.5	0.3521	0.2949
35.4	0.2860	0.2708
33.4	0.2440	0.2491
31.5	0.2592	0.2298
29.7	0.2324	0.2124
28.0	0.2242	0.1970
26.5	0.1820	0.1841
25.0	0.1897	0.1719
24.0	0.1712	0.1642
22.0	0.1514	0.1497
21.0	0.1517	0.1429
20.0	0.1443	0.1364
19.0	0.1247	0.1302
18.0	0.1225	0.1243
17.0	0.1205	0.1188
16.0	0.1112	0.1135
15.0	0.1135	0.1085
14.0	0.1118	0.1038
13.2	0.1041	0.1002
12.5	0.0973	0.0973
11.8	0.0965	0.0945
11.2	0.0915	0.0922
10.6	0.0877	0.0900
10.0	0.0822	0.0878
9.5	0.0870	0.0861
9.0	0.0824	0.0844
8.5	0.0837	0.0827
8.0	0.0820	0.0811
7.5	0.0841	0.0795
7.1	0.0797	0.0782
6.7	0.0745	0.0769
6.3	0.0767	0.0755
5.9	0.0739	0.0742
5.6	0.0716	0.0731
5.3	0.0734	0.0719
5.0	0.0650	0.0707
4.8	0.0691	0.0699
4.5	0.0709	0.0685
4.2	0.0619	0.0669
4.0	0.0558	0.0658



ABSORPTION OF SOUND IN AIR

TEMPERATURE =283.2 K   RELATIVE HUMIDITY = 19.5 %

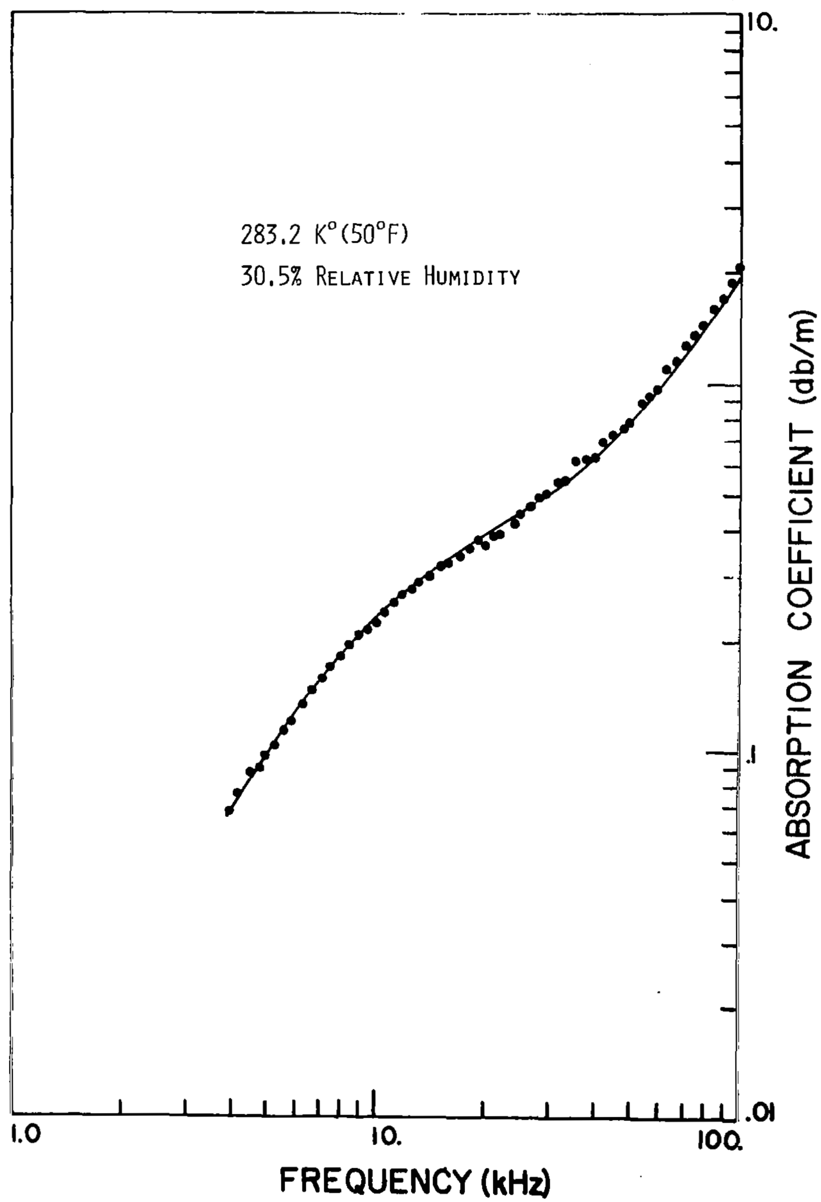
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.9	1.9047	1.8073
95.1	1.6486	1.6292
90.3	1.5036	1.4898
84.9	1.3645	1.3416
80.0	1.2259	1.2184
75.0	1.1073	1.0965
71.0	1.0032	1.0046
67.0	0.9213	0.9178
63.0	0.8252	0.8360
59.0	0.6991	0.7591
56.0	0.6670	0.7048
53.0	0.6060	0.6532
50.0	0.5821	0.6044
48.0	0.5389	0.5735
45.0	0.4984	0.5294
42.0	0.4291	0.4880
40.0	0.4360	0.4620
37.5	0.4735	0.4311
35.4	0.4425	0.4067
33.4	0.3948	0.3846
31.5	0.3862	0.3647
29.7	0.3411	0.3468
28.0	0.3266	0.3307
26.5	0.3013	0.3172
25.0	0.2779	0.3043
24.0	0.2806	0.2960
22.0	0.2670	0.2800
21.0	0.2527	0.2724
20.0	0.2458	0.2649
19.0	0.2432	0.2576
18.0	0.2340	0.2505
17.0	0.2285	0.2434
16.0	0.2219	0.2364
15.0	0.2127	0.2293
14.0	0.2140	0.2221
13.2	0.2045	0.2163
12.5	0.1950	0.2110
11.8	0.1928	0.2054
11.2	0.1862	0.2005
10.6	0.1867	0.1952
10.0	0.1830	0.1897
9.5	0.1796	0.1847
9.0	0.1750	0.1795
8.5	0.1682	0.1738
8.0	0.1596	0.1676
7.5	0.1545	0.1609
7.1	0.1486	0.1551
6.7	0.1452	0.1488
6.3	0.1390	0.1420
5.9	0.1312	0.1347
5.6	0.1284	0.1288
5.3	0.1194	0.1225
5.0	0.1140	0.1159
4.8	0.1108	0.1112
4.5	0.1122	0.1039
4.2	0.0968	0.0962
4.0	0.0955	0.0909



ABSORPTION OF SOUND IN AIR

TEMPERATURE =283.2 K RELATIVE HUMIDITY = 30.5 %

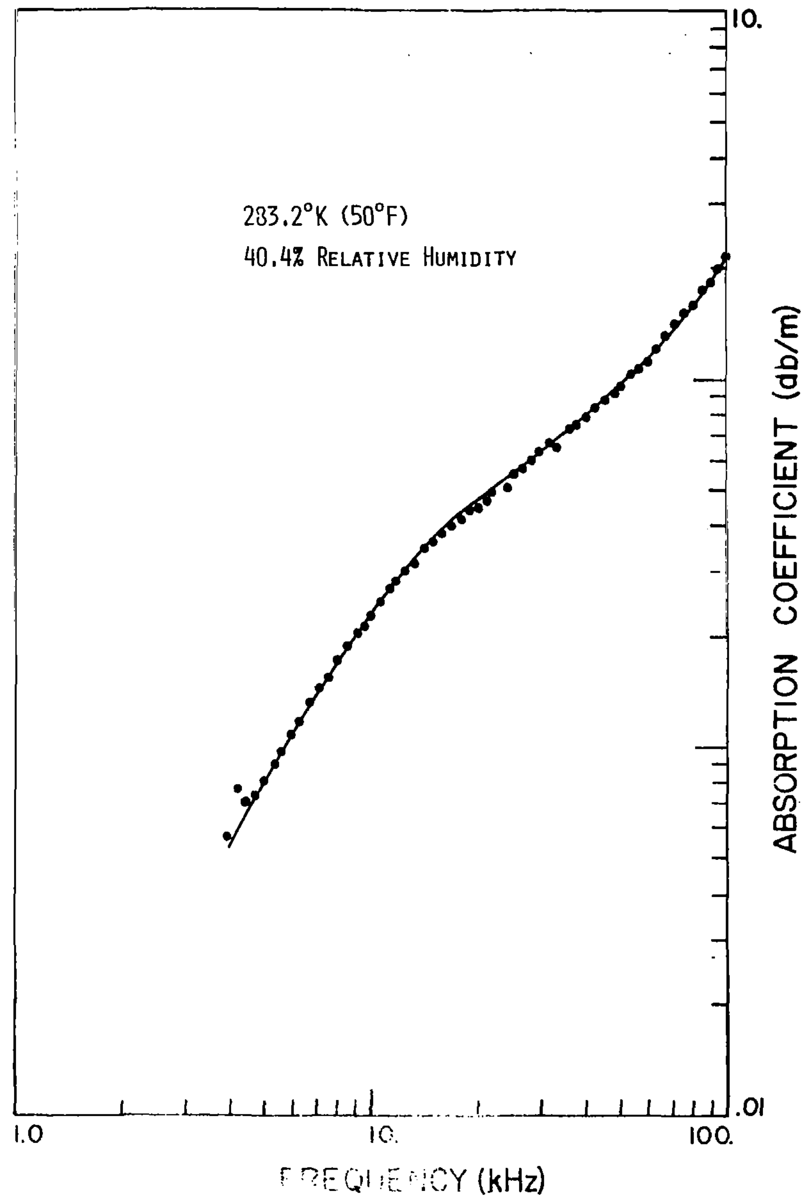
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	2.0329	1.9705
95.0	1.8690	1.8170
90.0	1.6854	1.6712
85.0	1.5836	1.5333
80.0	1.4298	1.4031
75.0	1.3555	1.2906
71.0	1.2480	1.1892
67.0	1.1426	1.1007
63.0	1.0871	1.0191
59.0	0.9554	0.9404
56.0	0.9136	0.8852
53.0	0.8790	0.8326
50.0	0.7842	0.7827
48.0	0.7562	0.7509
45.0	0.7209	0.7053
42.0	0.6891	0.6621
40.0	0.6332	0.6346
37.5	0.6421	0.6016
35.4	0.6186	0.5750
33.4	0.5570	0.5506
31.5	0.5471	0.5281
29.7	0.5083	0.5073
28.0	0.4898	0.4880
26.5	0.4648	0.4713
25.0	0.4450	0.4546
24.0	0.4143	0.4434
22.0	0.3939	0.4209
21.0	0.3830	0.4094
20.0	0.3617	0.3976
19.0	0.3757	0.3855
18.0	0.3543	0.3729
17.0	0.3398	0.3598
16.0	0.3287	0.3460
15.0	0.3213	0.3314
14.0	0.3034	0.3157
13.2	0.2898	0.3022
12.5	0.2782	0.2857
11.8	0.2657	0.2764
11.2	0.2556	0.2644
10.6	0.2430	0.2517
10.0	0.2244	0.2392
9.5	0.2154	0.2265
9.0	0.2091	0.2142
8.5	0.1970	0.2013
8.0	0.1832	0.1879
7.5	0.1704	0.1741
7.1	0.1610	0.1626
6.7	0.1493	0.1509
6.3	0.1352	0.1390
5.9	0.1227	0.1269
5.6	0.1153	0.1177
5.3	0.1053	0.1085
5.0	0.0990	0.0994
4.8	0.0902	0.0933
4.5	0.0881	0.0842
4.2	0.0781	0.0753
4.0	0.0690	0.0695



ABSORPTION OF SOUND IN AIR

TEMPERATURE =283.2 K   RELATIVE HUMIDITY = 40.4 %

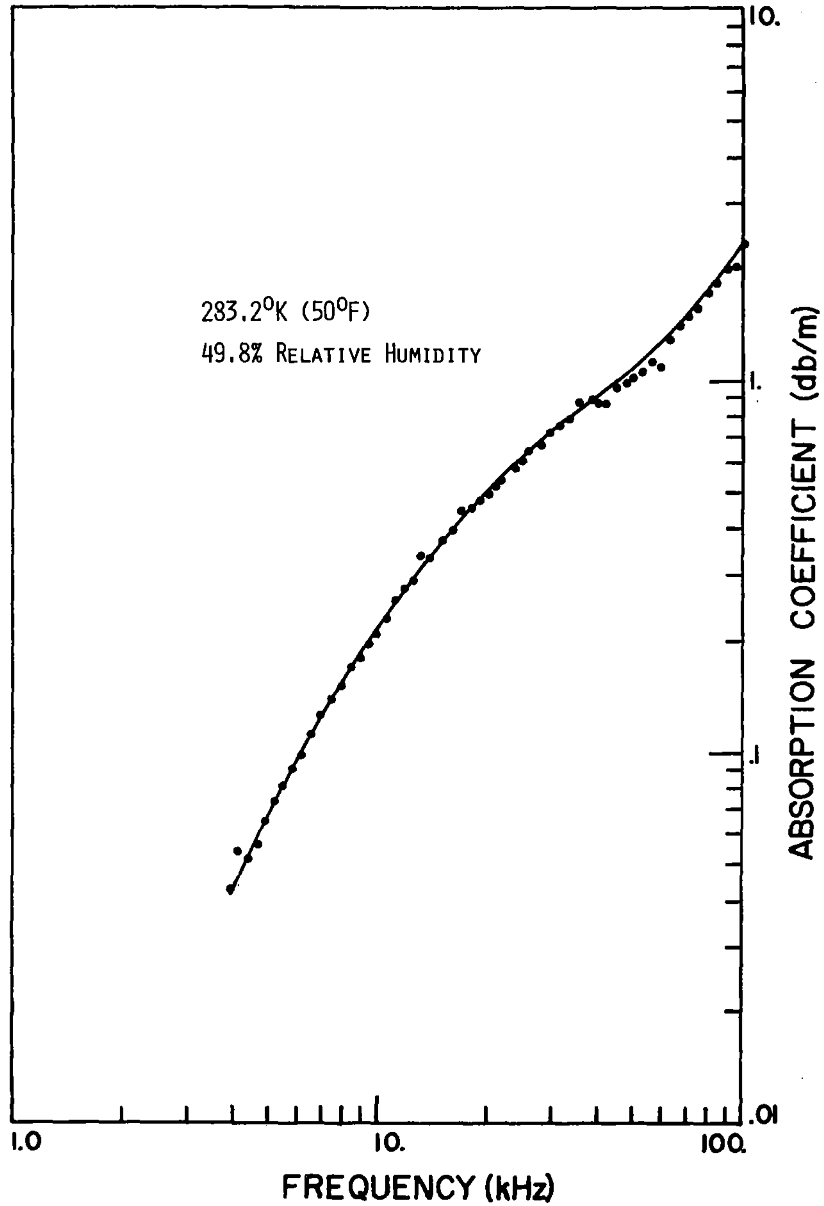
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	2.1560	2.1526
95.0	1.9961	1.9983
90.0	1.8269	1.8518
85.0	1.7495	1.7128
80.0	1.5844	1.5814
75.0	1.5047	1.4575
71.0	1.3907	1.3638
67.0	1.3006	1.2747
63.0	1.1967	1.1902
59.0	1.1033	1.1102
56.0	1.0593	1.0531
53.0	1.0225	0.9982
50.0	0.9305	0.9457
48.0	0.9002	0.9118
45.0	0.8621	0.8627
42.0	0.8377	0.8153
40.0	0.7859	0.7846
37.5	0.7389	0.7470
35.4	0.7117	0.7160
33.4	0.6268	0.6866
31.5	0.6604	0.6588
29.7	0.6264	0.6322
28.0	0.5950	0.6068
26.5	0.5608	0.5830
25.0	0.5474	0.5603
24.0	0.5081	0.5442
22.0	0.4923	0.5105
21.0	0.4665	0.4929
20.0	0.4475	0.4743
19.0	0.4366	0.4551
18.0	0.4102	0.4350
17.0	0.3944	0.4139
16.0	0.3776	0.3916
15.0	0.3583	0.3682
14.0	0.3391	0.3434
13.2	0.3123	0.3226
12.5	0.2984	0.3037
11.8	0.2794	0.2842
11.2	0.2657	0.2669
10.6	0.2437	0.2492
10.0	0.2263	0.2311
9.5	0.2130	0.2158
9.0	0.2010	0.2003
8.5	0.1865	0.1847
8.0	0.1695	0.1690
7.5	0.1533	0.1533
7.1	0.1429	0.1409
6.7	0.1301	0.1295
6.3	0.1169	0.1163
5.9	0.1057	0.1044
5.6	0.0977	0.0956
5.3	0.0890	0.0871
5.0	0.0802	0.0787
4.8	0.0724	0.0733
4.5	0.0709	0.0655
4.2	0.0773	0.0573
4.0	0.0573	0.0531



ABSORPTION OF SOUND IN AIR

TEMPERATURE =283.2 K   RELATIVE HUMIDITY = 49.8 %

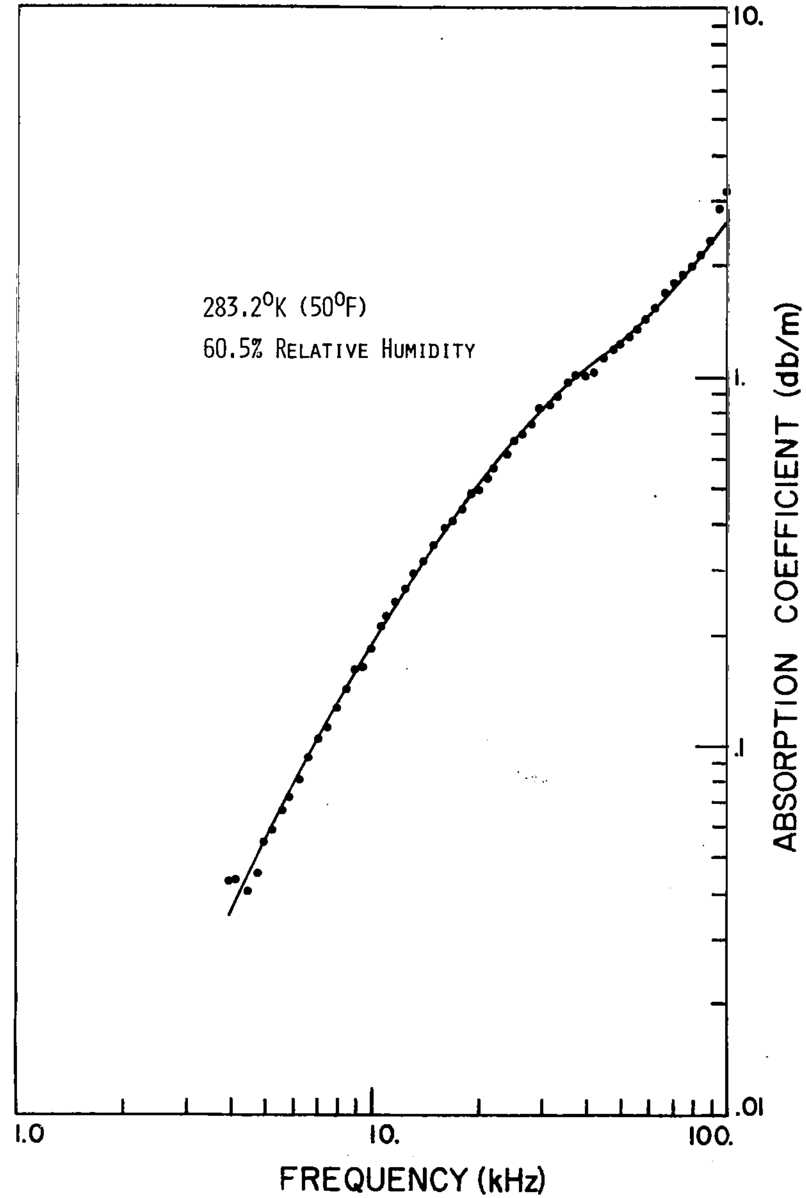
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	2.3165	2.3256
95.0	2.1344	2.1740
90.0	1.9827	2.0258
85.0	1.8417	1.8850
80.0	1.7327	1.7515
75.0	1.5727	1.6251
71.0	1.4808	1.5289
67.0	1.4005	1.4370
63.0	1.2710	1.3493
59.0	1.0882	1.2654
56.0	1.1082	1.2049
53.0	1.0551	1.1462
50.0	1.0134	1.0892
48.0	0.9876	1.0520
45.0	0.9510	0.9972
42.0	0.8684	0.9433
40.0	0.8655	0.9075
37.5	0.8846	0.8629
35.4	0.8638	0.8252
33.4	0.7815	0.7897
31.5	0.7566	0.7534
29.7	0.7243	0.7190
28.0	0.6690	0.6855
26.5	0.6369	0.6549
25.0	0.6081	0.6231
24.0	0.5760	0.6011
22.0	0.5362	0.5551
21.0	0.5140	0.5310
20.0	0.4831	0.5059
19.0	0.4692	0.4800
18.0	0.4428	0.4532
17.0	0.4233	0.4254
16.0	0.3898	0.3967
15.0	0.3652	0.3670
14.0	0.3338	0.3365
13.2	0.3117	0.3115
12.5	0.2866	0.2894
11.8	0.2710	0.2670
11.2	0.2536	0.2477
10.6	0.2303	0.2284
10.0	0.2084	0.2091
9.5	0.1926	0.1931
9.0	0.1825	0.1773
8.5	0.1691	0.1616
8.0	0.1491	0.1463
7.5	0.1372	0.1313
7.1	0.1249	0.1156
6.7	0.1112	0.1082
6.3	0.0986	0.0972
5.9	0.0890	0.0865
5.6	0.0815	0.0789
5.3	0.0738	0.0714
5.0	0.0649	0.0643
4.8	0.0569	0.0597
4.5	0.0521	0.0530
4.2	0.0530	0.0467
4.0	0.0428	0.0427



ABSORPTION OF SOUND IN AIR

TEMPERATURE =283.2 K   RELATIVE HUMIDITY = 60.5 %

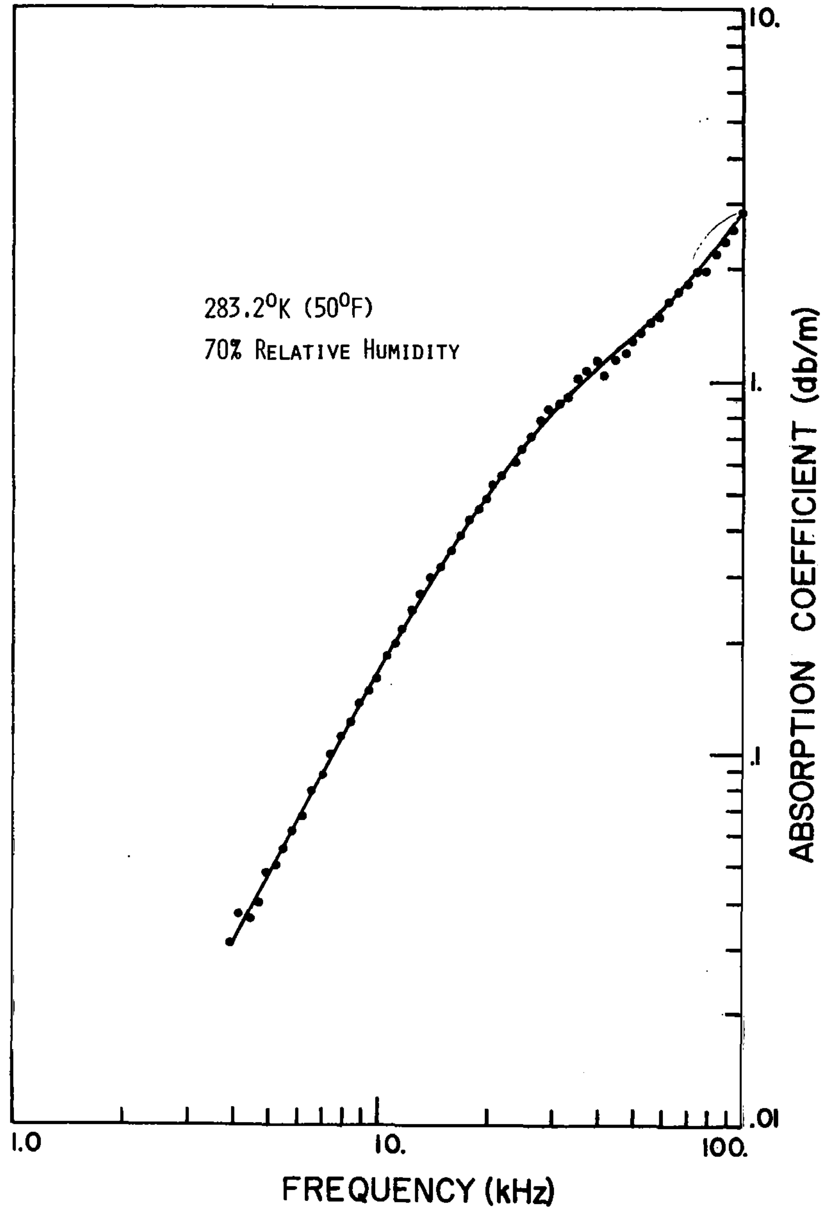
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	3.1204	2.5289
95.0	2.8391	2.3707
90.0	2.2730	2.2196
85.0	2.1292	2.0754
80.0	1.9539	1.9379
75.0	1.8631	1.8068
71.0	1.7450	1.7063
67.0	1.6630	1.6094
63.0	1.5167	1.5158
59.0	1.3936	1.4252
56.0	1.3273	1.3589
53.0	1.2557	1.2937
50.0	1.1980	1.2293
48.0	1.1520	1.1867
45.0	1.1030	1.1229
42.0	1.0026	1.0587
40.0	0.9873	1.0155
37.5	0.9873	0.9605
35.4	0.9499	0.9133
33.4	0.8664	0.8671
31.5	0.8248	0.8219
29.7	0.8008	0.7776
28.0	0.7331	0.7343
26.5	0.6861	0.6948
25.0	0.6507	0.6539
24.0	0.6067	0.6259
22.0	0.5544	0.5678
21.0	0.5285	0.5377
20.0	0.4861	0.5070
19.0	0.4748	0.4756
18.0	0.4377	0.4437
17.0	0.4054	0.4113
16.0	0.3800	0.3785
15.0	0.3405	0.3453
14.0	0.3128	0.3121
13.2	0.2873	0.2855
12.5	0.2634	0.2625
11.8	0.2399	0.2397
11.2	0.2225	0.2203
10.6	0.2063	0.2013
10.0	0.1816	0.1826
9.5	0.1619	0.1674
9.0	0.1561	0.1526
8.5	0.1422	0.1382
8.0	0.1252	0.1242
7.5	0.1123	0.1107
7.1	0.1031	0.1004
6.7	0.0921	0.0904
6.3	0.0806	0.0808
5.9	0.0723	0.0717
5.6	0.0661	0.0651
5.3	0.0586	0.0588
5.0	0.0546	0.0528
4.8	0.0456	0.0490
4.5	0.0406	0.0435
4.2	0.0432	0.0383
4.0	0.0432	0.0350



ABSORPTION OF SOUND IN AIR

TEMPERATURE =283.2 K RELATIVE HUMIDITY = 70.0 %

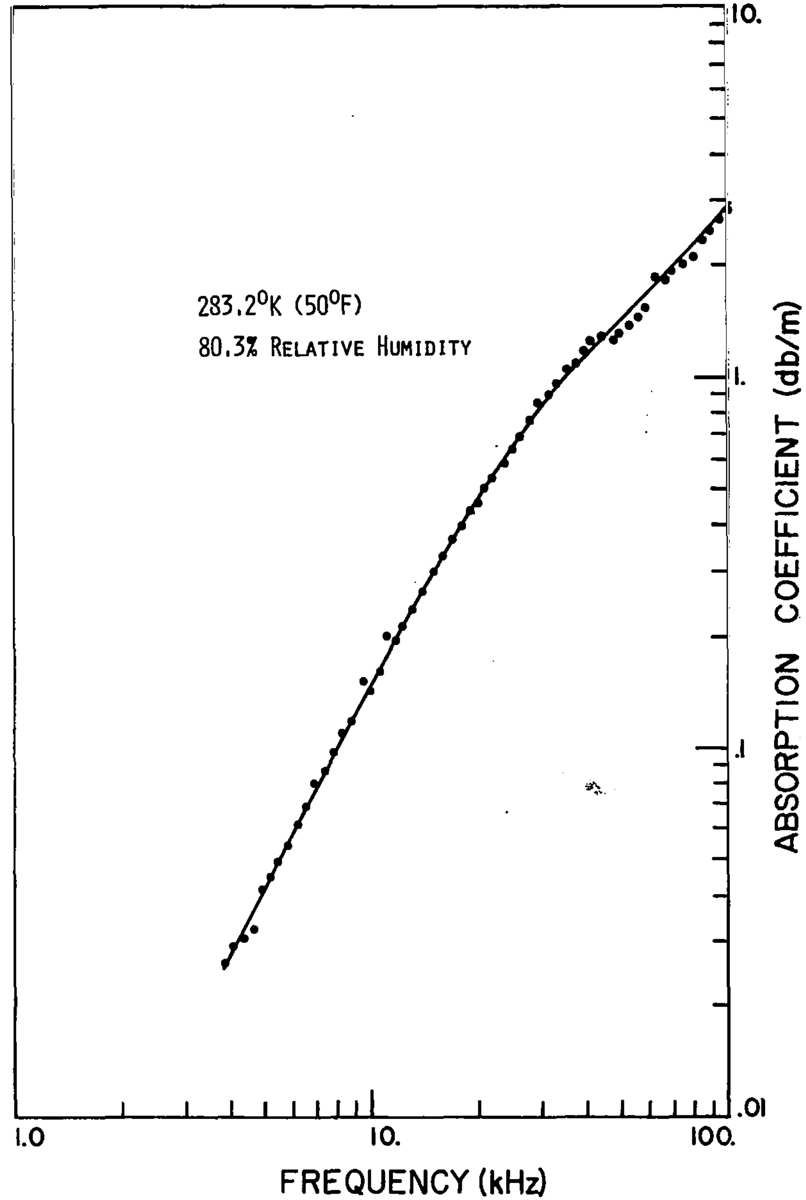
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	2.7094	2.6953
95.0	2.5293	2.5378
90.0	2.3556	2.3830
85.0	2.1964	2.2344
80.0	1.9795	2.0919
75.0	1.9460	1.9549
71.0	1.8164	1.8490
67.0	1.7235	1.7460
63.0	1.6037	1.6454
59.0	1.4661	1.5469
56.0	1.4122	1.4739
53.0	1.3381	1.4013
50.0	1.2763	1.3288
48.0	1.1741	1.2802
45.0	1.1278	1.2068
42.0	1.0233	1.1321
40.0	1.1256	1.0814
37.5	1.0668	1.0165
35.4	1.0174	0.9605
33.4	0.9146	0.9056
31.5	0.8706	0.8519
29.7	0.8341	0.7996
28.0	0.7827	0.7487
26.5	0.7026	0.7025
25.0	0.6544	0.6553
24.0	0.6070	0.6232
22.0	0.5527	0.5576
21.0	0.5211	0.5242
20.0	0.4774	0.4905
19.0	0.4495	0.4565
18.0	0.4209	0.4224
17.0	0.3834	0.3882
16.0	0.3485	0.3542
15.0	0.3150	0.3204
14.0	0.2948	0.2870
13.2	0.2645	0.2603
12.5	0.2425	0.2393
11.8	0.2146	0.2162
11.2	0.1979	0.1978
10.6	0.1827	0.1798
10.0	0.1589	0.1624
9.5	0.1462	0.1483
9.0	0.1368	0.1346
8.5	0.1219	0.1215
8.0	0.1106	0.1089
7.5	0.0999	0.0967
7.1	0.0887	0.0875
6.7	0.0791	0.0786
6.3	0.0682	0.0702
5.9	0.0620	0.0621
5.6	0.0558	0.0564
5.3	0.0505	0.0509
5.0	0.0482	0.0457
4.8	0.0395	0.0424
4.5	0.0365	0.0376
4.2	0.0377	0.0332
4.0	0.0311	0.0303



ABSORPTION OF SOUND IN AIR

TEMPERATURE =283.2 K RELATIVE HUMIDITY = 80.3 %

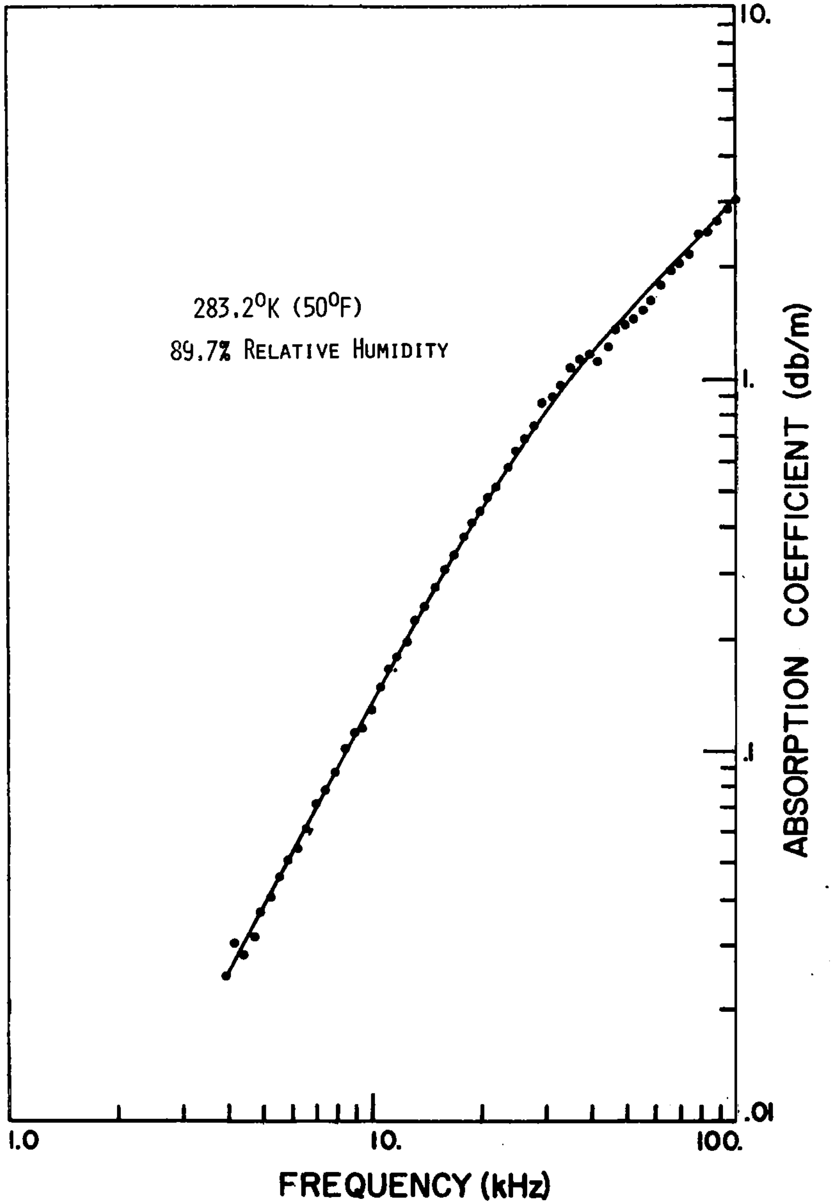
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	2.8300	2.8735
95.0	2.6406	2.7073
90.0	2.4517	2.5470
85.0	2.3216	2.3923
79.9	2.0971	2.2427
75.0	2.0149	2.0976
71.0	1.9181	1.9844
67.0	1.8101	1.8732
63.0	1.8743	1.7635
59.0	1.5383	1.6547
56.0	1.4656	1.5733
53.0	1.3797	1.4916
50.0	1.3117	1.4092
48.0	1.2464	1.3538
45.0	1.2196	1.2693
42.0	1.2543	1.1831
40.0	1.1606	1.1242
37.5	1.1012	1.0491
35.4	1.0359	0.9843
33.4	0.9581	0.9211
31.5	0.8857	0.8598
29.7	0.8555	0.8004
28.0	0.7541	0.7432
26.5	0.6905	0.6919
25.0	0.6356	0.6401
24.0	0.5863	0.6052
22.0	0.5317	0.5349
21.0	0.4920	0.4997
20.0	0.4490	0.4645
19.0	0.4329	0.4295
18.0	0.3964	0.3948
17.0	0.3606	0.3604
16.0	0.3272	0.3266
15.0	0.2959	0.2935
14.0	0.2646	0.2612
13.2	0.2365	0.2361
12.5	0.2121	0.2148
11.8	0.1944	0.1941
11.2	0.2073	0.1769
10.6	0.1608	0.1603
10.0	0.1428	0.1443
9.5	0.1504	0.1314
9.0	0.1195	0.1191
8.5	0.1113	0.1072
8.0	0.0972	0.0958
7.5	0.0864	0.0851
7.1	0.0801	0.0769
6.7	0.0681	0.0690
6.3	0.0611	0.0615
5.9	0.0545	0.0545
5.6	0.0496	0.0494
5.3	0.0448	0.0447
5.0	0.0419	0.0401
4.8	0.0319	0.0372
4.5	0.0304	0.0331
4.2	0.0298	0.0292
4.0	0.0250	0.0267



ABSORPTION OF SOUND IN AIR

TEMPERATURE =283.2 K RELATIVE HUMIDITY = 89.7 %

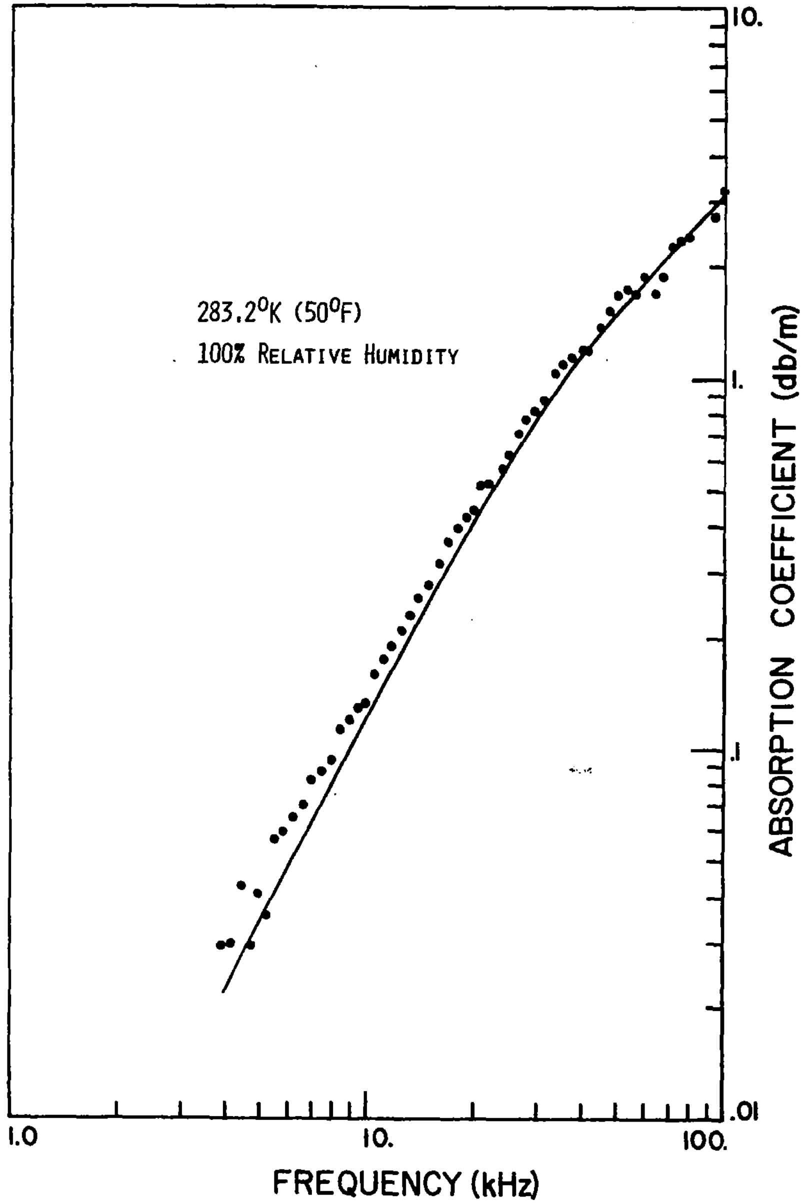
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	2.9676	3.0207
95.0	2.7926	2.8490
90.0	2.6025	2.6826
85.0	2.4369	2.5210
80.0	2.4067	2.3637
75.0	2.1488	2.2099
71.0	2.0255	2.0889
67.0	1.9095	1.9692
63.0	1.7668	1.8502
59.0	1.5907	1.7312
56.0	1.5164	1.6416
53.0	1.4342	1.5512
50.0	1.3624	1.4597
48.0	1.3313	1.3979
45.0	1.2151	1.3038
42.0	1.0946	1.2076
40.0	1.1491	1.1421
37.5	1.1147	1.0588
35.4	1.0499	0.9874
33.4	0.9417	0.9182
31.5	0.8703	0.8515
29.7	0.8454	0.7875
28.0	0.7382	0.7265
26.5	0.6748	0.6723
25.0	0.6256	0.6180
24.0	0.5707	0.5818
22.0	0.5073	0.5098
21.0	0.4725	0.4741
20.0	0.4308	0.4388
19.0	0.4028	0.4039
18.0	0.3765	0.3696
17.0	0.3377	0.3359
16.0	0.3020	0.3031
15.0	0.2722	0.2712
14.0	0.2439	0.2403
13.2	0.2201	0.2166
12.5	0.1943	0.1965
11.8	0.1776	0.1771
11.2	0.1640	0.1611
10.6	0.1476	0.1457
10.0	0.1275	0.1309
9.5	0.1139	0.1191
9.0	0.1117	0.1077
8.5	0.1004	0.0969
8.0	0.0879	0.0865
7.5	0.0786	0.0767
7.1	0.0715	0.0693
6.7	0.0614	0.0622
6.3	0.0547	0.0555
5.9	0.0504	0.0491
5.6	0.0459	0.0446
5.3	0.0404	0.0403
5.0	0.0371	0.0363
4.8	0.0318	0.0337
4.5	0.0282	0.0300
4.2	0.0302	0.0265
4.0	0.0246	0.0243



ABSORPTIUN OF SOUND IN AIR

TEMPERATURE =283.2 K RELATIVE HUMIDITY =100.0 %

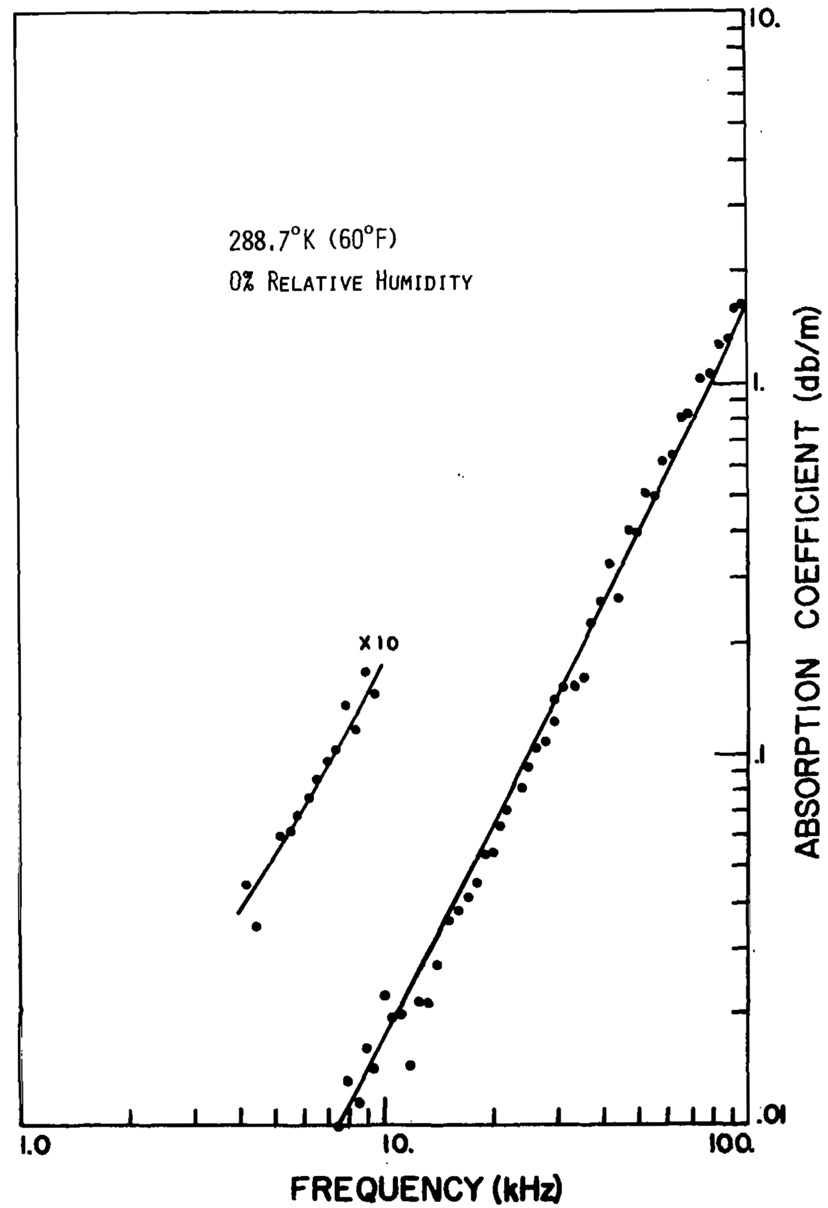
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	3.2124	3.1671
95.0	2.7017	2.9884
80.0	2.3891	2.4771
75.0	2.3221	2.3128
71.0	2.2365	2.1825
67.0	1.8875	2.0528
63.0	1.6774	1.9230
59.0	1.8776	1.7926
56.0	1.6659	1.6939
53.0	1.7233	1.5942
50.0	1.6868	1.4932
48.0	1.5119	1.4250
45.0	1.3645	1.3212
42.0	1.1857	1.2156
40.0	1.1881	1.1442
37.5	1.1225	1.0537
35.4	1.0854	0.9767
33.4	1.0152	0.9027
31.5	0.8760	0.8320
29.7	0.8031	0.7649
28.0	0.7716	0.7014
26.5	0.7073	0.6456
25.0	0.6164	0.5901
24.0	0.5670	0.5535
22.0	0.5158	0.4814
21.0	0.5125	0.4460
20.0	0.4376	0.4112
19.0	0.4199	0.3771
18.0	0.3930	0.3438
17.0	0.3598	0.3114
16.0	0.3151	0.2799
15.0	0.2767	0.2496
14.0	0.2560	0.2206
13.2	0.2281	0.1983
12.5	0.2076	0.1795
11.8	0.1884	0.1615
11.2	0.1723	0.1467
10.6	0.1567	0.1325
10.0	0.1321	0.1199
9.5	0.1277	0.1081
9.0	0.1190	0.0977
8.5	0.1116	0.0879
8.0	0.0926	0.0784
7.5	0.0864	0.0695
7.1	0.0823	0.0628
6.7	0.0702	0.0564
6.3	0.0644	0.0503
5.9	0.0600	0.0446
5.6	0.0573	0.0405
5.3	0.0358	0.0367
5.0	0.0405	0.0330
4.8	0.0294	0.0307
4.5	0.0426	0.0273
4.2	0.0297	0.0242
4.0	0.0295	0.0223



ABSORPTION OF SOUND IN AIR

TEMPERATURE =288.7 K   RELATIVE HUMIDITY = 0.0 %

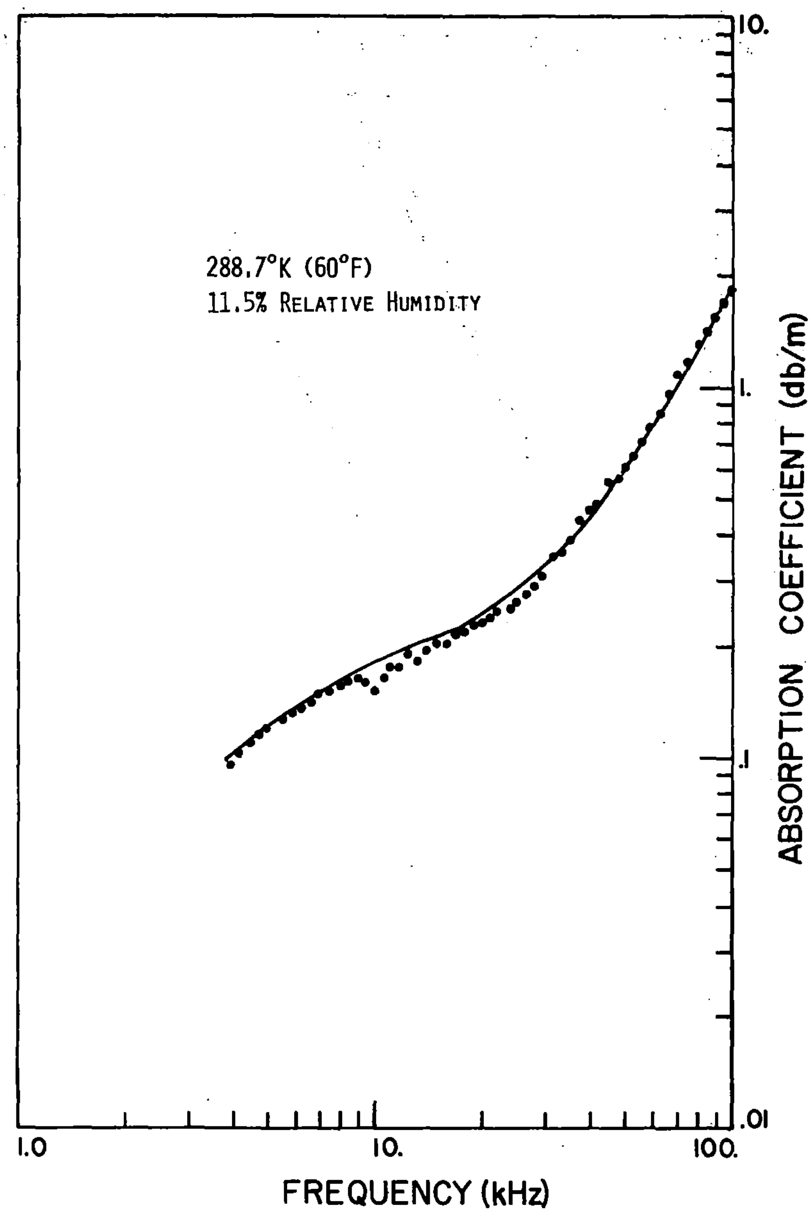
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	1.6283	1.5878
95.0	1.5631	1.4331
90.0	1.3160	1.2863
85.0	1.2735	1.1475
80.0	1.0547	1.0166
75.0	1.0283	0.8937
71.0	0.8240	0.8010
67.0	0.8197	0.7134
63.0	0.6397	0.6309
59.0	0.6214	0.5535
56.0	0.4942	0.4988
53.0	0.5191	0.4469
50.0	0.3978	0.3979
48.0	0.4075	0.3663
45.0	0.2677	0.3225
42.0	0.3270	0.2811
40.0	0.2572	0.2551
37.5	0.2291	0.2244
35.4	0.1602	0.2001
33.4	0.1531	0.1782
31.5	0.1508	0.1587
29.7	0.1327	0.1412
28.0	0.1099	0.1256
26.5	0.1041	0.1127
25.0	0.0920	0.1004
24.0	0.0812	0.0926
22.0	0.0717	0.0781
21.0	0.0648	0.0712
20.0	0.0545	0.0647
19.0	0.0548	0.0585
18.0	0.0459	0.0527
17.0	0.0418	0.0471
16.0	0.0384	0.0419
15.0	0.0366	0.0370
14.0	0.0272	0.0324
13.2	0.0216	0.0289
12.5	0.0219	0.0261
11.8	0.0148	0.0234
11.2	0.0201	0.0212
10.6	0.0200	0.0191
10.0	0.0227	0.0171
9.5	0.0143	0.0156
9.0	0.0165	0.0141
8.5	0.0119	0.0127
8.0	0.0138	0.0114
7.5	0.0103	0.0102
7.1	0.0097	0.0093
6.7	0.0087	0.0084
6.3	0.0079	0.0076
5.9	0.0068	0.0068
5.6	0.0063	0.0062
5.3	0.0061	0.0057
4.5	0.0036	0.0045
4.2	0.0045	0.0041



ABSORPTION OF SOUND IN AIR

TEMPERATURE =288.7 K   RELATIVE HUMIDITY = 11.5 %

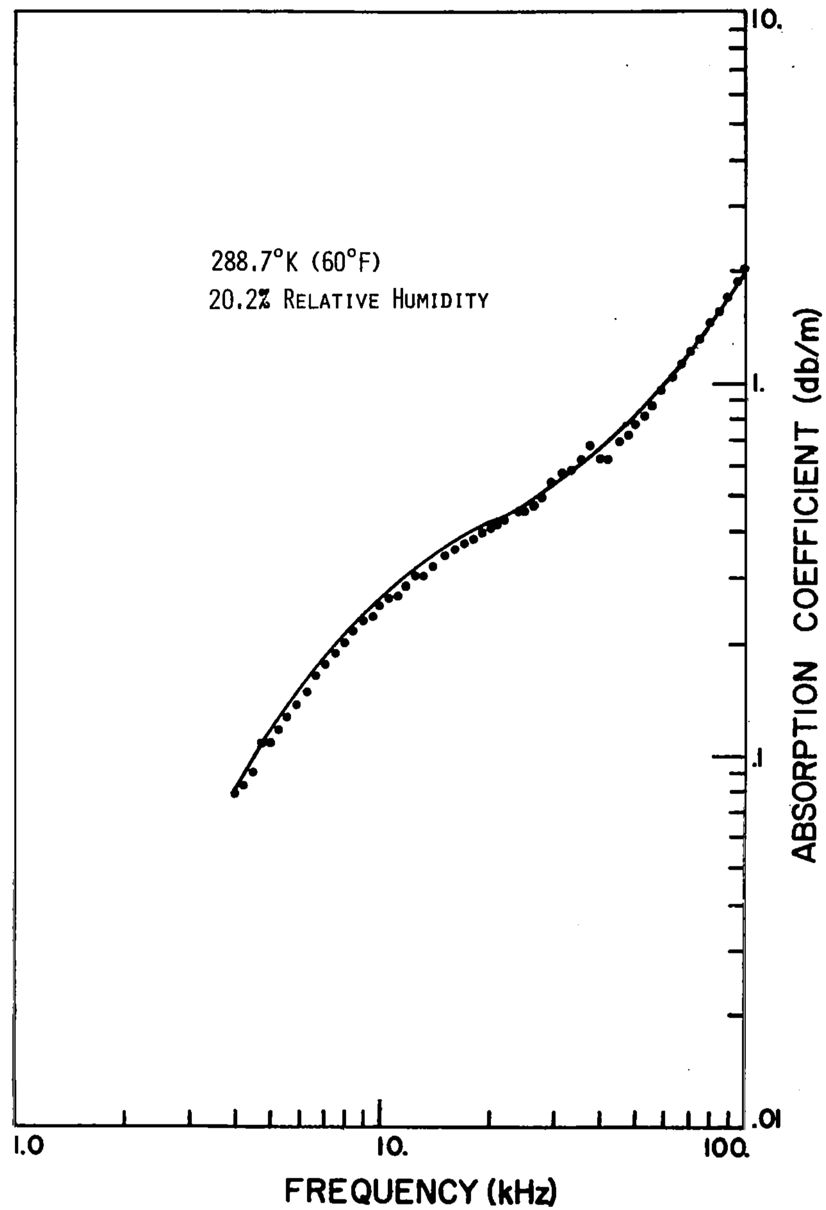
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	1.8655	1.7732
95.0	1.6964	1.6185
90.0	1.5384	1.4717
85.0	1.4201	1.3328
80.0	1.3093	1.2019
75.0	1.1768	1.0789
71.0	1.0768	0.9862
67.0	0.9718	0.8986
63.0	0.8717	0.8160
59.0	0.7950	0.7385
56.0	0.7306	0.6837
53.0	0.6685	0.6317
50.0	0.6157	0.5825
48.0	0.5830	0.5514
45.0	0.5668	0.5069
42.0	0.4909	0.4653
40.0	0.4788	0.4392
37.5	0.4478	0.4082
35.4	0.3964	0.3837
33.4	0.3683	0.3616
31.5	0.3568	0.3418
29.7	0.3199	0.3240
28.0	0.2935	0.3090
26.5	0.2786	0.2947
25.0	0.2652	0.2820
24.0	0.2552	0.2739
22.0	0.2506	0.2594
21.0	0.2421	0.2511
20.0	0.2324	0.2440
19.0	0.2295	0.2372
18.0	0.2200	0.2305
17.0	0.2167	0.2241
16.0	0.2056	0.2178
15.0	0.2039	0.2116
14.0	0.1942	0.2055
13.2	0.1866	0.2006
12.5	0.1916	0.1962
11.8	0.1773	0.1918
11.2	0.1799	0.1879
10.6	0.1687	0.1839
10.0	0.1528	0.1797
9.5	0.1612	0.1759
9.0	0.1660	0.1720
8.5	0.1640	0.1678
8.0	0.1585	0.1633
7.5	0.1533	0.1583
7.1	0.1493	0.1540
6.7	0.1417	0.1493
6.3	0.1383	0.1441
5.9	0.1337	0.1385
5.6	0.1275	0.1339
5.0	0.1202	0.1234
4.6	0.1140	0.1195
4.5	0.1107	0.1133
4.2	0.1039	0.1066
4.0	0.0977	0.1019



ABSORPTION OF SOUND IN AIR

TEMPERATURE =288.7 K   RELATIVE HUMIDITY = 20.2 %

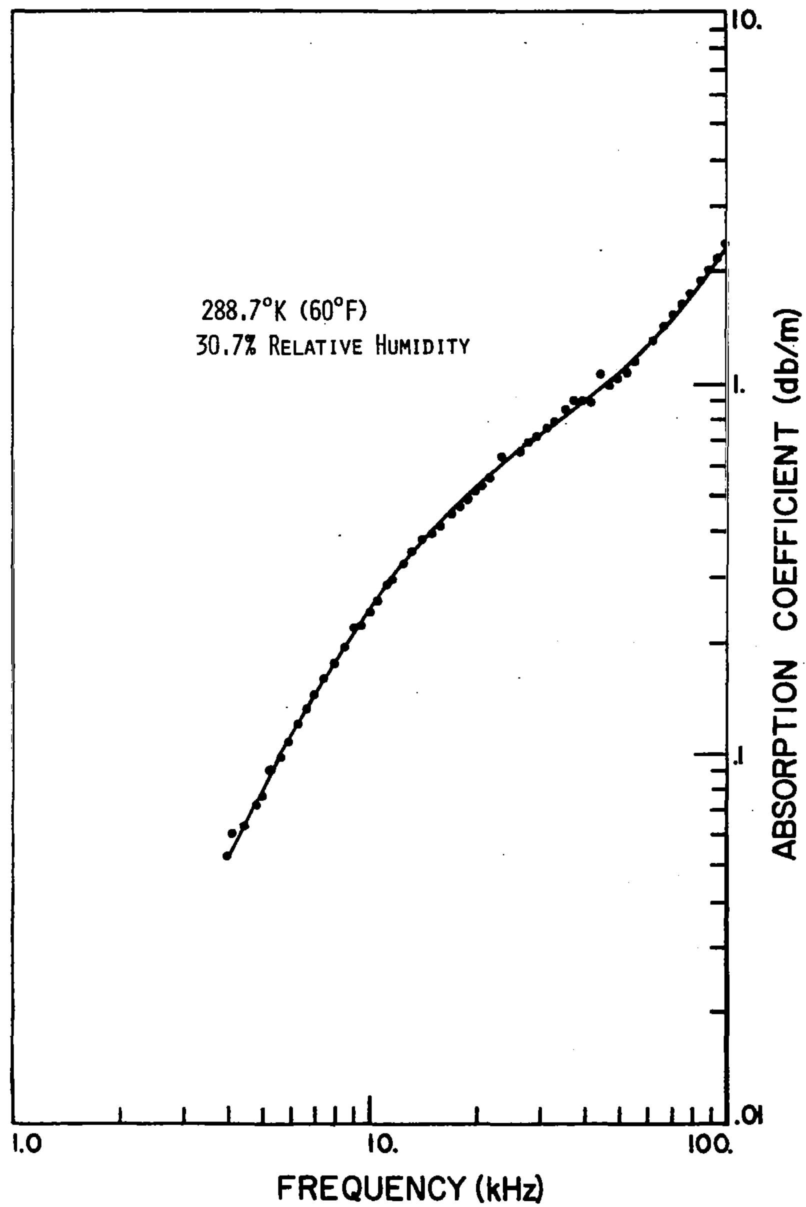
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	2.0193	2.0013
95.0	1.8562	1.8464
90.0	1.7035	1.6992
85.0	1.5735	1.5600
80.0	1.4569	1.4296
75.0	1.3146	1.3050
71.0	1.2132	1.2119
67.0	1.1211	1.1235
63.0	1.0212	1.0401
59.0	0.9406	0.9617
56.0	0.8804	0.9061
53.0	0.8189	0.8532
50.0	0.7608	0.8029
48.0	0.7208	0.7709
45.0	0.6965	0.7249
42.0	0.6258	0.6815
40.0	0.6230	0.6539
37.5	0.6704	0.6208
35.4	0.6238	0.5942
33.4	0.5886	0.5699
31.5	0.5746	0.5474
29.7	0.5296	0.5267
28.0	0.4876	0.5075
26.5	0.4677	0.4909
25.0	0.4516	0.4744
24.0	0.4495	0.4634
22.0	0.4247	0.4412
21.0	0.4116	0.4299
20.0	0.4062	0.4184
19.0	0.3925	0.4065
18.0	0.3800	0.3942
17.0	0.3699	0.3914
16.0	0.3565	0.3678
15.0	0.3431	0.3534
14.0	0.3211	0.3380
13.2	0.3065	0.3247
12.5	0.3027	0.3123
11.8	0.2825	0.2990
11.2	0.2693	0.2869
10.6	0.2624	0.2741
10.0	0.2515	0.2605
9.5	0.2351	0.2485
9.0	0.2300	0.2359
8.5	0.2148	0.2226
8.0	0.2015	0.2096
7.5	0.1887	0.1941
7.1	0.1758	0.1820
6.7	0.1645	0.1695
6.3	0.1492	0.1567
5.9	0.1368	0.1436
5.6	0.1283	0.1336
5.3	0.1195	0.1236
5.0	0.1083	0.1135
4.8	0.1095	0.1067
4.5	0.0903	0.0967
4.2	0.0840	0.0867
4.0	0.0792	0.0802



ABSORPTION OF SOUND IN AIR

TEMPERATURE =288.7 K RELATIVE HUMIDITY = 30.7 %

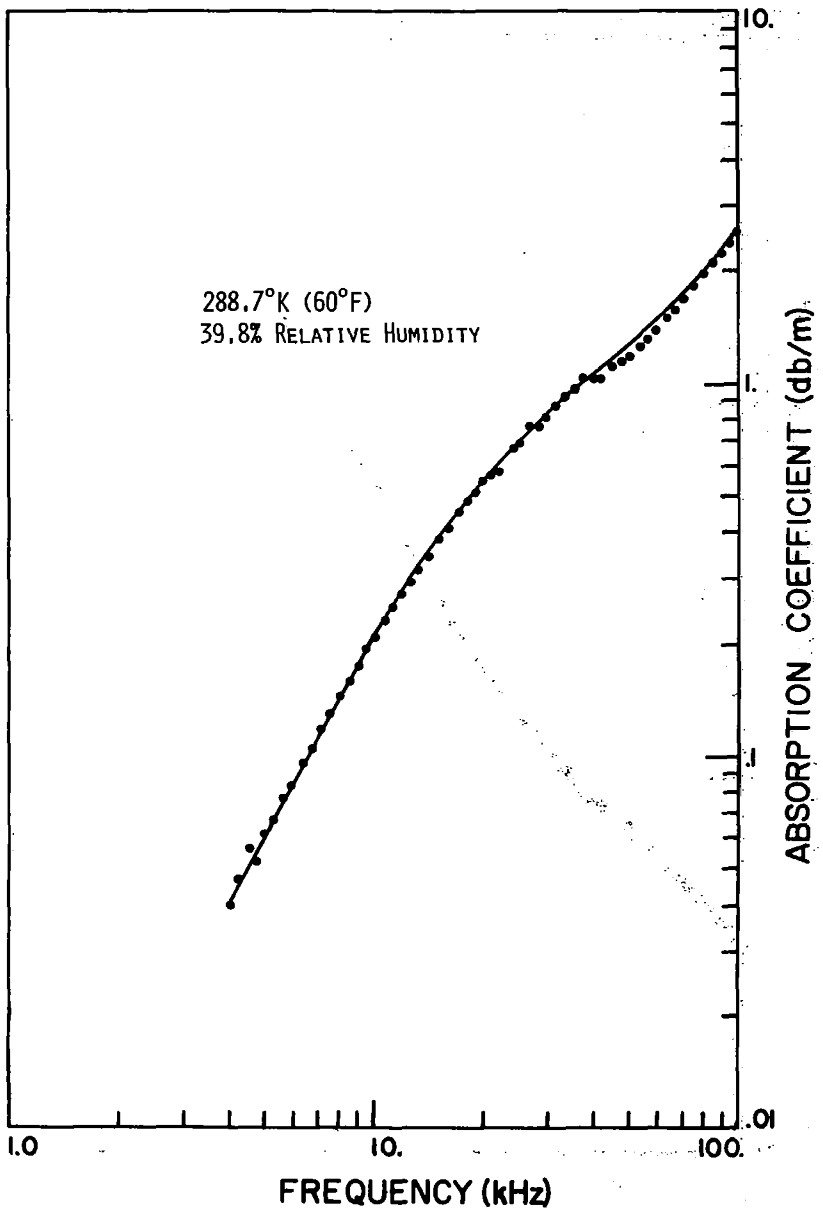
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	2.3797	2.3105
95.0	2.1766	2.1541
90.0	2.0175	2.0054
85.0	1.8909	1.8642
80.0	1.7555	1.7306
75.0	1.6476	1.6043
71.0	1.5324	1.5085
67.0	1.4151	1.4173
63.0	1.3052	1.3304
56.0	1.1587	1.1885
53.0	1.0948	1.1314
50.0	1.0288	1.0762
48.0	0.9909	1.0404
45.0	1.0809	0.9880
42.0	0.8936	0.9370
40.0	0.8826	0.9035
37.5	0.8950	0.8620
35.4	0.8341	0.8272
33.5	0.8006	0.7939
31.5	0.7584	0.7618
29.7	0.7054	0.7309
28.0	0.6885	0.7008
26.5	0.6465	0.6733
24.0	0.6358	0.6252
22.0	0.5550	0.5837
21.0	0.5384	0.5618
20.0	0.5058	0.5390
19.0	0.4804	0.5151
18.0	0.4640	0.4902
17.0	0.4479	0.4640
16.0	0.4190	0.4366
15.0	0.3923	0.4079
14.0	0.3703	0.3779
13.2	0.3393	0.3529
12.5	0.3255	0.3304
11.8	0.2999	0.3073
11.2	0.2797	0.2871
10.6	0.2583	0.2666
10.0	0.2431	0.2459
9.5	0.2228	0.2285
9.0	0.2122	0.2110
8.5	0.1945	0.1936
8.0	0.1772	0.1763
7.5	0.1609	0.1592
7.1	0.1475	0.1456
6.7	0.1336	0.1324
6.3	0.1206	0.1194
5.9	0.1078	0.1068
5.6	0.0987	0.0976
5.3	0.0909	0.0886
5.0	0.0774	0.0800
4.8	0.0733	0.0744
4.5	0.0650	0.0663
4.2	0.0619	0.0585
4.0	0.0535	0.0536



ABSORPTION OF SOUND IN AIR

TEMPERATURE =288.7 K   RELATIVE HUMIDITY = 39.8 %

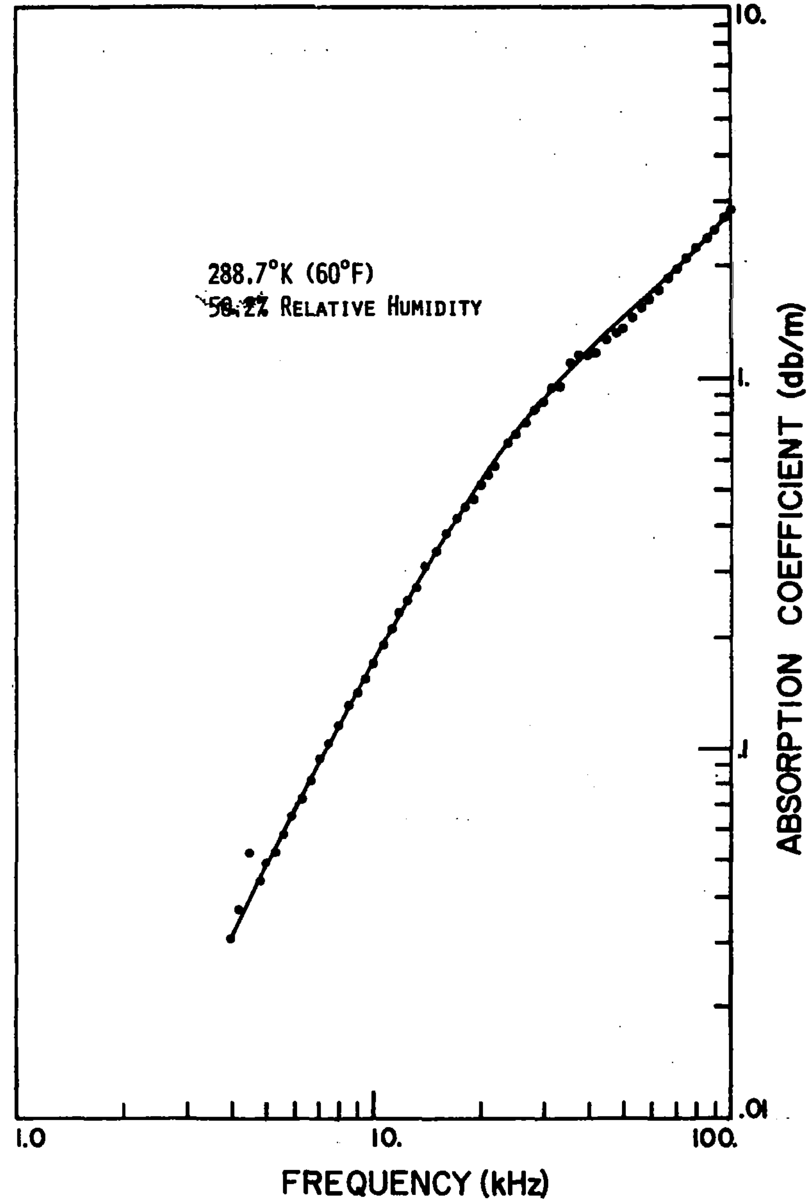
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	2.5106	2.5831
95.0	2.3543	2.4239
90.0	2.1977	2.2719
85.0	2.0571	2.1270
80.0	1.9789	1.9889
75.0	1.8196	1.8573
71.0	1.7000	1.7566
67.0	1.5947	1.6597
63.0	1.4813	1.5652
59.0	1.4002	1.4759
56.0	1.3372	1.4099
53.0	1.2502	1.3451
50.0	1.1825	1.2813
48.0	1.1526	1.2390
45.0	1.1160	1.1759
42.0	1.0280	1.1125
40.0	1.0320	1.0697
37.5	1.0410	1.0155
35.4	0.9664	0.9687
33.4	0.9192	0.9230
31.5	0.8645	0.8781
29.7	0.8103	0.8340
28.0	0.7732	0.7907
26.5	0.7297	0.7510
25.0	0.6910	0.7097
24.0	0.6693	0.6813
22.0	0.5874	0.6219
21.0	0.5670	0.5909
20.0	0.5442	0.5591
19.0	0.5130	0.5264
18.0	0.4834	0.4930
17.0	0.4510	0.4587
16.0	0.4147	0.4238
15.0	0.3819	0.3893
14.0	0.3414	0.3524
13.2	0.3175	0.3235
12.5	0.2931	0.2983
11.8	0.2714	0.2731
11.2	0.2528	0.2517
10.6	0.2311	0.2306
10.0	0.2076	0.2097
9.5	0.1939	0.1926
9.0	0.1763	0.1759
8.5	0.1608	0.1596
8.0	0.1484	0.1437
7.5	0.1305	0.1284
7.1	0.1192	0.1165
6.7	0.1059	0.1051
6.3	0.0965	0.0941
5.9	0.0845	0.0835
5.6	0.0783	0.0760
5.3	0.0683	0.0687
5.0	0.0634	0.0617
4.8	0.0528	0.0573
4.5	0.0571	0.0509
4.2	0.0480	0.0448
4.0	0.0410	0.0410



ABSORPTION OF SOUND IN AIR

TEMPERATURE =288.7 K RELATIVE HUMIDITY = 50.2 %

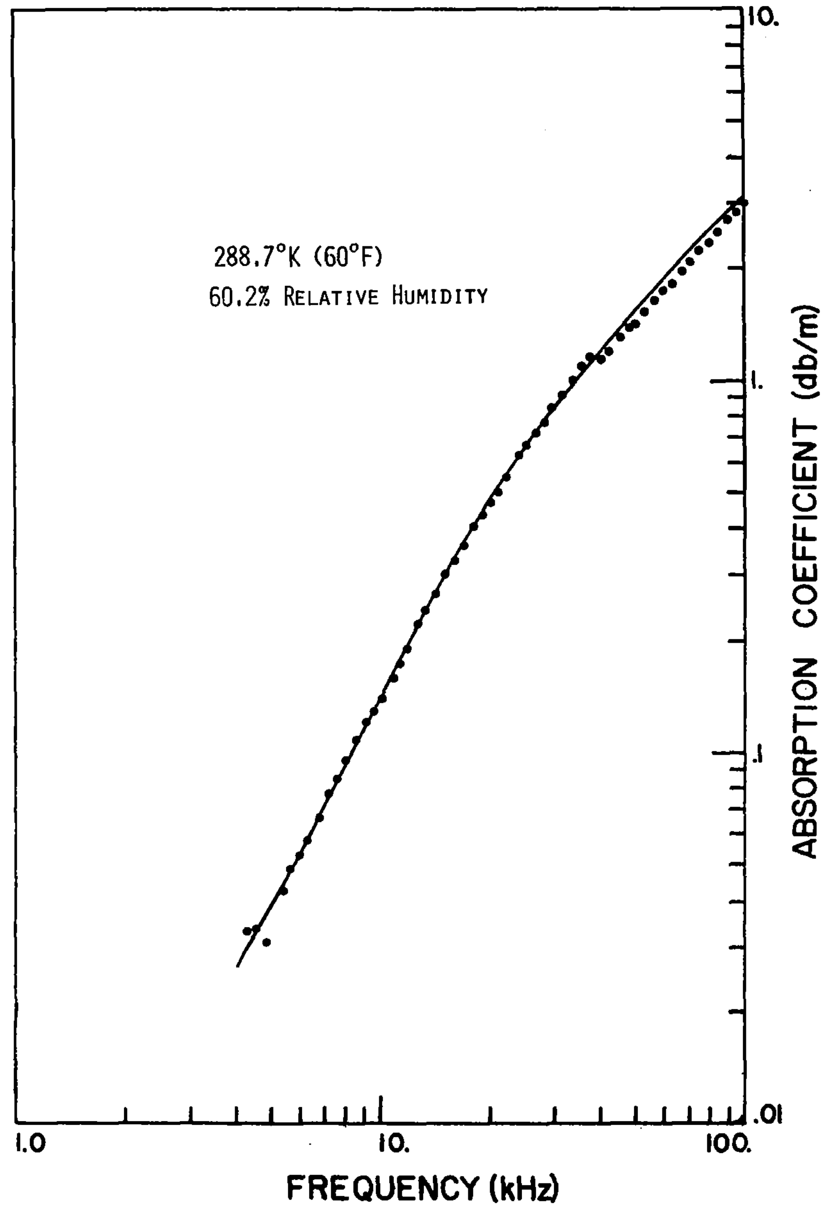
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
99.9	2.8806	2.8814
95.0	2.7009	2.7165
90.0	2.5367	2.5580
85.0	2.3905	2.4055
80.0	2.2597	2.2587
75.0	2.1123	2.1171
71.0	1.9891	2.0071
67.0	1.8694	1.8997
63.0	1.7490	1.7942
59.0	1.6484	1.6902
56.0	1.5710	1.6126
53.0	1.4823	1.5351
50.0	1.3965	1.4572
48.0	1.3569	1.4047
45.0	1.2958	1.3250
42.0	1.1987	1.2434
40.0	1.1799	1.1877
37.5	1.1783	1.1162
35.4	1.1132	1.0542
33.4	0.9598	0.9933
31.5	0.9527	0.9337
29.7	0.8784	0.8754
28.0	0.8278	0.8188
26.5	0.7617	0.7675
25.0	0.7161	0.7149
24.0	0.6752	0.6792
22.0	0.5869	0.6065
21.0	0.5581	0.5695
20.0	0.5232	0.5322
19.0	0.4872	0.4949
18.0	0.4555	0.4572
17.0	0.4237	0.4197
16.0	0.3817	0.3824
15.0	0.3436	0.3454
14.0	0.3104	0.3091
13.2	0.2765	0.2805
12.5	0.2570	0.2561
11.8	0.2351	0.2322
11.2	0.2124	0.2122
10.6	0.1915	0.1928
10.0	0.1705	0.1740
9.5	0.1561	0.1589
9.0	0.1424	0.1442
8.5	0.1331	0.1301
8.0	0.1188	0.1165
7.5	0.1063	0.1035
7.1	0.0942	0.0936
6.7	0.0840	0.0842
6.3	0.0746	0.0751
5.9	0.0678	0.0666
5.6	0.0603	0.0605
5.3	0.0539	0.0546
5.0	0.0503	0.0491
4.8	0.0457	0.0455
4.5	0.0534	0.0404
4.2	0.0388	0.0357
4.0	0.0310	0.0327



ABSORPTION OF SOUND IN AIR

TEMPERATURE =288.7 K   RELATIVE HUMIDITY = 60.2 %

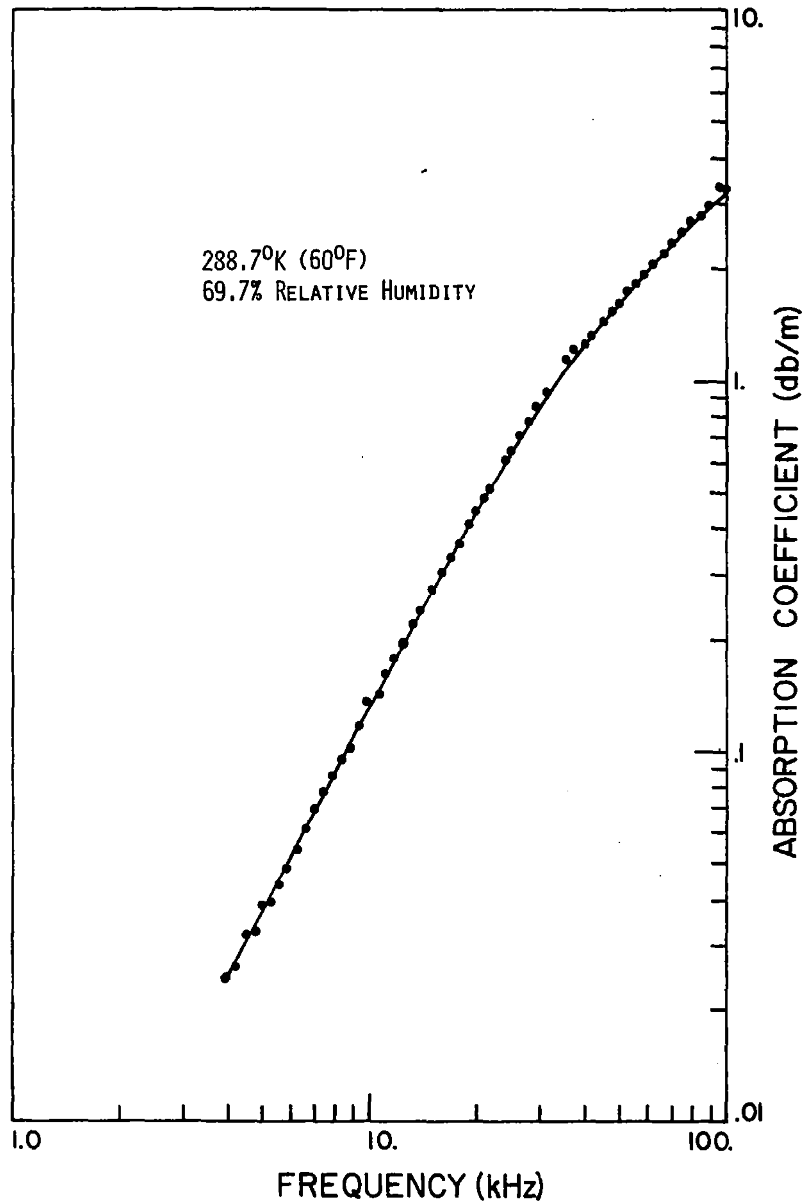
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	3.0403	3.1429
95.0	2.8475	2.9698
90.0	2.6951	2.8020
85.0	2.5414	2.6391
80.0	2.3864	2.4804
75.0	2.2508	2.3252
71.0	2.1094	2.2031
67.0	1.9894	2.0821
63.0	1.8480	1.9616
59.0	1.7468	1.8410
56.0	1.6510	1.7500
53.0	1.5443	1.6579
50.0	1.4415	1.5646
48.0	1.4045	1.5013
45.0	1.3236	1.4047
42.0	1.2107	1.3055
40.0	1.1544	1.2379
37.5	1.1809	1.1511
35.4	1.1016	1.0766
33.4	1.0066	1.0040
31.5	0.9266	0.9336
29.7	0.8529	0.8659
28.0	0.7856	0.8009
26.5	0.7265	0.7429
25.0	0.6789	0.6846
24.0	0.6413	0.6456
22.0	0.5531	0.5675
21.0	0.5139	0.5287
20.0	0.4824	0.4901
19.0	0.4431	0.4519
18.0	0.4103	0.4141
17.0	0.3702	0.3770
16.0	0.3344	0.3407
15.0	0.3039	0.3053
14.0	0.2681	0.2710
13.2	0.2423	0.2445
12.5	0.2252	0.2220
11.8	0.1938	0.2003
11.2	0.1768	0.1824
10.6	0.1627	0.1651
10.0	0.1424	0.1484
9.5	0.1315	0.1351
9.0	0.1250	0.1223
8.5	0.1118	0.1101
8.0	0.0993	0.0984
7.5	0.0878	0.0873
7.1	0.0791	0.0789
6.7	0.0692	0.0709
6.3	0.0619	0.0632
5.9	0.0554	0.0560
5.6	0.0504	0.0509
5.3	0.0442	0.0460
5.0	0.0410	0.0414
4.8	0.0322	0.0385
4.5	0.0353	0.0342
4.2	0.0347	0.0303



ABSORPTION OF SOUND IN AIR

TEMPERATURE =288.7 K   RELATIVE HUMIDITY = 69.7 %

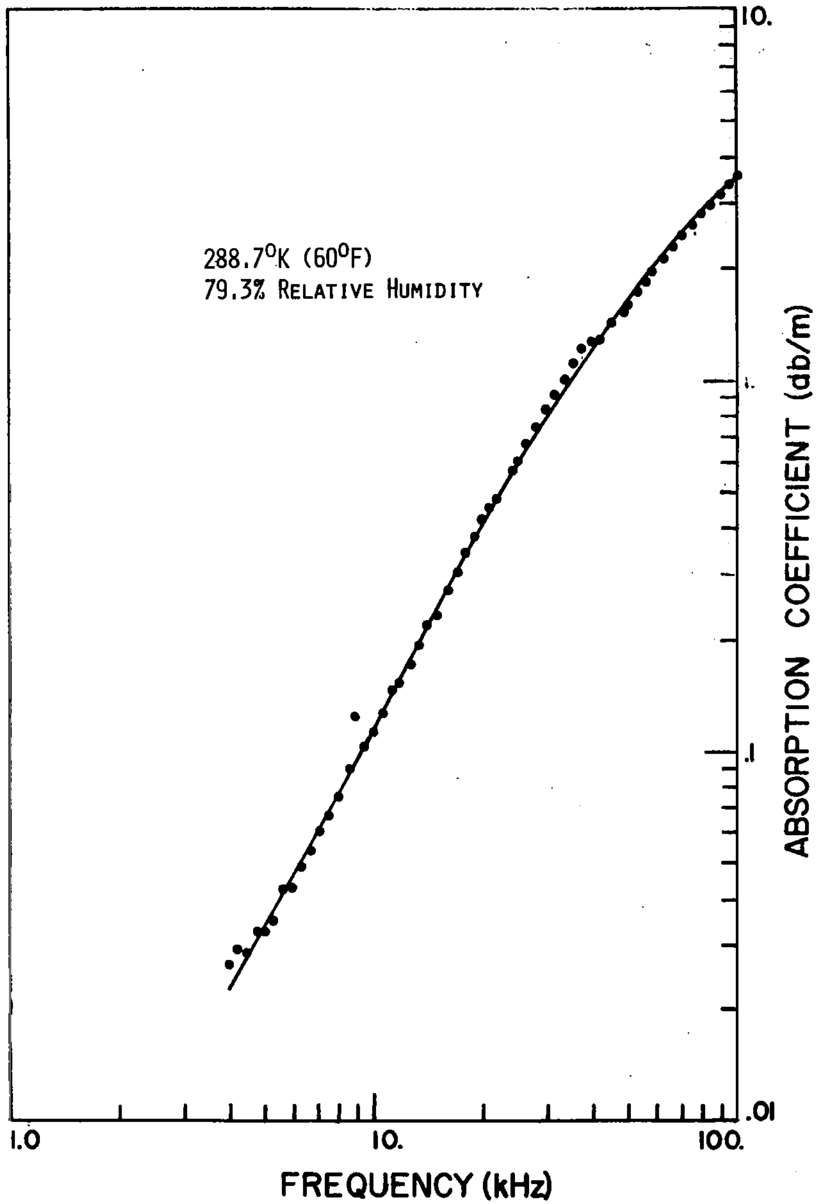
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	3.3304	3.3617
95.0	3.1390	3.1785
90.0	2.9544	2.9995
85.0	2.7988	2.8240
80.0	2.6711	2.6514
75.0	2.4804	2.4809
71.0	2.3303	2.3452
67.0	2.1959	2.2096
63.0	2.0408	2.0734
59.0	1.9061	1.9359
56.0	1.8083	1.8316
53.0	1.7401	1.7258
50.0	1.5718	1.6183
48.0	1.5095	1.5455
45.0	1.4138	1.4345
42.0	1.2881	1.3211
40.0	1.2560	1.2442
37.5	1.2129	1.1467
35.4	1.1310	1.0635
33.4	1.0335	0.9835
31.5	0.9240	0.9069
29.7	0.8463	0.8340
28.0	0.7732	0.7651
26.5	0.7086	0.7045
25.0	0.6470	0.6442
24.0	0.6063	0.6043
22.0	0.5172	0.5257
21.0	0.4771	0.4872
20.0	0.4468	0.4493
19.0	0.4066	0.4121
18.0	0.3646	0.3758
17.0	0.3331	0.3404
16.0	0.3037	0.3061
15.0	0.2737	0.2731
14.0	0.2391	0.2413
13.2	0.2159	0.2170
12.5	0.1920	0.1965
11.8	0.1774	0.1769
11.2	0.1622	0.1607
10.6	0.1413	0.1451
10.0	0.1362	0.1303
9.5	0.1183	0.1195
9.0	0.1042	0.1072
8.5	0.0958	0.0964
8.0	0.0865	0.0861
7.5	0.0786	0.0764
7.1	0.0697	0.0690
6.7	0.0621	0.0620
6.3	0.0543	0.0554
5.9	0.0481	0.0491
5.6	0.0442	0.0447
5.3	0.0396	0.0405
5.0	0.0387	0.0365
4.8	0.0337	0.0339
4.5	0.0324	0.0303
4.2	0.0266	0.0269
4.0	0.0249	0.0242



ABSORPTION OF SOUND IN AIR

TEMPERATURE =288.7 K   RELATIVE HUMIDITY = 79.3 %

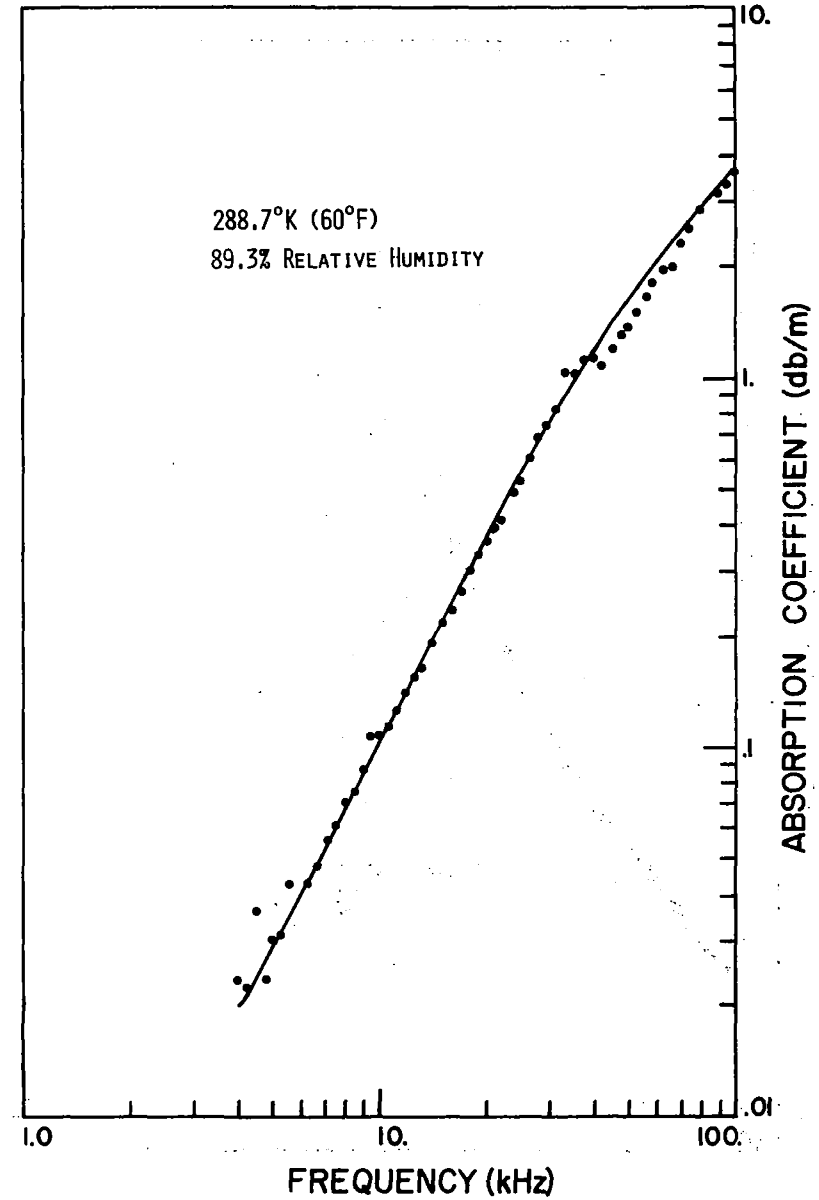
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	3.5265	3.5501
95.0	3.3175	3.3549
90.0	3.1205	3.1628
85.0	2.9485	2.9730
80.0	2.8011	2.7849
75.0	2.6056	2.5974
71.0	2.4276	2.4474
67.0	2.2831	2.2966
63.0	2.1045	2.1446
59.0	1.9572	1.9908
56.0	1.8467	1.8740
53.0	1.7117	1.7558
50.0	1.5857	1.6359
48.0	1.5258	1.5551
45.0	1.4138	1.4326
42.0	1.2722	1.3085
40.0	1.2502	1.2250
37.5	1.1981	1.1201
35.4	1.0990	1.0317
33.4	0.9893	0.9475
31.5	0.9141	0.8678
29.7	0.8375	0.7928
28.0	0.7378	0.7227
26.5	0.6715	0.6617
25.0	0.6047	0.6017
24.0	0.5612	0.5623
22.0	0.4816	0.4855
21.0	0.4508	0.4483
20.0	0.4229	0.4119
19.0	0.3761	0.3765
18.0	0.3440	0.3422
17.0	0.3018	0.3089
16.0	0.2700	0.2770
15.0	0.2324	0.2463
14.0	0.2209	0.2171
13.2	0.1932	0.1948
12.5	0.1714	0.1761
11.8	0.1525	0.1583
11.2	0.1449	0.1437
10.6	0.1282	0.1297
10.0	0.1127	0.1163
9.5	0.1034	0.1057
9.0	0.1232	0.0956
8.5	0.0894	0.0860
8.0	0.0759	0.0769
7.5	0.0671	0.0682
7.1	0.0621	0.0617
6.7	0.0542	0.0555
6.3	0.0490	0.0496
5.9	0.0435	0.0441
5.6	0.0421	0.0402
5.3	0.0349	0.0365
5.0	0.0331	0.0329
4.8	0.0332	0.0307
4.5	0.0286	0.0275
4.2	0.0298	0.0245
4.0	0.0269	0.0226



ABSORPTION OF SOUND IN AIR

TEMPERATURE =288.7 K   RELATIVE HUMIDITY = 89.3 %

FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	3.5711	3.7109
95.0	3.3637	3.5020
90.0	3.1444	3.2951
80.0	2.8702	3.0896
75.0	2.5550	2.8847
71.0	2.3495	2.6797
67.0	2.0030	2.5150
63.0	1.9710	2.3493
59.0	1.8227	2.1822
56.0	1.6907	2.0134
53.0	1.5341	1.8856
50.0	1.4034	1.7568
48.0	1.3375	1.6269
48.0	1.3375	1.5399
45.0	1.2142	1.4087
42.0	1.0848	1.2772
40.0	1.1425	1.1896
37.5	1.1471	1.0804
35.4	1.0284	0.9894
33.4	1.0480	0.9035
31.5	0.8392	0.8230
29.7	0.7529	0.7479
28.0	0.6906	0.6784
26.5	0.6128	0.6184
25.0	0.5370	0.5599
24.0	0.4983	0.5218
22.0	0.4268	0.4481
21.0	0.4047	0.4127
20.0	0.3680	0.3782
19.0	0.3388	0.3449
18.0	0.3084	0.3127
17.0	0.2692	0.2817
16.0	0.2385	0.2520
15.0	0.2223	0.2237
14.0	0.1971	0.1968
13.2	0.1690	0.1764
12.5	0.1591	0.1594
11.8	0.1424	0.1431
11.2	0.1271	0.1258
10.6	0.1157	0.1172
10.0	0.1006	0.1051
9.5	0.1016	0.0955
9.0	0.0887	0.0864
8.5	0.0776	0.0778
8.0	0.0726	0.0696
7.5	0.0620	0.0618
7.1	0.0588	0.0560
6.7	0.0494	0.0504
6.3	0.0447	0.0452
5.6	0.0448	0.0367
5.3	0.0323	0.0334
5.0	0.0314	0.0303
4.8	0.0245	0.0283
4.5	0.0374	0.0254
4.2	0.0233	0.0227
4.0	0.0248	0.0211

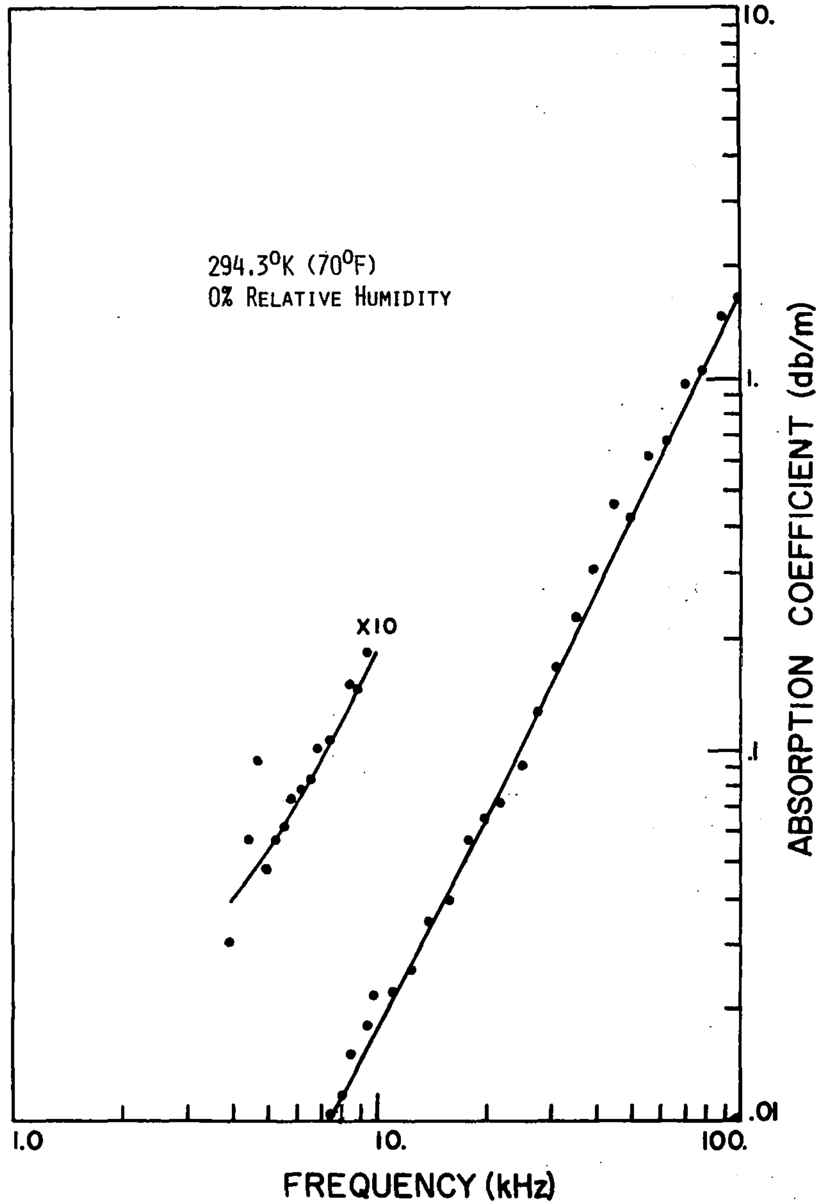


ABSORPTION OF SOUND IN AIR

TEMPERATURE =294.3 K   RELATIVE HUMIDITY = 0.0 %

FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	1.6008	1.6031
90.0	1.4596	1.2998
80.0	1.0390	1.0265
71.0	0.9573	0.8089
63.0	0.6578	0.6371
56.0	0.6175	0.5037
50.0	0.4100	0.4018
45.0	0.4560	0.3257
40.0	0.3027	0.2577
35.4	0.2266	0.2021
31.5	0.1670	0.1603
28.0	0.1266	0.1270
25.0	0.0884	0.1015
22.0	0.0719	0.0789
20.0	0.0657	0.0655
18.0	0.0574	0.0533
16.0	0.0395	0.0424
14.0	0.0346	0.0328
12.5	0.0253	0.0264
11.2	0.0221	0.0215
10.0	0.0218	0.0174
9.5	0.0182	0.0159
9.0	0.0145	0.0144
8.5	0.0153	0.0130
8.0	0.0119	0.0117
7.5	0.0105	0.0104
7.1	0.0100	0.0095
6.7	0.0083	0.0086
6.3	0.0078	0.0078
5.9	0.0074	0.0070
5.6	0.0062	0.0064
5.3	0.0056	0.0059
5.0	0.0048	0.0054
4.8	0.0093	0.0051
4.5	0.0058	0.0046
4.0	0.0030	0.0040

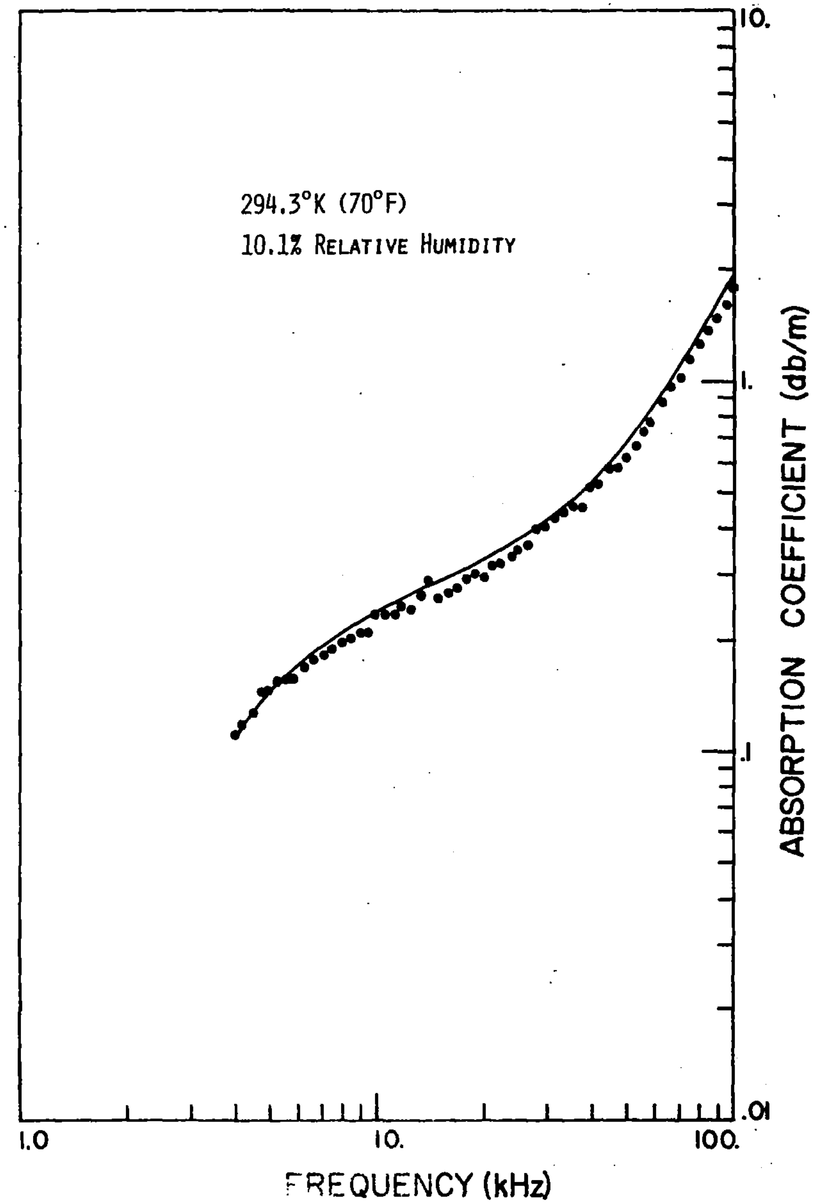
Additional data is given in Appendix A.2. Measurements were not taken at the missing frequencies.



ABSORPTION OF SOUND IN AIR

TEMPERATURE =294.3 K   RELATIVE HUMIDITY = 10.1 %

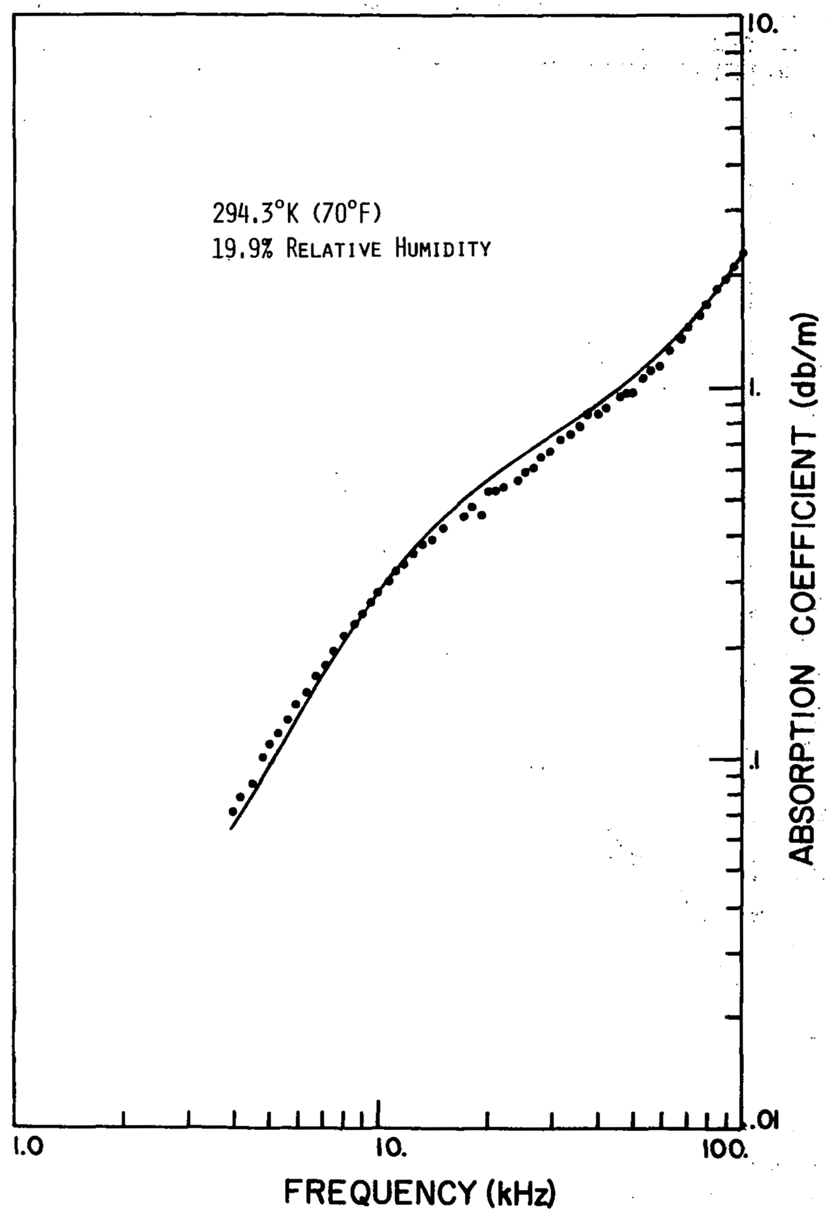
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	1.7763	1.8841
95.0	1.5994	1.7278
90.0	1.4671	1.5796
85.0	1.3533	1.4393
80.0	1.2437	1.3070
75.0	1.1399	1.1827
71.0	1.0152	1.0890
67.0	0.9518	1.0004
63.0	0.8626	0.9169
59.0	0.7758	0.8385
56.0	0.7250	0.7830
53.0	0.6658	0.7304
50.0	0.6131	0.6806
48.0	0.5886	0.6489
45.0	0.5769	0.6038
42.0	0.5231	0.5614
40.0	0.5058	0.5348
37.5	0.4414	0.5031
35.4	0.4517	0.4779
33.4	0.4340	0.4552
31.5	0.4207	0.4346
29.7	0.4000	0.4161
28.0	0.3930	0.3994
26.5	0.3681	0.3852
25.0	0.3444	0.3716
24.0	0.3365	0.3629
22.0	0.3185	0.3459
21.0	0.3143	0.3376
20.0	0.2908	0.3295
19.0	0.2992	0.3215
18.0	0.2893	0.3135
17.0	0.2719	0.3055
16.0	0.2684	0.2974
15.0	0.2676	0.2892
14.0	0.2866	0.2806
13.2	0.2593	0.2735
12.5	0.2375	0.2669
11.8	0.2472	0.2599
11.2	0.2228	0.2536
10.6	0.2363	0.2469
10.0	0.2332	0.2396
9.5	0.2084	0.2331
9.0	0.2093	0.2260
8.5	0.2043	0.2184
8.0	0.1978	0.2102
7.5	0.1861	0.2012
7.1	0.1822	0.1934
6.7	0.1733	0.1849
6.3	0.1677	0.1759
5.9	0.1569	0.1661
5.6	0.1533	0.1583
5.3	0.1545	0.1500
5.0	0.1455	0.1413
4.8	0.1453	0.1352
4.5	0.1270	0.1258
4.2	0.1179	0.1159
4.0	0.1103	0.1092
4.0	0.1103	0.1092



ABSORPTION OF SOUND IN AIR

TEMPERATURE =294.3 K RELATIVE HUMIDITY = 19.9 %

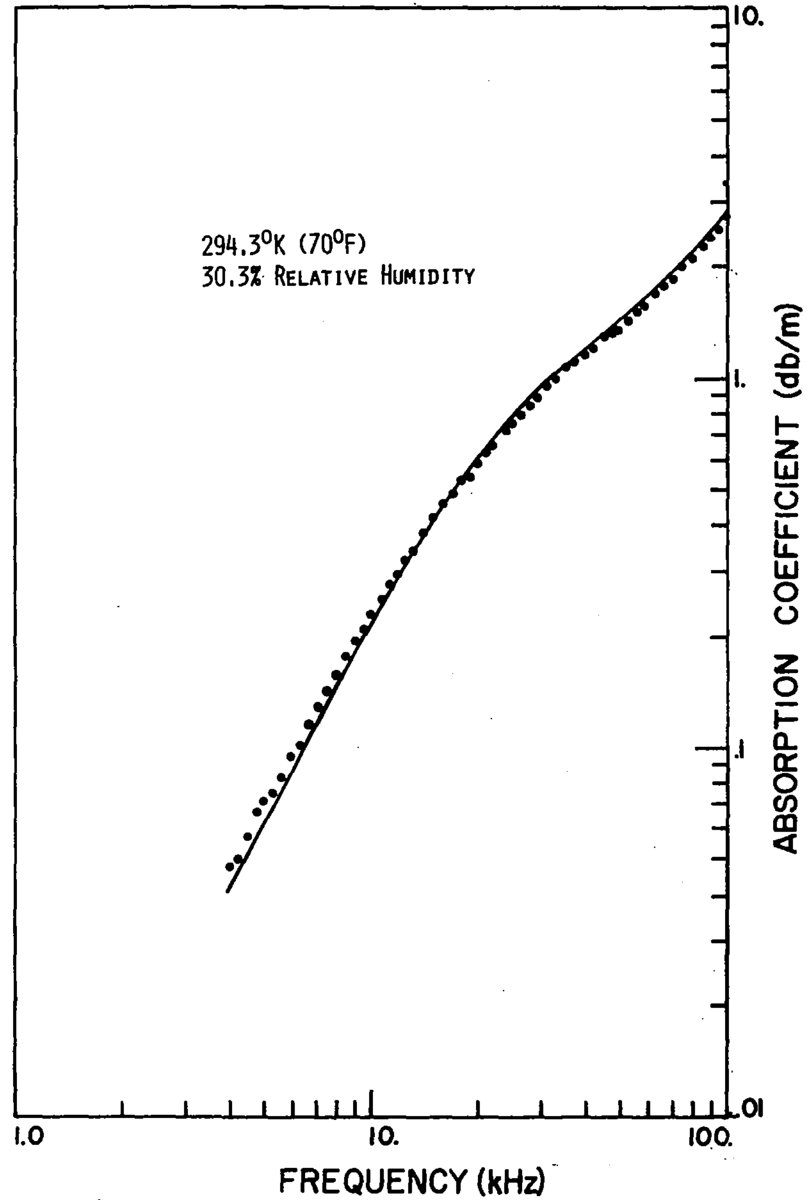
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	2.2724	2.3132
95.0	2.1049	2.1607
90.0	1.9494	2.0110
85.0	1.8311	1.8690
80.0	1.6874	1.7346
75.0	1.5769	1.6079
71.0	1.4556	1.5118
67.0	1.3693	1.4205
63.0	1.2669	1.3337
59.0	1.1473	1.2514
56.0	1.1130	1.1925
53.0	1.0527	1.1358
50.0	0.9796	1.0813
48.0	0.9659	1.0461
45.0	0.9448	0.9948
42.0	0.8852	0.9451
40.0	0.8548	0.9127
37.5	0.8434	0.8728
35.4	0.7851	0.8395
33.4	0.7453	0.8079
31.5	0.7237	0.7776
29.7	0.6768	0.7495
28.0	0.6580	0.7203
26.5	0.6133	0.6947
25.0	0.5912	0.6682
24.0	0.5631	0.6459
22.0	0.5461	0.6113
21.0	0.5277	0.5908
20.0	0.5207	0.5694
19.0	0.4954	0.5470
18.0	0.4815	0.5234
17.0	0.4539	0.4984
16.0	0.4410	0.4721
15.0	0.4199	0.4442
14.0	0.3928	0.4146
13.2	0.3814	0.3897
12.5	0.3571	0.3671
11.8	0.3390	0.3436
11.2	0.3233	0.3228
10.6	0.3018	0.3015
10.0	0.2821	0.2797
9.5	0.2676	0.2612
9.0	0.2484	0.2425
8.5	0.2323	0.2236
8.0	0.2147	0.2046
7.5	0.1982	0.1857
7.1	0.1829	0.1706
6.7	0.1683	0.1557
6.3	0.1526	0.1409
5.9	0.1405	0.1265
5.6	0.1282	0.1159
5.3	0.1174	0.1056
5.0	0.1104	0.0955
4.8	0.1040	0.0890
4.5	0.0868	0.0795
4.2	0.0798	0.0703
4.0	0.0730	0.0645



ABSORPTION OF SOUND IN AIR

TEMPERATURE =294.3 K   RELATIVE HUMIDITY = 30.3 %

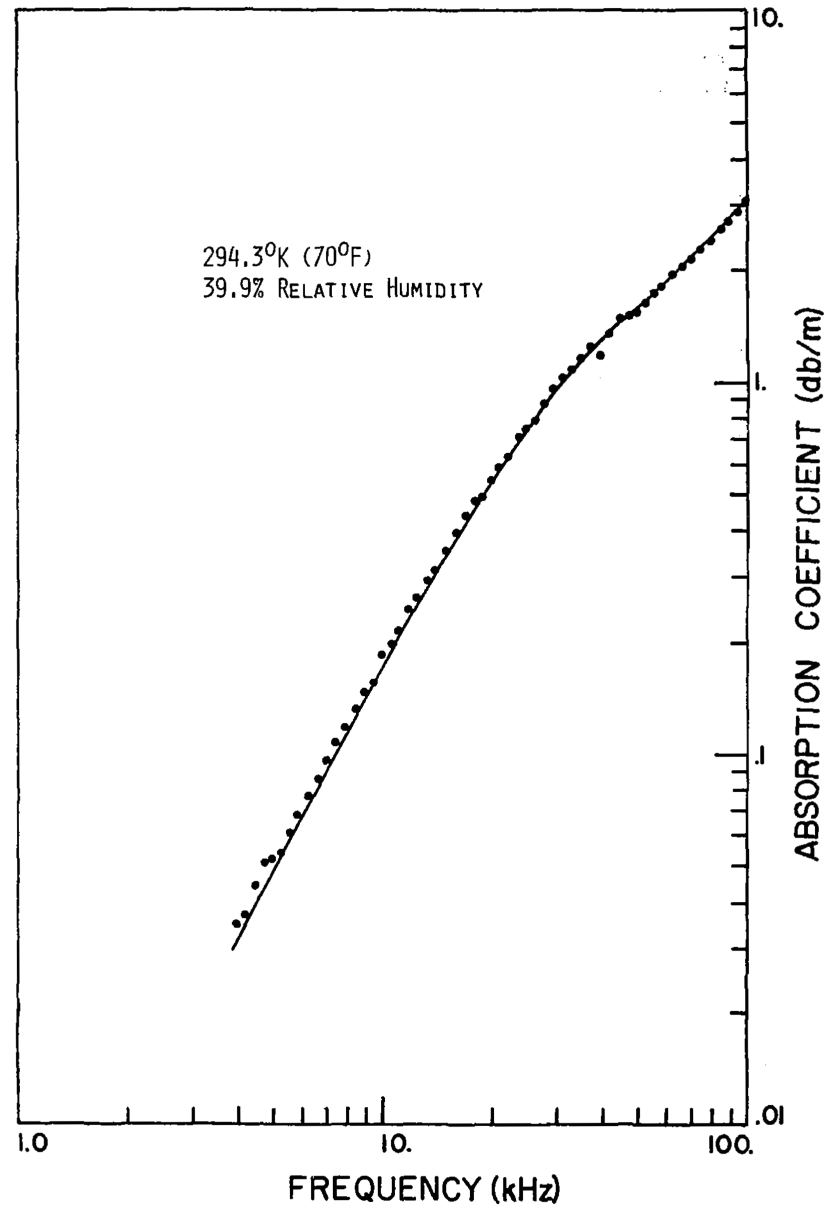
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	2.7082	2.8038
95.0	2.5421	2.6410
90.0	2.3886	2.4853
85.0	2.2537	2.3363
80.0	2.1175	2.1938
75.0	2.0013	2.0573
71.0	1.8622	1.9523
67.0	1.7918	1.8505
63.0	1.6854	1.7516
59.0	1.5650	1.6552
56.0	1.5134	1.5841
53.0	1.4412	1.5136
50.0	1.3609	1.4435
48.0	1.3351	1.3967
45.0	1.3087	1.3260
42.0	1.2153	1.2542
40.0	1.1787	1.2053
37.5	1.1144	1.1426
35.4	1.0796	1.0882
33.4	1.0088	1.0346
31.5	0.9494	0.9818
29.7	0.8816	0.9297
28.0	0.8416	0.8784
26.5	0.7964	0.8315
25.0	0.7589	0.7827
24.0	0.7218	0.7491
22.0	0.6626	0.6795
21.0	0.6306	0.6434
20.0	0.5951	0.6064
19.0	0.5468	0.5687
18.0	0.5350	0.5303
17.0	0.4893	0.4913
16.0	0.4642	0.4518
15.0	0.4275	0.4121
14.0	0.3862	0.3722
13.2	0.3431	0.3404
12.5	0.3268	0.3127
11.8	0.2982	0.2854
11.2	0.2805	0.2623
10.6	0.2573	0.2395
10.0	0.2341	0.2173
9.5	0.2132	0.1991
9.0	0.1963	0.1815
8.5	0.1784	0.1643
8.0	0.1599	0.1477
7.5	0.1450	0.1317
7.1	0.1320	0.1194
6.7	0.1178	0.1075
6.3	0.1047	0.0962
5.9	0.0962	0.0853
5.6	0.0858	0.0776
5.3	0.0779	0.0702
5.0	0.0739	0.0631
4.8	0.0680	0.0585
4.5	0.0585	0.0520
4.2	0.0514	0.0458
4.0	0.0485	0.0420



ABSORPTION OF SOUND IN AIR

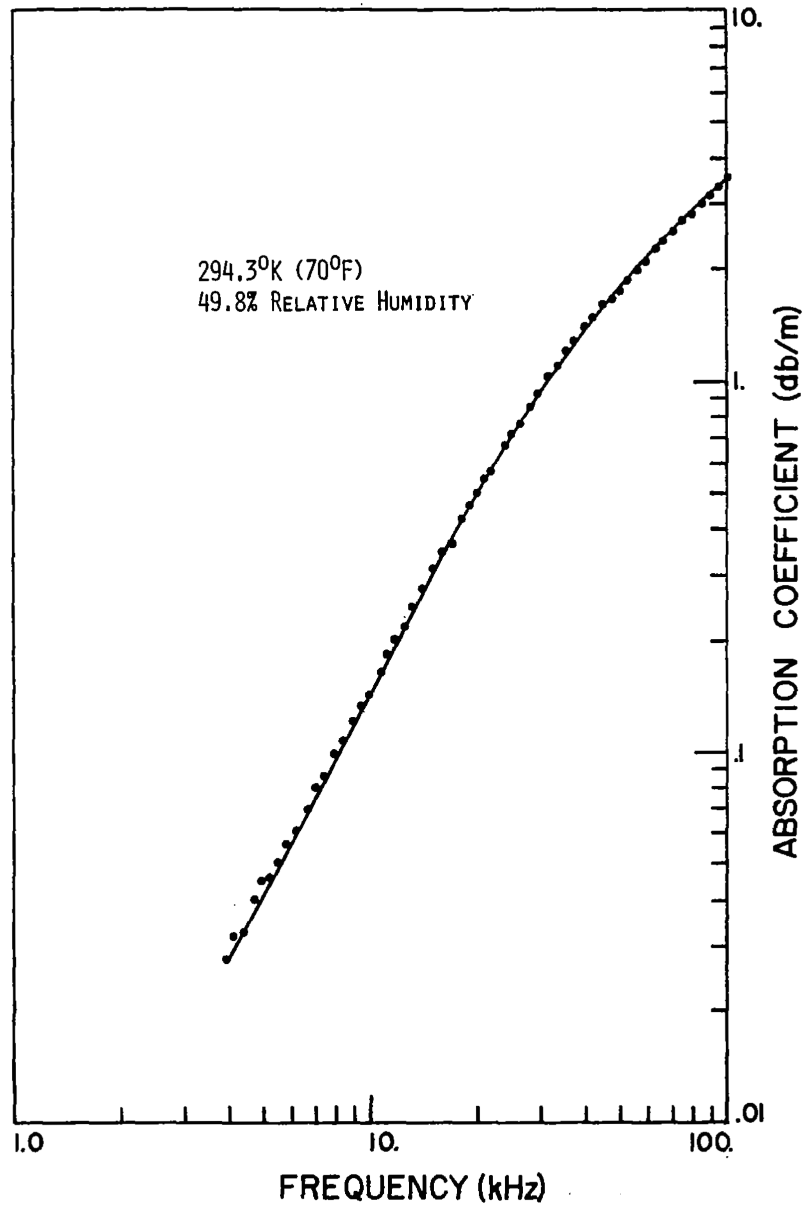
TEMPERATURE =294.3 K   RELATIVE HUMIDITY = 39.9 %

FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	3.0960	3.2183
95.0	2.9272	3.0454
90.0	2.7538	2.8791
85.0	2.6345	2.7169
80.0	2.4580	2.5594
75.0	2.3378	2.4046
71.0	2.1604	2.2837
67.0	2.0887	2.1642
63.0	1.9677	2.0454
59.0	1.8426	1.9265
56.0	1.7736	1.8368
53.0	1.6843	1.7461
50.0	1.5775	1.6539
48.0	1.5413	1.5914
45.0	1.4946	1.4956
42.0	1.3786	1.3969
40.0	1.3205	1.3292
37.5	1.2732	1.2422
35.4	1.1952	1.1668
33.4	1.1098	1.0930
31.5	1.0442	1.0210
29.7	0.9867	0.9510
28.0	0.8915	0.8935
26.5	0.8154	0.8229
25.0	0.7743	0.7614
24.0	0.7360	0.7200
22.0	0.6166	0.6366
21.0	0.6063	0.5949
20.0	0.5582	0.5530
19.0	0.5088	0.5113
18.0	0.4935	0.4700
17.0	0.4504	0.4291
16.0	0.4076	0.3889
15.0	0.3631	0.3495
14.0	0.3225	0.3111
13.2	0.3018	0.2912
12.5	0.2769	0.2559
11.8	0.2490	0.2313
11.2	0.2222	0.2109
10.6	0.2065	0.1911
10.0	0.1900	0.1721
9.5	0.1612	0.1568
9.0	0.1520	0.1421
8.5	0.1378	0.1280
8.0	0.1233	0.1145
7.5	0.1104	0.1017
7.1	0.0999	0.0920
6.7	0.0890	0.0826
6.3	0.0805	0.0738
5.9	0.0713	0.0654
5.6	0.0642	0.0595
5.3	0.0568	0.0529
5.0	0.0543	0.0484
4.8	0.0535	0.0449
4.5	0.0465	0.0400
4.2	0.0383	0.0354
4.0	0.0361	0.0325



ABSORPTION OF SOUND IN AIR
TEMPERATURE =294.3 K RELATIVE HUMIDITY = 49.8 %

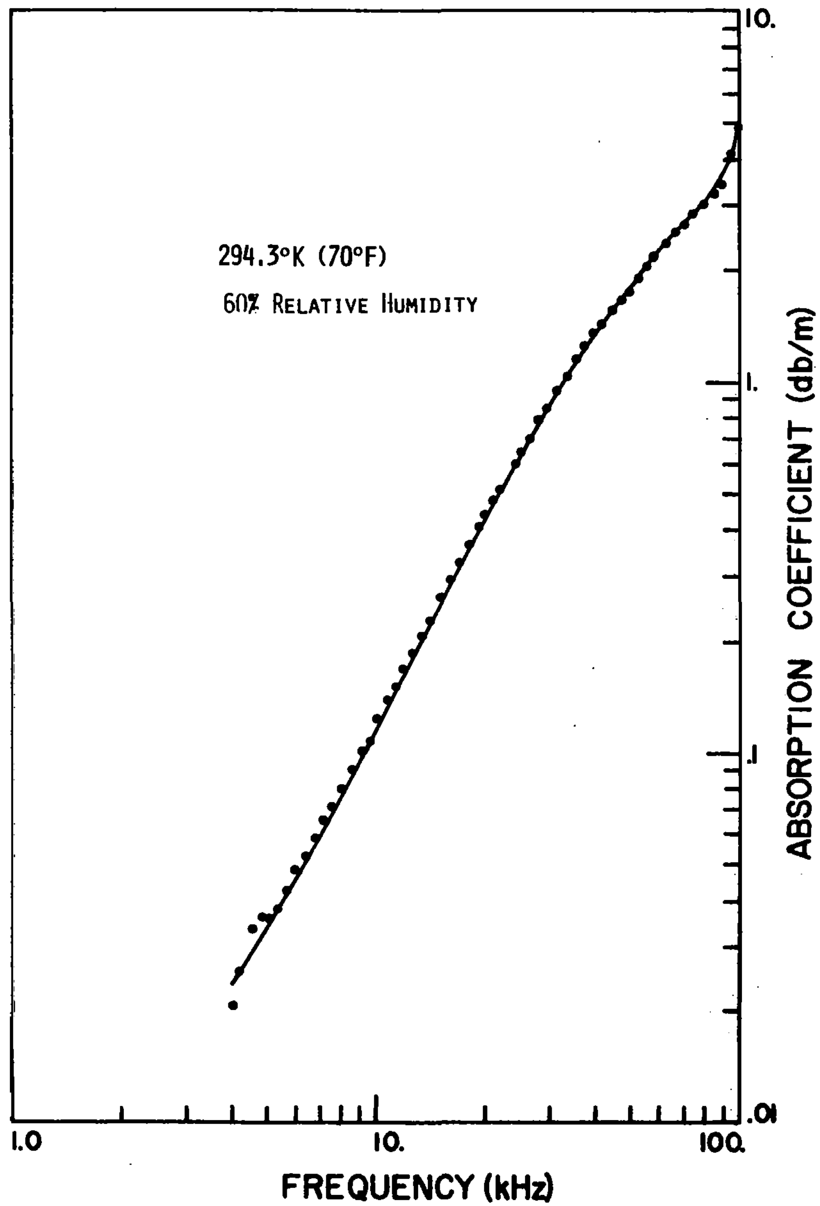
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	3.5268	3.5820
95.0	3.3360	3.3932
90.0	3.1545	3.2082
85.0	3.0002	3.0263
80.0	2.8278	2.8466
75.0	2.6702	2.6682
71.0	2.5110	2.5258
67.0	2.3846	2.3828
63.0	2.2457	2.2387
59.0	2.0917	2.0925
56.0	2.0029	1.9812
53.0	1.8750	1.8690
50.0	1.7497	1.7526
48.0	1.6963	1.6743
45.0	1.6094	1.5546
42.0	1.4826	1.4322
40.0	1.4072	1.3490
37.5	1.2975	1.2433
35.4	1.2078	1.1531
33.4	1.1024	1.0663
31.5	1.0203	0.9831
29.7	0.9143	0.9040
28.0	0.8530	0.8292
26.5	0.7756	0.7633
25.0	0.7208	0.6979
24.0	0.6752	0.6546
22.0	0.5796	0.5693
21.0	0.5408	0.5275
20.0	0.5047	0.4864
19.0	0.4634	0.4461
18.0	0.4236	0.4069
17.0	0.3740	0.3685
16.0	0.3471	0.3313
15.0	0.3137	0.2955
14.0	0.2749	0.2612
13.2	0.2433	0.2349
12.5	0.2197	0.2127
11.8	0.2007	0.1915
11.2	0.1841	0.1740
10.6	0.1646	0.1572
10.0	0.1449	0.1412
9.5	0.1332	0.1284
9.0	0.1214	0.1162
8.5	0.1087	0.1045
8.0	0.0992	0.0935
7.5	0.0879	0.0830
7.1	0.0814	0.0750
6.7	0.0706	0.0675
6.3	0.0629	0.0603
5.9	0.0577	0.0535
5.6	0.0515	0.0483
5.3	0.0470	0.0442
5.0	0.0455	0.0399
4.8	0.0408	0.0372
4.5	0.0333	0.0333
4.2	0.0325	0.0296
4.0	0.0283	0.0273



ABSORPTION OF SOUND IN AIR

TEMPERATURE =294.3 K   RELATIVE HUMIDITY = 60.0 %

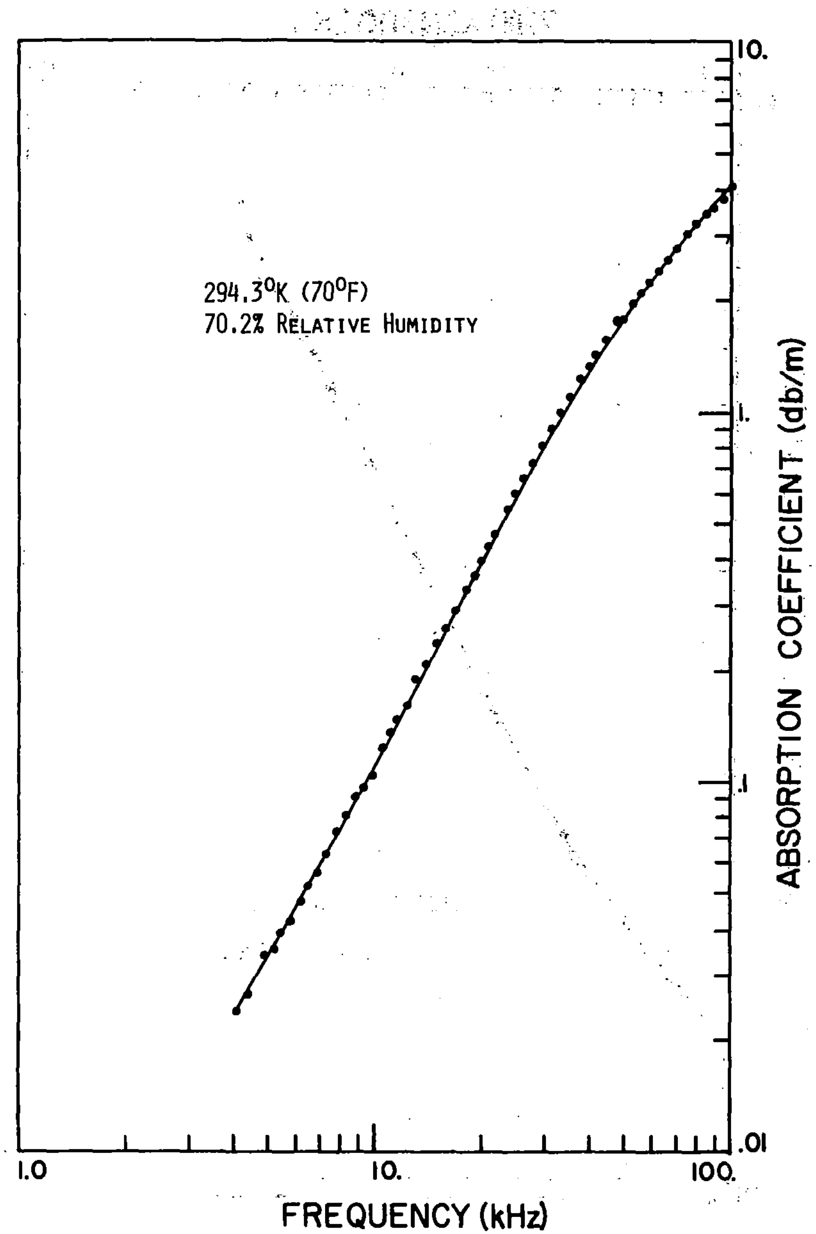
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	3.7989	3.8762
95.0	3.6059	3.6667
90.0	3.3930	3.4552
85.0	3.2229	3.2529
80.0	3.0285	3.0470
75.0	2.8449	2.8405
71.0	2.6561	2.6742
67.0	2.5140	2.5064
63.0	2.3341	2.3366
59.0	2.1923	2.1643
56.0	2.0533	2.0333
53.0	1.9067	1.9006
50.0	1.7572	1.7662
48.0	1.6994	1.6757
45.0	1.5921	1.5387
42.0	1.4417	1.4005
40.0	1.3501	1.3079
37.5	1.2675	1.1919
35.4	1.1609	1.0946
33.4	1.0561	1.0023
31.5	0.9526	0.9154
29.7	0.8654	0.8340
28.0	0.7920	0.7583
26.5	0.7098	0.6927
25.0	0.6550	0.6284
24.0	0.6032	0.5864
22.0	0.5193	0.5049
21.0	0.4800	0.4656
20.0	0.4395	0.4272
19.0	0.4117	0.3900
18.0	0.3691	0.3540
17.0	0.3289	0.3193
16.0	0.2962	0.2860
15.0	0.2643	0.2541
14.0	0.2292	0.2238
13.2	0.2106	0.2008
12.5	0.1891	0.1815
11.8	0.1721	0.1631
11.2	0.1546	0.1481
10.6	0.1422	0.1337
10.0	0.1268	0.1200
9.5	0.1101	0.1091
9.0	0.1044	0.0987
8.5	0.0927	0.0889
8.0	0.0825	0.0795
7.5	0.0733	0.0707
7.1	0.0673	0.0640
6.7	0.0603	0.0577
6.3	0.0535	0.0517
5.9	0.0499	0.0461
5.6	0.0436	0.0421
5.3	0.0391	0.0383
5.0	0.0372	0.0347
4.8	0.0374	0.0324
4.5	0.0341	0.0292
4.2	0.0266	0.0261
4.0	0.0214	0.0242



ABSORPTION OF SOUND IN AIR

TEMPERATURE =294.3 K   RELATIVE HUMIDITY = 70.2 %

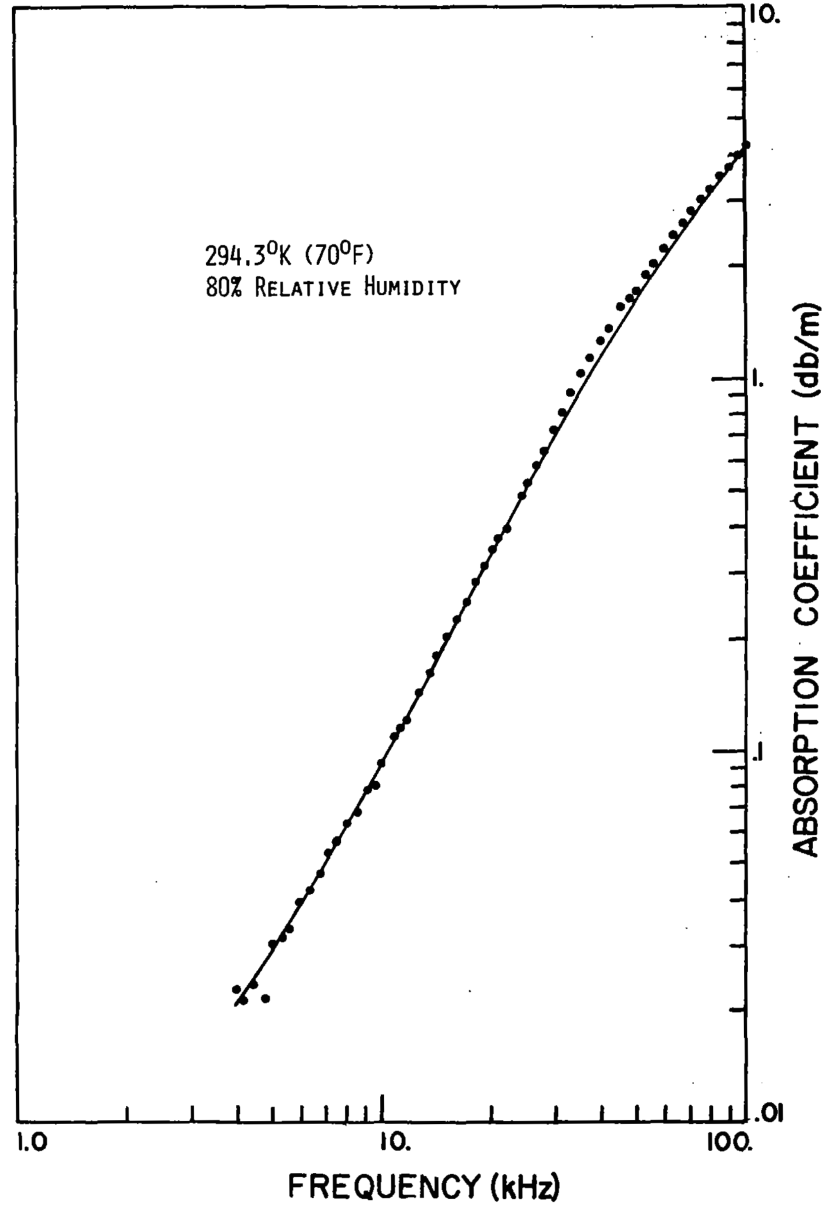
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	3.9994	4.0886
95.0	3.7880	3.8565
90.0	3.5661	3.6251
85.0	3.3724	3.3938
80.0	3.1589	3.1617
75.0	2.9457	2.9284
71.0	2.7340	2.7404
67.0	2.5699	2.5509
63.0	2.3800	2.3597
59.0	2.1924	2.1670
56.0	2.0602	2.0214
53.0	1.9115	1.8752
50.0	1.7446	1.7284
48.0	1.6745	1.6305
45.0	1.5718	1.4830
42.0	1.4051	1.3379
40.0	1.3228	1.2414
37.5	1.2107	1.1219
35.4	1.0951	1.0230
33.4	0.9821	0.9305
31.5	0.8794	0.8443
29.7	0.8088	0.7645
28.0	0.7217	0.6912
26.5	0.6543	0.6292
25.0	0.5955	0.5672
24.0	0.5352	0.5277
22.0	0.4614	0.4516
21.0	0.4295	0.4152
20.0	0.3908	0.3800
19.0	0.3563	0.3460
18.0	0.3241	0.3133
17.0	0.2890	0.2819
16.0	0.2567	0.2520
15.0	0.2337	0.2235
14.0	0.2046	0.1966
13.2	0.1847	0.1762
12.5	0.1594	0.1592
11.8	0.1467	0.1430
11.2	0.1362	0.1299
10.6	0.1209	0.1172
10.0	0.1029	0.1053
9.5	0.0960	0.0959
9.0	0.0899	0.0868
8.5	0.0796	0.0782
8.0	0.0731	0.0701
7.5	0.0640	0.0625
7.1	0.0564	0.0567
6.7	0.0518	0.0513
6.3	0.0470	0.0461
5.9	0.0419	0.0412
5.6	0.0390	0.0378
5.3	0.0355	0.0345
5.0	0.0345	0.0314
4.5	0.0265	0.0266
4.2	0.0237	0.0240



ABSORPTION OF SOUND IN AIR

TEMPERATURE =294.3 K RELATIVE HUMIDITY = 80.0 %

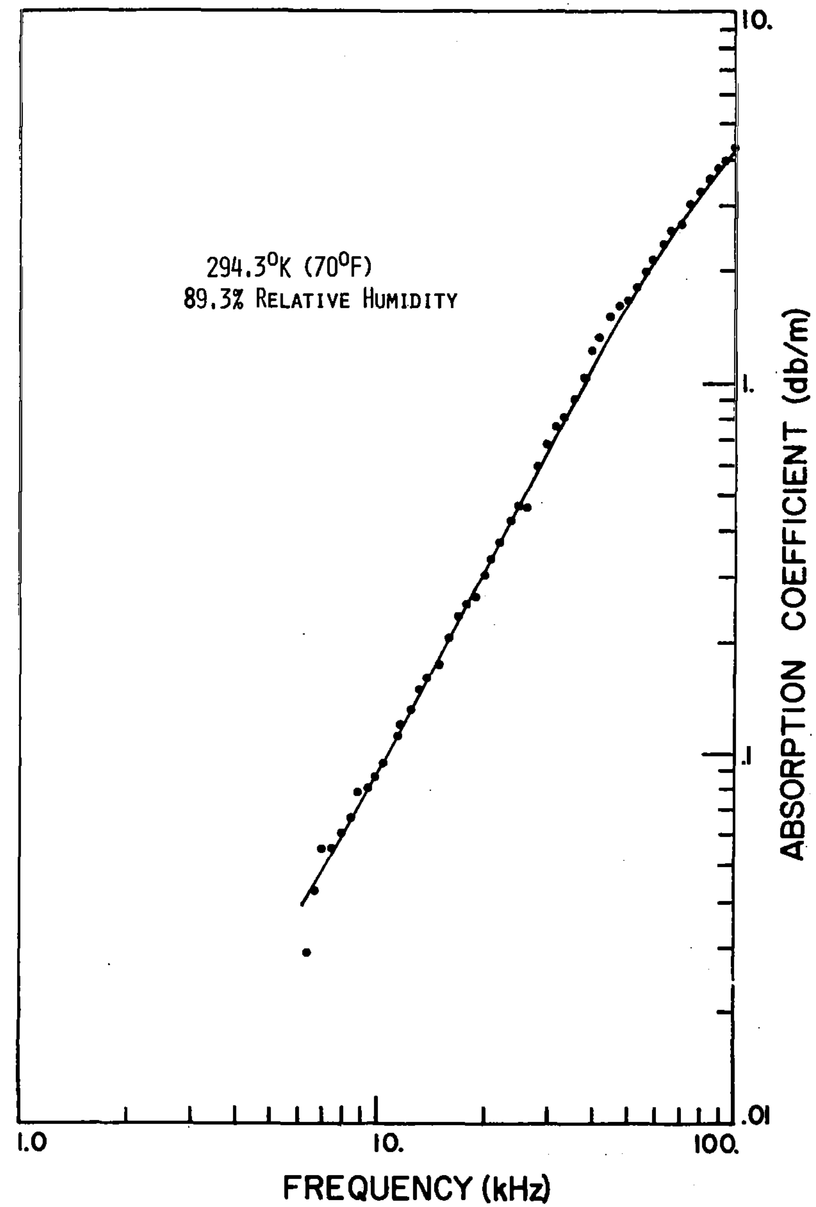
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	4.2695	4.2235
95.0	3.9900	3.9709
90.0	3.7645	3.7167
85.0	3.5464	3.4631
80.0	3.2823	3.2087
75.0	3.0754	2.9534
71.0	2.8379	2.7494
67.0	2.6402	2.5427
63.0	2.4234	2.3365
59.0	2.2148	2.1301
56.0	2.0916	1.9756
53.0	1.9130	1.8216
50.0	1.7311	1.6695
48.0	1.6710	1.5671
45.0	1.5365	1.4167
42.0	1.3761	1.2686
40.0	1.2882	1.1717
37.5	1.1329	1.0529
35.4	1.0318	0.9554
33.4	0.9065	0.8650
31.5	0.8210	0.7815
29.7	0.7293	0.7049
28.0	0.6446	0.6349
26.5	0.5917	0.5754
25.0	0.5381	0.5179
23.0	0.4901	0.4809
22.0	0.3935	0.4101
21.0	0.3773	0.3765
20.0	0.3562	0.3440
19.0	0.3158	0.3128
18.0	0.2925	0.2820
17.0	0.2575	0.2543
16.0	0.2339	0.2271
15.0	0.2031	0.2013
14.0	0.1832	0.1770
13.2	0.1611	0.1596
12.5	0.1454	0.1433
11.8	0.1215	0.1289
11.2	0.1167	0.1170
10.6	0.1105	0.1057
10.0	0.0944	0.0951
9.5	0.0815	0.0866
9.0	0.0800	0.0786
8.5	0.0686	0.0709
8.0	0.0653	0.0637
7.5	0.0575	0.0549
7.1	0.0544	0.0518
6.7	0.0471	0.0470
6.3	0.0430	0.0424
5.9	0.0399	0.0381
5.6	0.0342	0.0350
5.3	0.0321	0.0321
5.0	0.0308	0.0294
4.8	0.0219	0.0276
4.5	0.0240	0.0251
4.2	0.0221	0.0228
4.0	0.0232	0.0213



ABSORPTION OF SOUND IN AIR

TEMPERATURE =294.3 K   RELATIVE HUMIDITY = 89.3 %

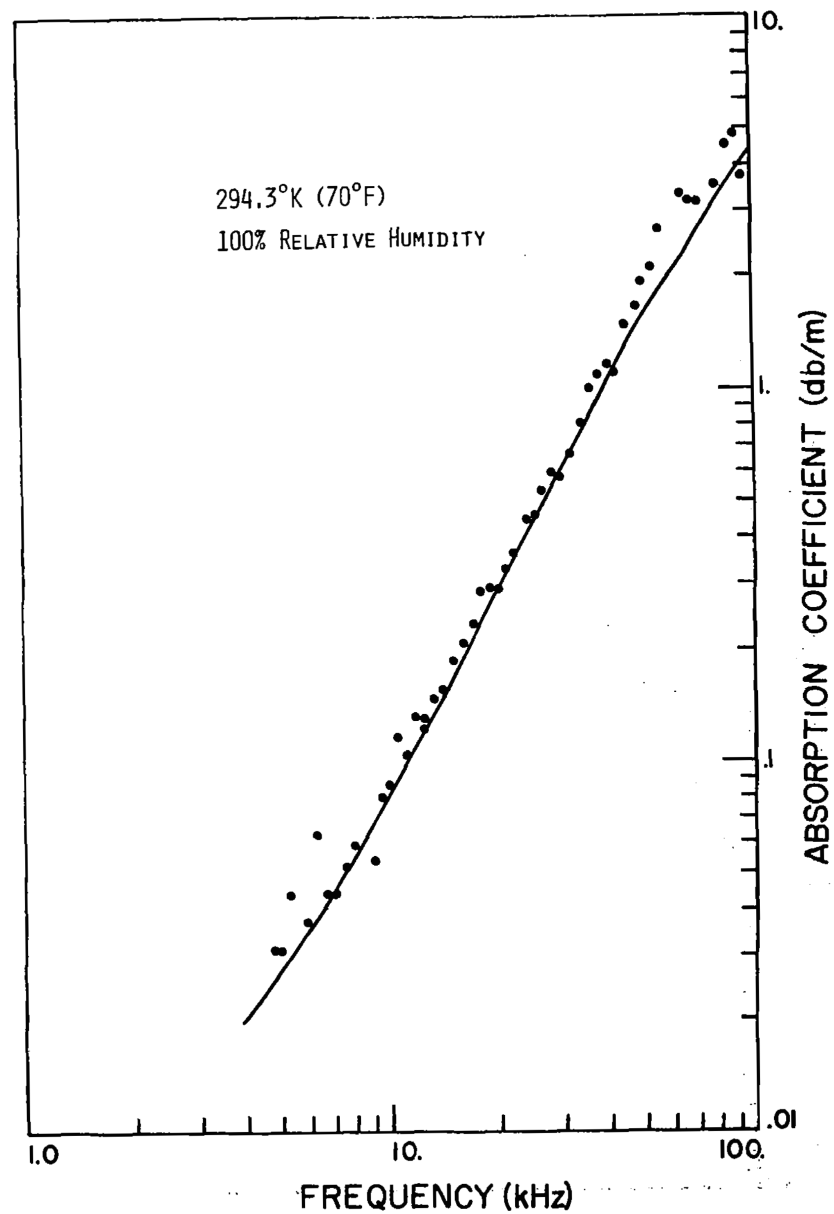
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	4.3611	4.2990
95.0	4.0742	4.0269
90.0	3.8266	3.7550
85.0	3.5908	3.4832
80.0	3.3316	3.2114
75.0	3.0821	2.9396
71.0	2.6878	2.7224
67.0	2.6346	2.5057
63.0	2.3858	2.2899
59.0	2.1591	2.0756
56.0	2.0093	1.9163
53.0	1.8414	1.7586
50.0	1.6649	1.6031
48.0	1.6175	1.5009
45.0	1.5091	1.3501
42.0	1.3321	1.2031
40.0	1.2371	1.1075
37.5	1.0552	0.9912
35.4	0.9237	0.8965
33.4	0.8256	0.8091
31.5	0.7377	0.7299
29.7	0.6949	0.6558
28.0	0.5980	0.5853
26.5	0.4700	0.5339
25.0	0.4784	0.4789
24.0	0.4423	0.4441
22.0	0.3823	0.3780
21.0	0.3433	0.3466
20.0	0.3127	0.3145
19.0	0.2704	0.2876
18.0	0.2602	0.2559
17.0	0.2392	0.2335
16.0	0.2130	0.2035
15.0	0.1789	0.1848
14.0	0.1633	0.1625
13.2	0.1511	0.1457
12.5	0.1320	0.1317
11.8	0.1207	0.1195
11.2	0.1135	0.1077
10.6	0.0964	0.0974
10.0	0.0692	0.0877
9.5	0.0817	0.0800
9.0	0.0811	0.0727
8.5	0.0662	0.0659
8.0	0.0626	0.0592
7.5	0.0583	0.0521
7.1	0.0576	0.0484
6.7	0.0431	0.0440
6.3	0.0299	0.0398



ABSORPTION OF SOUND IN AIR

TEMPERATURE =294.3 K   RELATIVE HUMIDITY =100.0 %

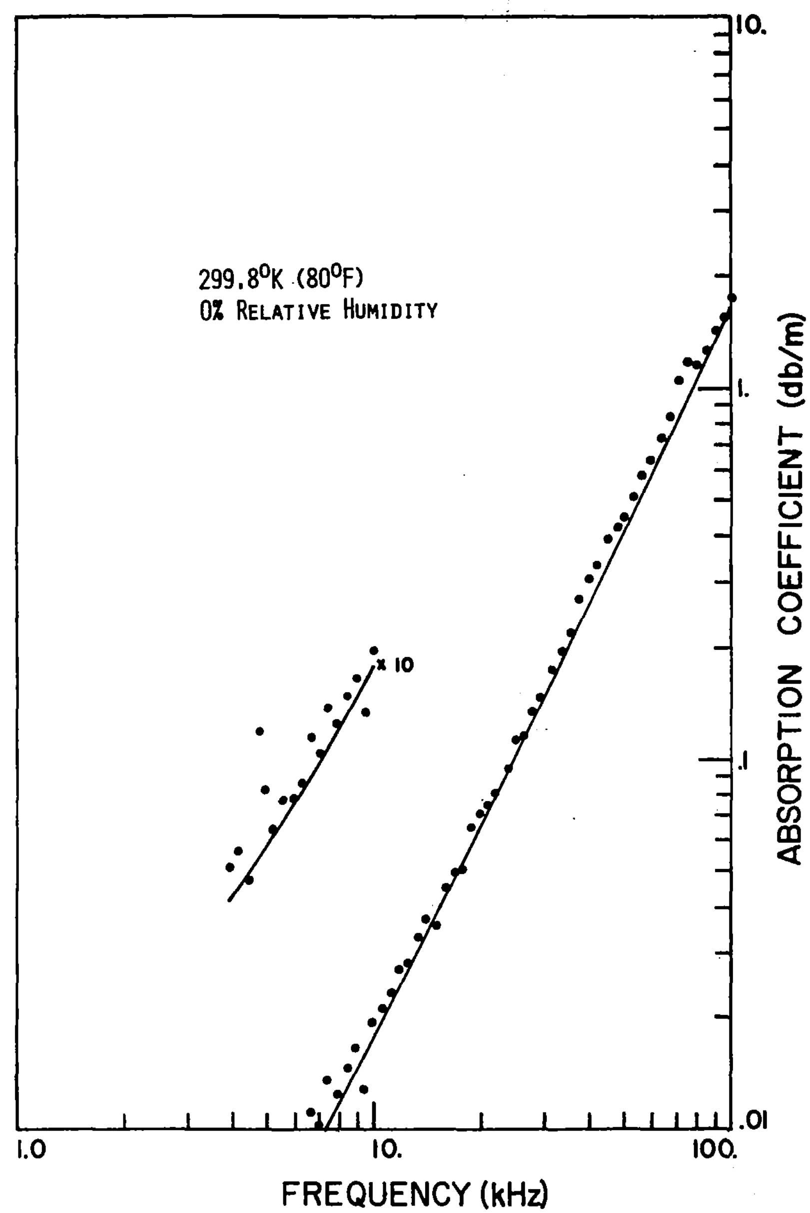
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	4.9022	4.3355
95.0	3.7414	4.0459
90.0	4.8403	3.7555
85.0	4.5352	3.4670
80.0	3.5084	3.1799
71.0	3.2350	2.6675
67.0	3.2811	2.4423
63.0	3.3328	2.2207
56.0	2.6934	1.8404
53.0	2.1261	1.6819
50.0	1.9625	1.5265
48.0	1.6748	1.4259
45.0	1.4608	1.2764
42.0	1.1002	1.1326
40.0	1.1588	1.0397
37.5	1.0811	0.9272
35.4	0.9790	0.8364
33.4	0.8059	0.7530
31.5	0.6622	0.6763
29.7	0.5766	0.6076
28.0	0.5902	0.5450
26.5	0.5276	0.4922
25.0	0.4616	0.4416
24.0	0.4485	0.4092
22.0	0.3599	0.3473
21.0	0.3289	0.3159
20.0	0.2894	0.2909
19.0	0.2893	0.2642
18.0	0.2870	0.2387
17.0	0.2339	0.2145
16.0	0.2108	0.1916
15.0	0.1877	0.1699
14.0	0.1542	0.1495
13.2	0.1486	0.1341
12.5	0.1302	0.1214
11.8	0.1311	0.1093
11.2	0.1035	0.0994
10.6	0.1179	0.0901
10.0	0.0865	0.0813
9.5	0.0792	0.0743
9.0	0.0541	0.0675
8.5	0.0060	0.0613
8.0	0.0589	0.0554
7.5	0.0524	0.0498
7.1	0.0440	0.0455
6.7	0.0447	0.0415
6.3	0.0643	0.0377
5.9	0.0372	0.0342
5.3	0.0440	0.0293
5.0	0.0314	0.0270
4.8	0.0318	0.0256
4.2	0.0401	0.0215



ABSORPTION OF SOUND IN AIR

TEMPERATURE =299.8 K   RELATIVE HUMIDITY = 0.0 %

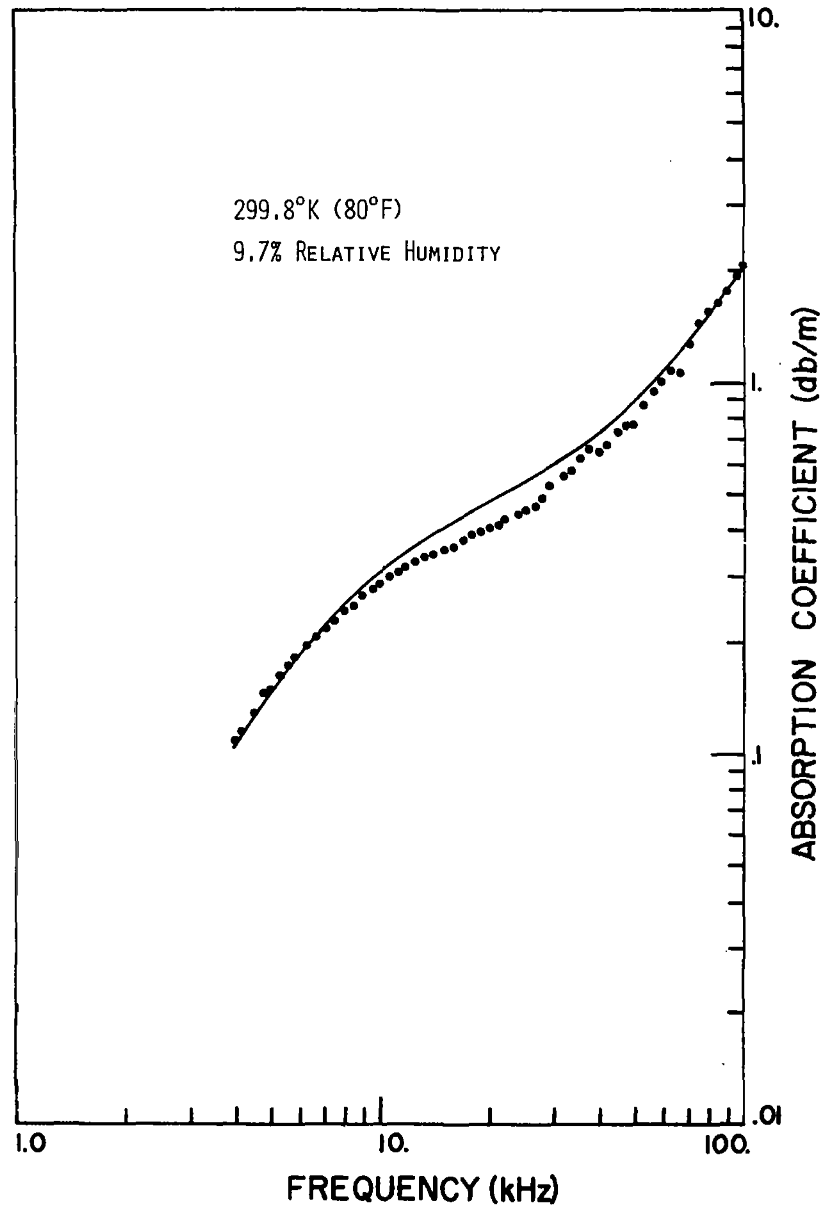
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	1.7543	1.6183
95.0	1.5488	1.4606
90.0	1.4105	1.3111
85.0	1.2694	1.1696
80.0	1.1588	1.0363
75.0	1.1840	0.9110
71.0	1.0557	0.8165
67.0	0.8426	0.7273
63.0	0.7292	0.6432
59.0	0.6269	0.5643
56.0	0.5767	0.5086
53.0	0.5073	0.4557
50.0	0.4363	0.4057
48.0	0.4176	0.3740
45.0	0.3928	0.3299
42.0	0.3286	0.2867
40.0	0.3087	0.2602
37.5	0.2739	0.2289
35.4	0.2203	0.2041
33.4	0.1963	0.1819
31.5	0.1722	0.1620
29.7	0.1489	0.1442
28.0	0.1351	0.1283
26.5	0.1161	0.1151
25.0	0.1111	0.1026
24.0	0.0950	0.0947
22.0	0.0812	0.0798
21.0	0.0747	0.0728
20.0	0.0708	0.0662
19.0	0.0657	0.0599
18.0	0.0512	0.0539
17.0	0.0498	0.0483
16.0	0.0454	0.0429
15.0	0.0364	0.0379
14.0	0.0378	0.0332
13.2	0.0335	0.0297
12.5	0.0284	0.0268
11.8	0.0271	0.0241
11.2	0.0232	0.0218
10.6	0.0214	0.0197
10.0	0.0196	0.0177
9.5	0.0131	0.0161
9.0	0.0165	0.0146
8.5	0.0150	0.0132
8.0	0.0125	0.0119
7.5	0.0139	0.0106
7.1	0.0103	0.0097
6.7	0.0114	0.0088
6.3	0.0087	0.0080
5.9	0.0077	0.0072
5.6	0.0077	0.0066
5.3	0.0063	0.0061
5.0	0.0082	0.0056
4.8	0.0119	0.0053
4.5	0.0047	0.0048
4.2	0.0057	0.0044
4.0	0.0052	0.0041



ABSORPTION OF SOUND IN AIR

TEMPERATURE =299.8 K   RELATIVE HUMIDITY = 9.7 %

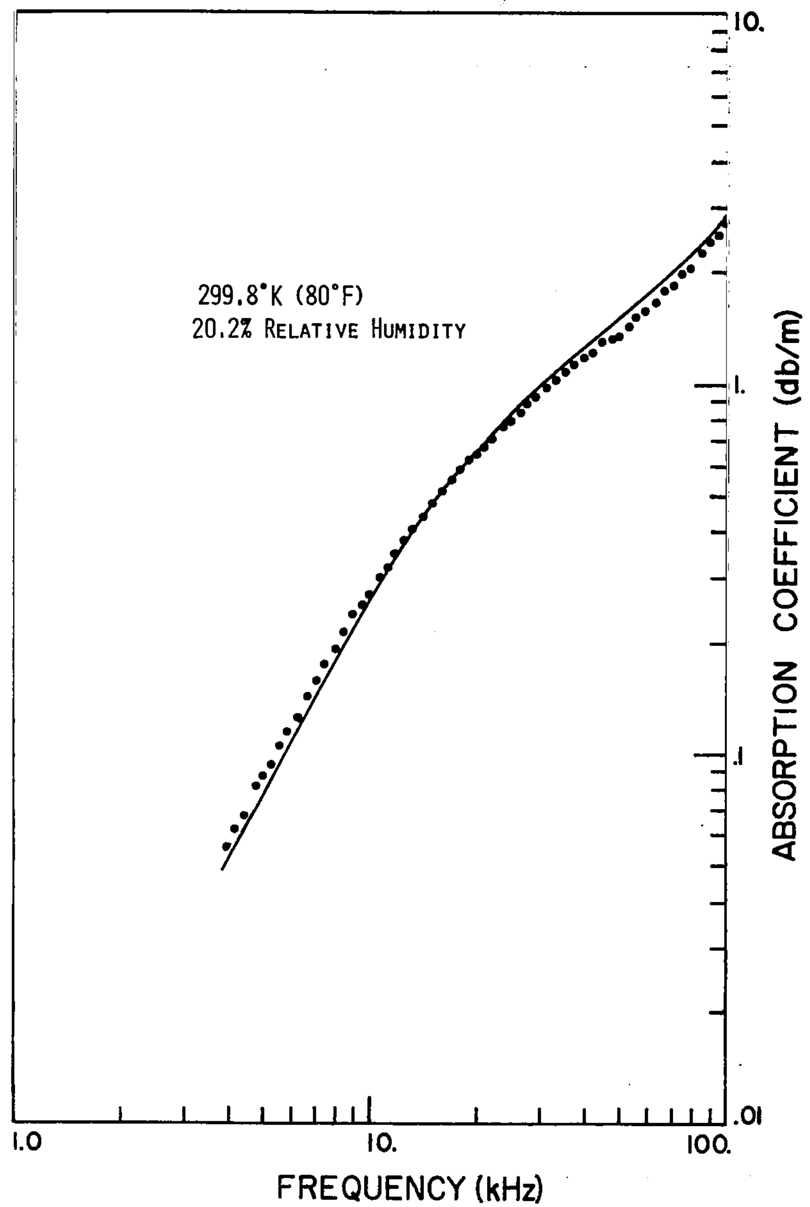
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	2.0320	2.0860
95.0	1.8988	1.9280
90.0	1.7664	1.7781
85.0	1.6170	1.6362
80.0	1.5217	1.5024
75.0	1.4099	1.3764
71.0	1.2622	1.2814
67.0	1.0650	1.1915
63.0	1.0928	1.1066
59.0	0.9872	1.0267
56.0	0.9435	0.9701
53.0	0.8648	0.9162
50.0	0.7681	0.8650
48.0	0.7682	0.8324
45.0	0.7348	0.7856
42.0	0.6669	0.7414
40.0	0.6422	0.7134
37.5	0.6536	0.6797
35.4	0.6144	0.6527
33.4	0.5706	0.6279
31.5	0.5463	0.6050
29.7	0.5168	0.5840
28.0	0.4864	0.5646
26.5	0.4541	0.5477
25.0	0.4475	0.5309
24.0	0.4378	0.5198
22.0	0.4198	0.4972
21.0	0.4035	0.4857
20.0	0.4046	0.4740
19.0	0.3965	0.4619
18.0	0.3838	0.4493
17.0	0.3711	0.4361
16.0	0.3572	0.4222
15.0	0.3528	0.4073
14.0	0.3398	0.3912
13.2	0.3281	0.3773
12.5	0.3194	0.3643
11.8	0.3094	0.3502
11.2	0.2974	0.3374
10.6	0.2948	0.3236
10.0	0.2796	0.3088
9.5	0.2713	0.2957
9.0	0.2629	0.2819
8.5	0.2504	0.2672
8.0	0.2392	0.2516
7.5	0.2258	0.2352
7.1	0.2171	0.2214
6.7	0.2048	0.2071
6.3	0.1932	0.1923
5.9	0.1797	0.1770
5.6	0.1705	0.1653
5.3	0.1596	0.1534
5.0	0.1486	0.1414
4.8	0.1467	0.1333
4.5	0.1297	0.1212
4.2	0.1195	0.1091
4.0	0.1099	0.1011



ABSORPTION OF SOUND IN AIR

TEMPERATURE =299.8 K   RELATIVE HUMIDITY = 20.2 %

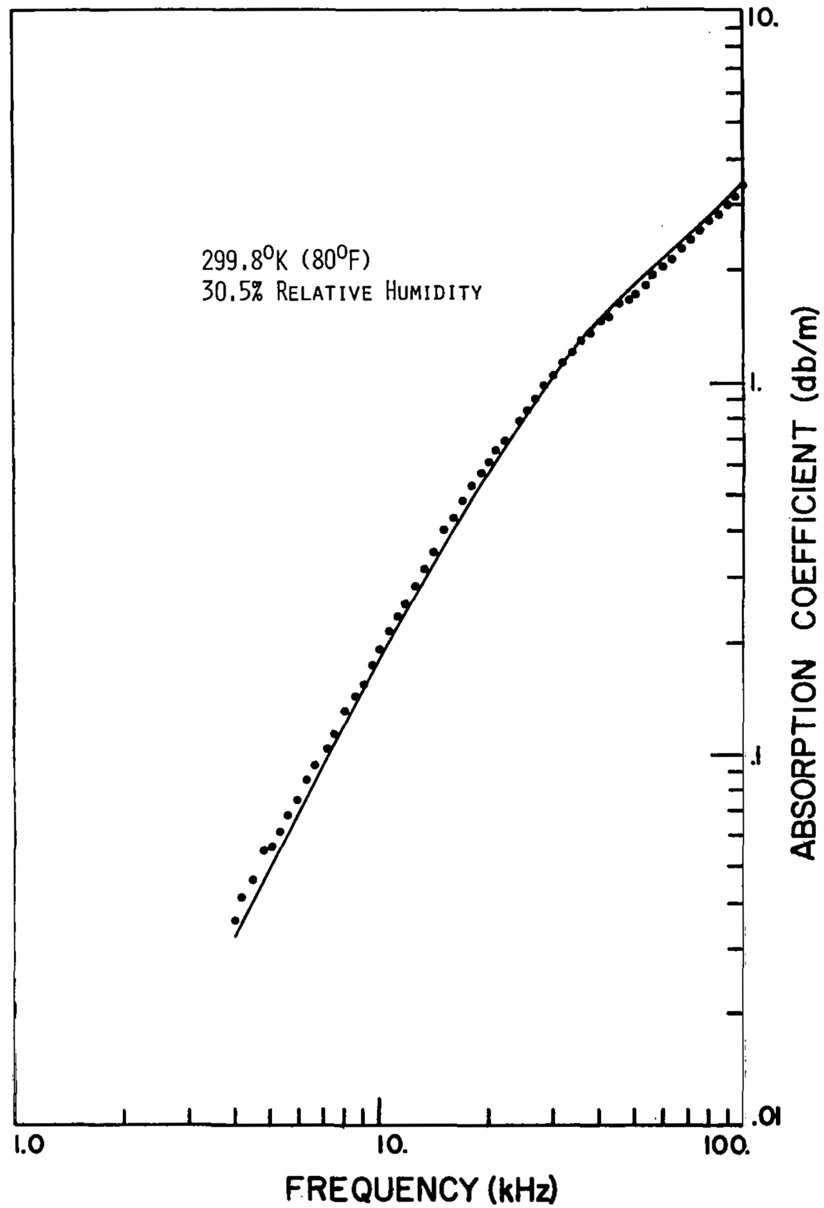
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	2.7377	2.8324
95.0	2.5308	2.6692
90.0	2.3933	2.5132
85.0	2.2418	2.3642
80.0	2.1240	2.2219
75.0	2.0133	2.0861
71.0	1.8643	1.9817
67.0	1.7916	1.8810
63.0	1.6822	1.7834
59.0	1.5751	1.6886
56.0	1.5238	1.6189
53.0	1.4380	1.5502
50.0	1.3601	1.4820
48.0	1.3431	1.4366
45.0	1.3037	1.3693
42.0	1.2228	1.2991
40.0	1.1970	1.2521
37.5	1.1405	1.1918
35.4	1.0950	1.1396
33.4	1.0261	1.0880
31.5	0.9751	1.0370
29.7	0.9243	0.9866
28.0	0.8829	0.9368
26.5	0.8349	0.8909
25.0	0.7891	0.8429
24.0	0.7660	0.8097
22.0	0.7089	0.7401
21.0	0.6764	0.7037
20.0	0.6465	0.6662
19.0	0.6196	0.6276
18.0	0.5874	0.5880
17.0	0.5530	0.5475
16.0	0.5107	0.5060
15.0	0.4774	0.4638
14.0	0.4377	0.4211
13.2	0.4092	0.3868
12.5	0.3823	0.3567
11.8	0.3512	0.3267
11.2	0.3249	0.3012
10.6	0.3057	0.2759
10.0	0.2729	0.2510
9.5	0.2552	0.2307
9.0	0.2357	0.2107
8.5	0.2152	0.1912
8.0	0.1946	0.1723
7.5	0.1745	0.1539
7.1	0.1588	0.1398
6.7	0.1435	0.1261
6.3	0.1282	0.1130
5.9	0.1170	0.1004
5.6	0.1059	0.0913
5.3	0.0952	0.0927
5.0	0.0885	0.0744
4.8	0.0842	0.0690
4.5	0.0686	0.0614
4.2	0.0644	0.0542
4.0	0.0572	0.0496



ABSORPTION OF SOUND IN AIR

TEMPERATURE =299.8 K RELATIVE HUMIDITY = 30.5 %

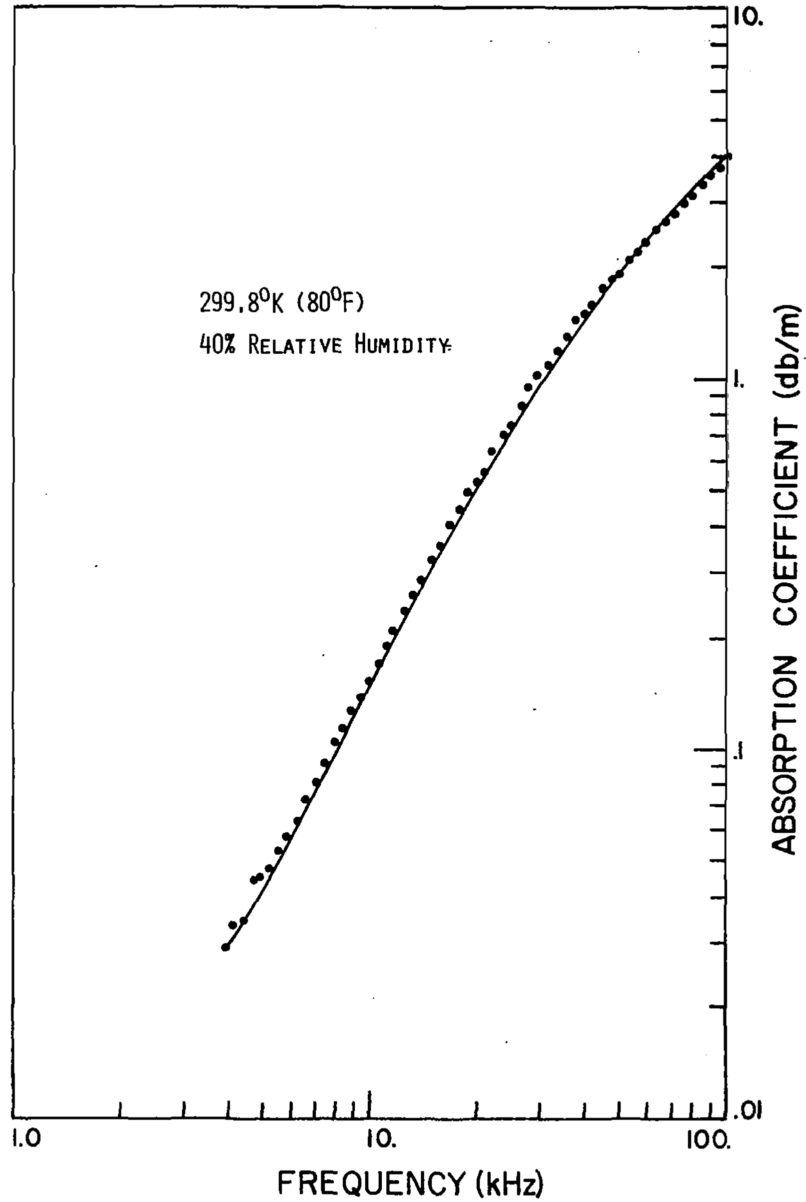
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	3.3674	3.5102
95.0	3.1633	3.3300
90.0	3.0044	3.1547
85.0	2.8430	2.9837
80.0	2.7097	2.8164
75.0	2.5649	2.6517
71.0	2.4011	2.5212
67.0	2.3023	2.3912
63.0	2.1661	2.2608
59.0	2.0311	2.1292
56.0	1.9547	2.0290
53.0	1.8358	1.9272
50.0	1.7296	1.8232
48.0	1.6899	1.7523
45.0	1.6198	1.6433
42.0	1.5052	1.5308
40.0	1.4503	1.4534
37.5	1.3870	1.3540
35.4	1.3289	1.2691
33.4	1.1978	1.1841
31.5	1.1360	1.1024
29.7	1.0518	1.0234
28.0	0.9811	0.9475
26.5	0.9002	0.8797
25.0	0.8408	0.8112
24.0	0.7938	0.7653
22.0	0.7029	0.6735
21.0	0.6556	0.6277
20.0	0.6126	0.5821
19.0	0.5650	0.5370
18.0	0.5259	0.4923
17.0	0.4795	0.4485
16.0	0.4352	0.4055
15.0	0.4004	0.3635
14.0	0.3507	0.3229
13.2	0.3161	0.2914
12.5	0.2914	0.2648
11.8	0.2578	0.2390
11.2	0.2392	0.2177
10.6	0.2150	0.1971
10.0	0.1942	0.1774
9.5	0.1734	0.1616
9.0	0.1564	0.1464
8.5	0.1443	0.1318
8.0	0.1308	0.1180
7.5	0.1140	0.1048
7.1	0.1042	0.0948
6.7	0.0954	0.0852
6.3	0.0864	0.0762
5.9	0.0758	0.0676
5.6	0.0687	0.0615
5.3	0.0618	0.0557
5.0	0.0567	0.0502
4.8	0.0563	0.0467
4.5	0.0474	0.0417
4.2	0.0417	0.0370
4.0	0.0360	0.0340



ABSORPTION OF SOUND IN AIR

TEMPERATURE =299.8 K RELATIVE HUMIDITY = 40.0 %

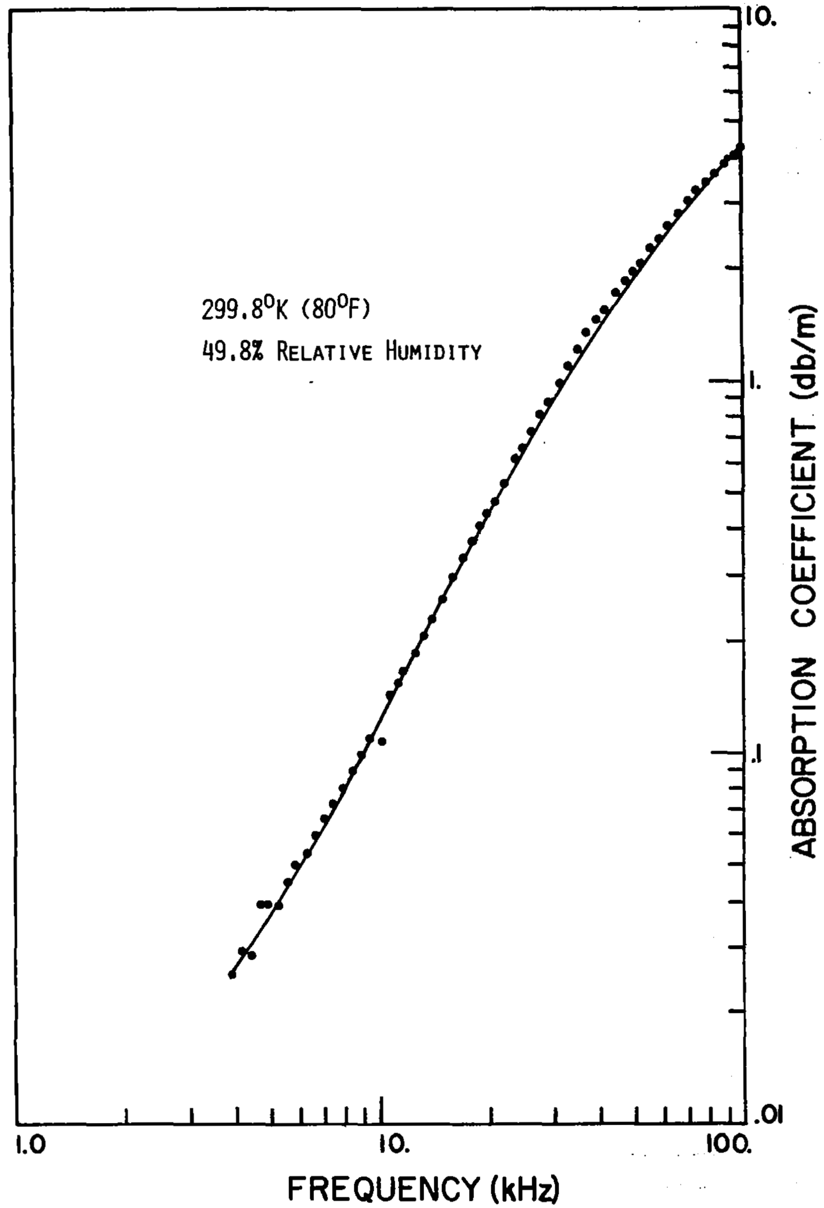
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	3.8957	3.9965
95.0	3.6529	3.7899
90.0	3.4699	3.5856
85.0	3.2851	3.3826
80.0	3.1179	3.1800
75.0	2.9431	2.9768
71.0	2.7546	2.8130
67.0	2.6262	2.6474
63.0	2.4535	2.4793
59.0	2.2802	2.3080
56.0	2.1836	2.1772
53.0	2.0305	2.0440
50.0	1.8914	1.9084
48.0	1.8305	1.8165
45.0	1.7219	1.6766
42.0	1.5664	1.5343
40.0	1.4957	1.4383
37.5	1.4178	1.3171
35.4	1.2792	1.2146
33.4	1.1890	1.1169
31.5	1.0841	1.0239
29.7	1.0043	0.9364
28.0	0.9293	0.8544
26.5	0.8278	0.7828
25.0	0.7443	0.7124
24.0	0.7014	0.6671
22.0	0.6153	0.5759
21.0	0.5684	0.5319
20.0	0.5229	0.4891
19.0	0.4860	0.4473
18.0	0.4409	0.4067
17.0	0.3997	0.3675
16.0	0.3530	0.3266
15.0	0.3220	0.2934
14.0	0.2778	0.2588
13.2	0.2546	0.2324
12.5	0.2310	0.2105
11.8	0.2085	0.1891
11.2	0.1884	0.1719
10.6	0.1698	0.1552
10.0	0.1496	0.1394
9.5	0.1356	0.1268
9.0	0.1257	0.1143
8.5	0.1112	0.1024
8.0	0.1011	0.0925
7.5	0.0902	0.0823
7.1	0.0808	0.0745
6.7	0.0727	0.0671
6.3	0.0649	0.0602
5.9	0.0579	0.0536
5.6	0.0534	0.0490
5.3	0.0467	0.0445
5.0	0.0448	0.0404
4.8	0.0437	0.0377
4.5	0.0344	0.0334
4.7	0.0332	0.0302
4.0	0.0269	0.0281



ABSORPTION OF SOUND IN AIR

TEMPERATURE =299.8 K RELATIVE HUMIDITY = 49.8 %

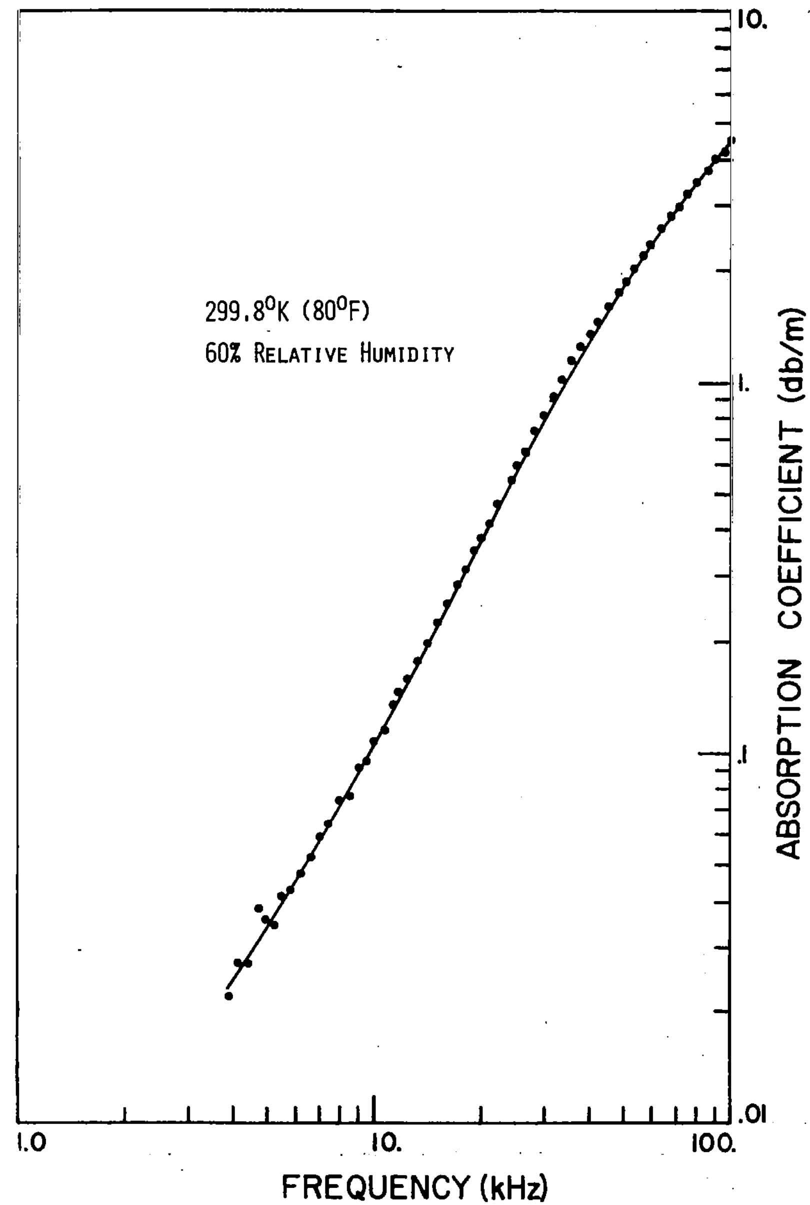
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	4.2942	4.3377
95.0	4.0232	4.0982
90.0	3.8101	3.8589
85.0	3.5861	3.6190
80.0	3.4213	3.3776
75.0	3.2086	3.1341
71.0	2.9925	2.9372
67.0	2.8220	2.7383
63.0	2.5950	2.5370
59.0	2.3917	2.3334
56.0	2.2622	2.1793
53.0	2.0829	2.0240
50.0	1.9117	1.8679
48.0	1.8369	1.7635
45.0	1.7021	1.6068
42.0	1.5330	1.4505
40.0	1.4541	1.3469
37.5	1.3161	1.2185
35.4	1.2015	1.1120
33.4	1.0929	1.0172
31.5	0.9858	0.9191
29.7	0.8890	0.8328
28.0	0.8091	0.7534
26.5	0.7270	0.6852
25.0	0.6629	0.6190
24.0	0.6086	0.5761
22.0	0.5258	0.4934
21.0	0.4740	0.4538
20.0	0.4422	0.4155
19.0	0.4057	0.3785
18.0	0.3653	0.3428
17.0	0.3344	0.3087
16.0	0.2911	0.2760
15.0	0.2594	0.2450
14.0	0.2296	0.2156
13.2	0.2046	0.1933
12.5	0.1874	0.1748
11.8	0.1686	0.1571
11.2	0.1533	0.1427
10.6	0.1411	0.1289
10.0	0.1077	0.1158
9.5	0.1109	0.1055
9.0	0.1003	0.0956
8.5	0.0699	0.0863
8.0	0.0814	0.0774
7.5	0.0741	0.0691
7.1	0.0665	0.0627
6.7	0.0604	0.0569
6.3	0.0539	0.0511
5.9	0.0502	0.0458
5.6	0.0452	0.0420
5.3	0.0386	0.0385
5.0	0.0396	0.0351
4.8	0.0395	0.0329
4.5	0.0289	0.0298
4.2	0.0292	0.0270
4.0	0.0255	0.0251



ABSORPTION OF SOUND IN AIR

TEMPERATURE =299.8 K   RELATIVE HUMIDITY = 60.0 %

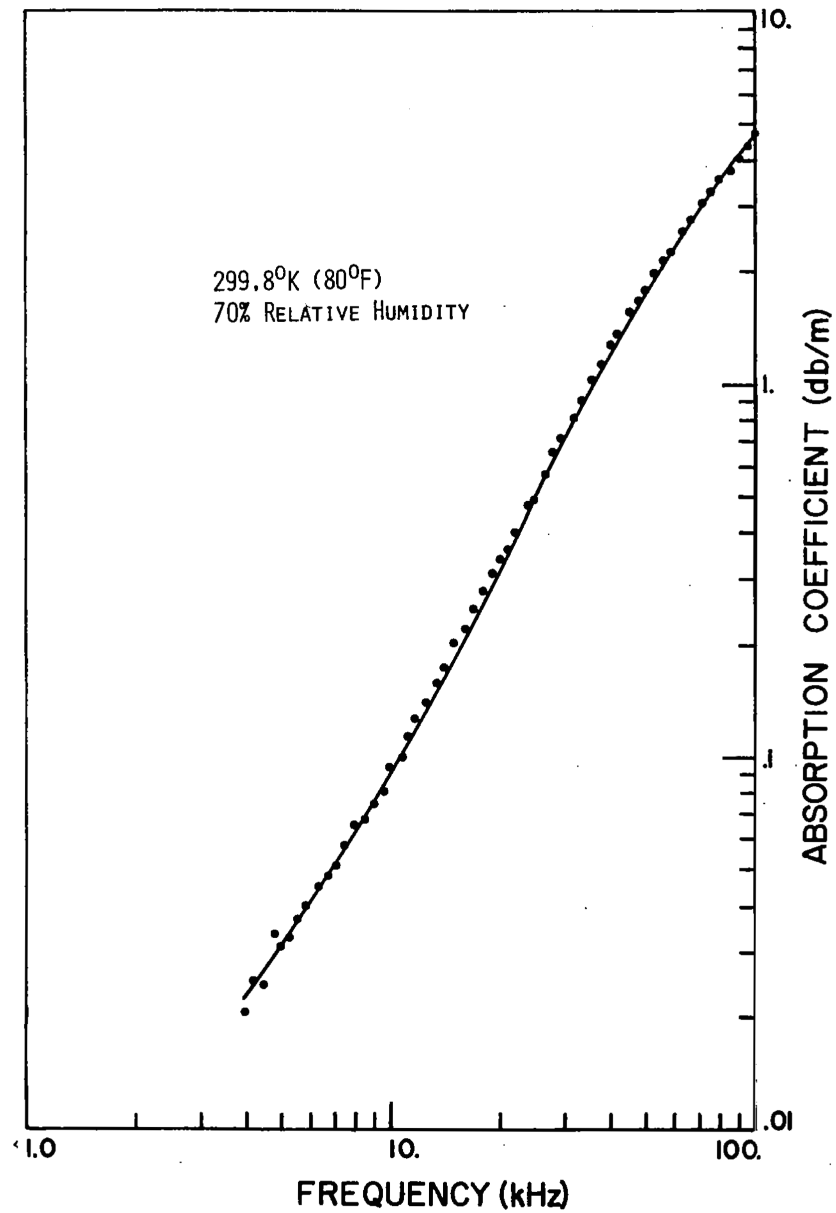
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	4.4448	4.5384
95.0	4.1545	4.2652
90.0	3.9221	3.9915
85.0	3.6547	3.7167
80.0	3.4298	3.4407
75.0	3.1806	3.1633
71.0	2.9802	2.9404
67.0	2.7958	2.7168
63.0	2.5582	2.4929
59.0	2.3251	2.2690
56.0	2.1791	2.1015
53.0	1.9914	1.9350
50.0	1.8146	1.7697
48.0	1.7341	1.6605
45.0	1.5969	1.4987
42.0	1.4290	1.3399
40.0	1.3376	1.2362
37.5	1.2239	1.1093
35.4	1.1386	1.0055
33.4	0.9991	0.9094
31.5	0.8955	0.8209
29.7	0.8080	0.7398
28.0	0.7352	0.6659
26.5	0.6405	0.6031
25.0	0.5893	0.5426
24.0	0.5370	0.5037
22.0	0.4582	0.4293
21.0	0.4122	0.3940
20.0	0.3839	0.3600
19.0	0.3522	0.3274
18.0	0.3137	0.2961
17.0	0.2821	0.2662
16.0	0.2495	0.2378
15.0	0.2199	0.2110
14.0	0.1951	0.1856
13.2	0.1776	0.1665
12.5	0.1585	0.1506
11.8	0.1435	0.1355
11.2	0.1318	0.1231
10.6	0.1135	0.1114
10.0	0.1081	0.1003
9.5	0.0932	0.0916
9.0	0.0905	0.0832
8.5	0.0779	0.0753
8.0	0.0727	0.0679
7.5	0.0645	0.0607
7.1	0.0593	0.0554
6.7	0.0520	0.0504
6.3	0.0468	0.0456
5.9	0.0430	0.0411
5.6	0.0407	0.0379
5.3	0.0345	0.0349
5.0	0.0351	0.0321
4.8	0.0379	0.0303
4.5	0.0269	0.0277
4.2	0.0270	0.0252
4.0	0.0223	0.0237



ABSORPTION OF SOUND IN AIR

TEMPERATURE =299.8 K RELATIVE HUMIDITY = 70.0 %

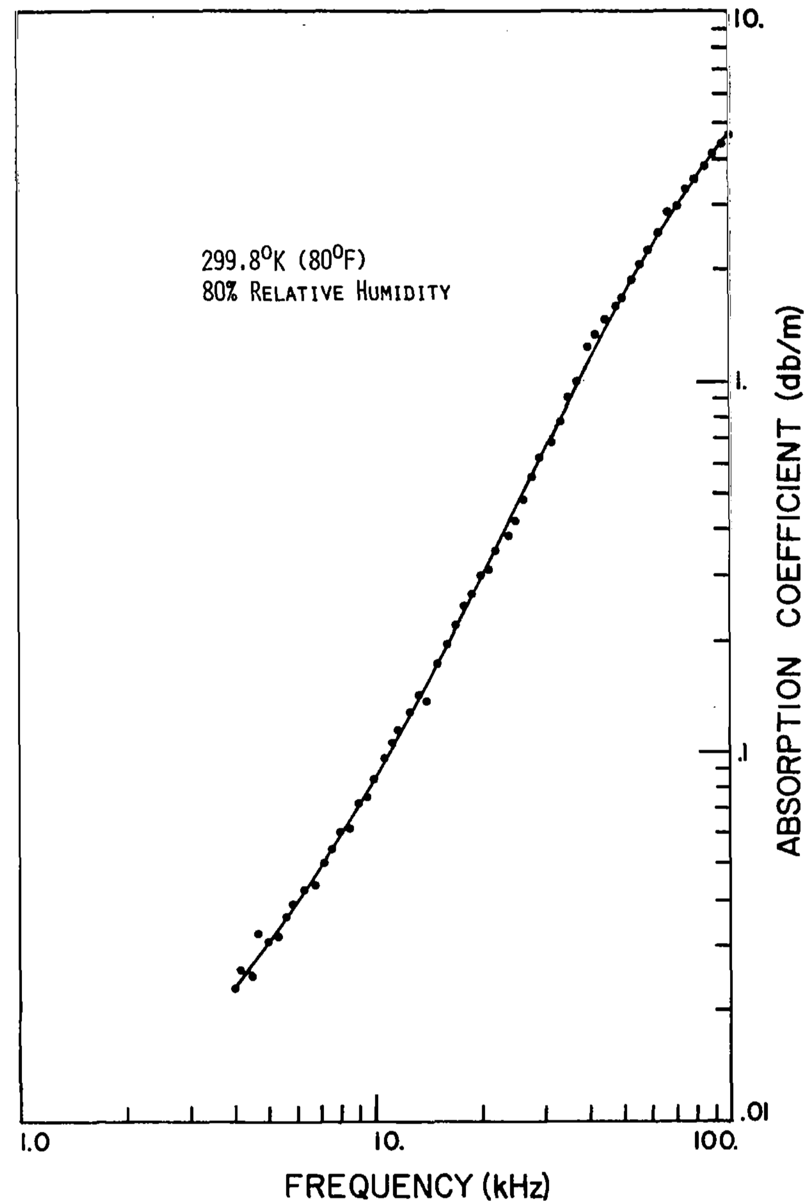
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	4.6380	4.6174
95.0	4.3187	4.2161
90.0	4.0500	4.0150
85.0	3.7518	3.7132
80.0	3.5260	3.4132
75.0	3.2640	3.1133
71.0	2.9927	2.8743
67.0	2.7936	2.6367
63.0	2.5258	2.4011
59.0	2.2892	2.1683
56.0	2.1293	1.9961
53.0	1.9287	1.8265
50.0	1.7431	1.6600
48.0	1.6732	1.5510
45.0	1.5331	1.3911
42.0	1.3632	1.2359
40.0	1.2739	1.1355
37.5	1.1224	1.0139
35.4	1.0156	0.9152
33.4	0.9010	0.8246
31.5	0.8204	0.7417
29.7	0.7157	0.6664
28.0	0.6600	0.5932
26.5	0.5746	0.5405
25.0	0.4897	0.4852
24.0	0.4806	0.4499
22.0	0.4045	0.3826
21.0	0.3645	0.3508
20.0	0.3372	0.3203
19.0	0.3121	0.2911
18.0	0.2818	0.2632
17.0	0.2504	0.2366
16.0	0.2203	0.2114
15.0	0.2012	0.1876
14.0	0.1737	0.1652
13.2	0.1579	0.1493
12.5	0.1401	0.1343
11.8	0.1267	0.1210
11.2	0.1137	0.1102
10.6	0.1006	0.0999
10.0	0.0945	0.0902
9.5	0.0829	0.0825
9.0	0.0756	0.0752
8.5	0.0686	0.0682
8.0	0.0662	0.0617
7.5	0.0580	0.0555
7.1	0.0516	0.0509
6.7	0.0484	0.0465
6.3	0.0448	0.0423
5.9	0.0403	0.0384
5.6	0.0368	0.0356
5.3	0.0329	0.0330
5.0	0.0318	0.0305
4.8	0.0345	0.0289
4.5	0.0249	0.0266
4.2	0.0254	0.0245
4.0	0.0213	0.0231



ABSORPTION OF SOUND IN AIR

TEMPERATURE =299.8 K   RELATIVE HUMIDITY = 80.0 %

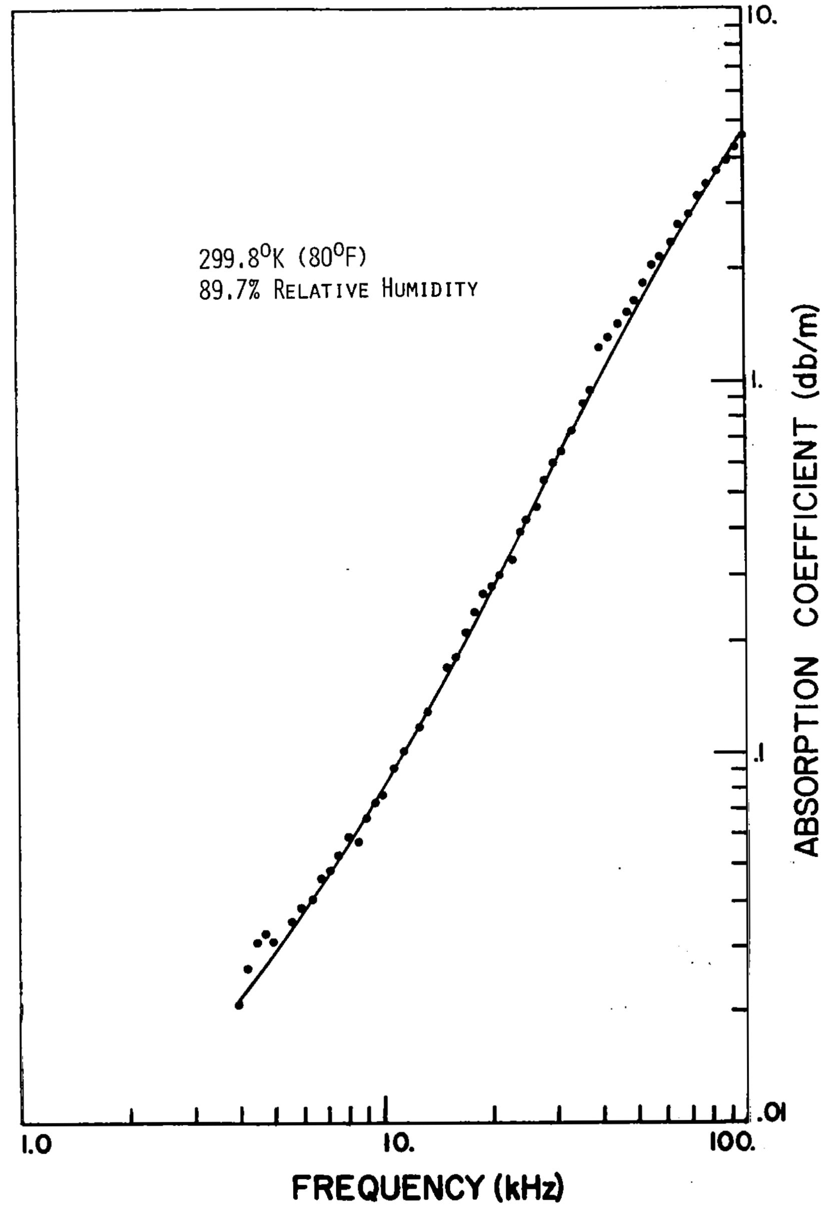
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	4.6482	4.6152
95.0	4.3949	4.2926
90.0	4.1075	3.9716
85.0	3.7908	3.6526
80.0	3.5013	3.3362
75.0	3.2730	3.0232
71.0	2.9836	2.7759
67.0	2.7746	2.5321
63.0	2.4912	2.2925
59.0	2.2435	2.0581
56.0	2.0814	1.8862
53.0	1.8785	1.7182
50.0	1.6846	1.5546
48.0	1.6016	1.4483
45.0	1.4709	1.2933
42.0	1.3129	1.1441
40.0	1.2277	1.0483
37.5	1.0013	0.9329
35.4	0.9091	0.8399
33.4	0.7758	0.7550
31.5	0.6872	0.6777
29.7	0.6226	0.6077
28.0	0.5515	0.5447
26.5	0.4775	0.4915
25.0	0.4269	0.4408
24.0	0.3871	0.4084
22.0	0.3511	0.3471
21.0	0.3101	0.3181
20.0	0.2997	0.2904
19.0	0.2729	0.2639
18.0	0.2523	0.2387
17.0	0.2243	0.2147
16.0	0.1972	0.1919
15.0	0.1761	0.1705
14.0	0.1388	0.1503
13.2	0.1424	0.1352
12.5	0.1292	0.1226
11.8	0.1145	0.1107
11.2	0.1072	0.1010
10.6	0.0964	0.0918
10.0	0.0849	0.0831
9.5	0.0761	0.0762
9.0	0.0721	0.0697
8.5	0.0631	0.0635
8.0	0.0609	0.0576
7.5	0.0553	0.0521
7.1	0.0504	0.0479
6.7	0.0443	0.0440
6.3	0.0429	0.0403
5.9	0.0389	0.0368
5.6	0.0358	0.0343
5.3	0.0325	0.0319
5.0	0.0309	0.0297
4.8	0.0327	0.0282
4.5	0.0251	0.0262
4.2	0.0261	0.0242
4.0	0.0230	0.0230



ABSORPTION OF SOUND IN AIR

TEMPERATURE =299.8 K   RELATIVE HUMIDITY = 89.7 %

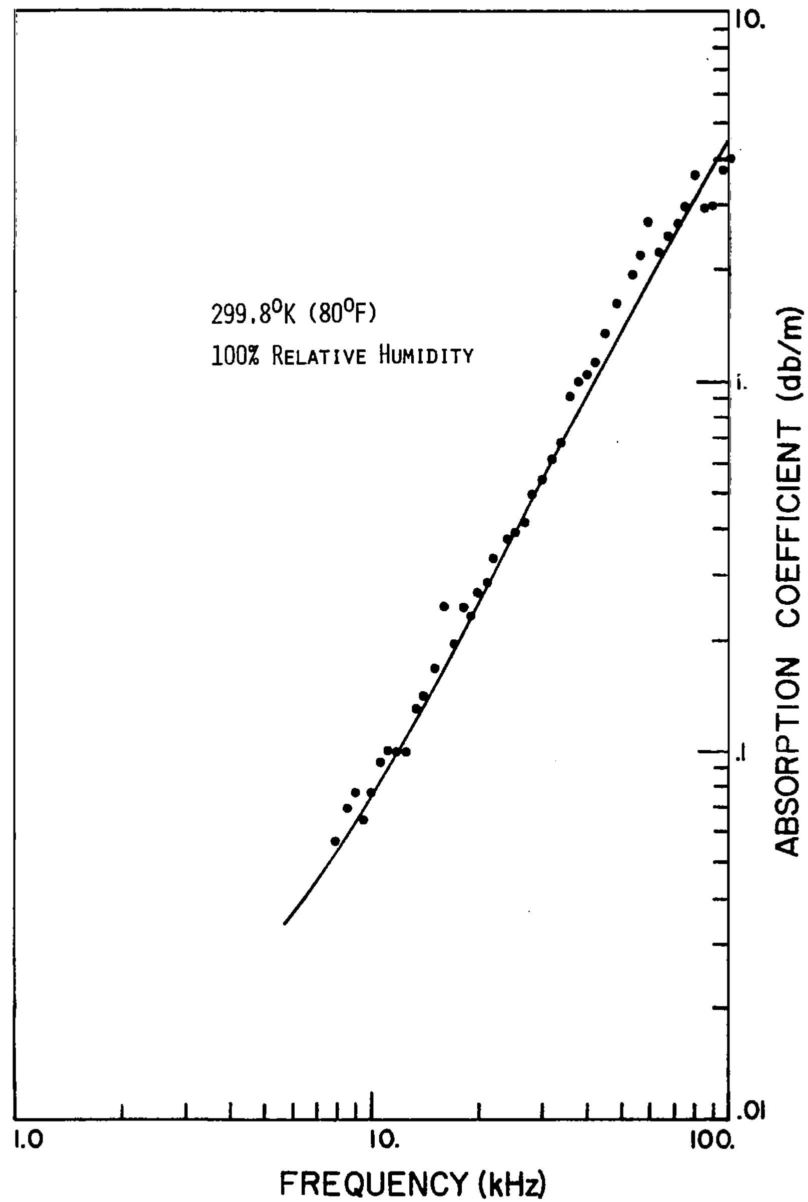
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	4.5957	4.5628
95.0	4.2572	4.2259
90.0	3.9841	3.8923
85.0	3.6793	3.5629
80.0	3.3992	3.2382
75.0	3.1156	2.9195
71.0	2.8344	2.6695
67.0	2.6715	2.4247
63.0	2.3373	2.1858
59.0	2.1573	1.9539
56.0	2.0187	1.7850
53.0	1.8170	1.6209
50.0	1.6285	1.4620
48.0	1.5378	1.3593
45.0	1.4264	1.2102
42.0	1.2939	1.0677
40.0	1.2254	0.9765
37.5	0.9393	0.8672
35.4	0.8745	0.7795
33.4	0.7317	0.6996
31.5	0.6509	0.6272
29.7	0.5992	0.5619
28.0	0.5357	0.5032
26.5	0.4604	0.4538
25.0	0.4201	0.4068
24.0	0.3919	0.3768
22.0	0.3289	0.3202
21.0	0.3024	0.2935
20.0	0.2808	0.2680
19.0	0.2680	0.2437
18.0	0.2383	0.2205
17.0	0.2149	0.1984
16.0	0.1810	0.1776
15.0	0.1704	0.1580
13.2	0.1349	0.1257
12.5	0.1186	0.1142
11.2	0.1020	0.0945
10.6	0.0917	0.0861
10.0	0.0767	0.0781
9.5	0.0750	0.0719
9.0	0.0681	0.0659
8.5	0.0585	0.0602
8.0	0.0602	0.0549
7.5	0.0544	0.0499
7.1	0.0488	0.0461
6.7	0.0472	0.0425
6.3	0.0414	0.0391
5.9	0.0389	0.0359
5.6	0.0358	0.0336
5.3	0.0317	0.0314
5.0	0.0313	0.0293
4.8	0.0328	0.0280
4.5	0.0325	0.0261
4.2	0.0271	0.0243
4.0	[illegible]	[illegible]



ABSORPTION OF SOUND IN AIR

TEMPERATURE =299.8 K   RELATIVE HUMIDITY =100.0 %

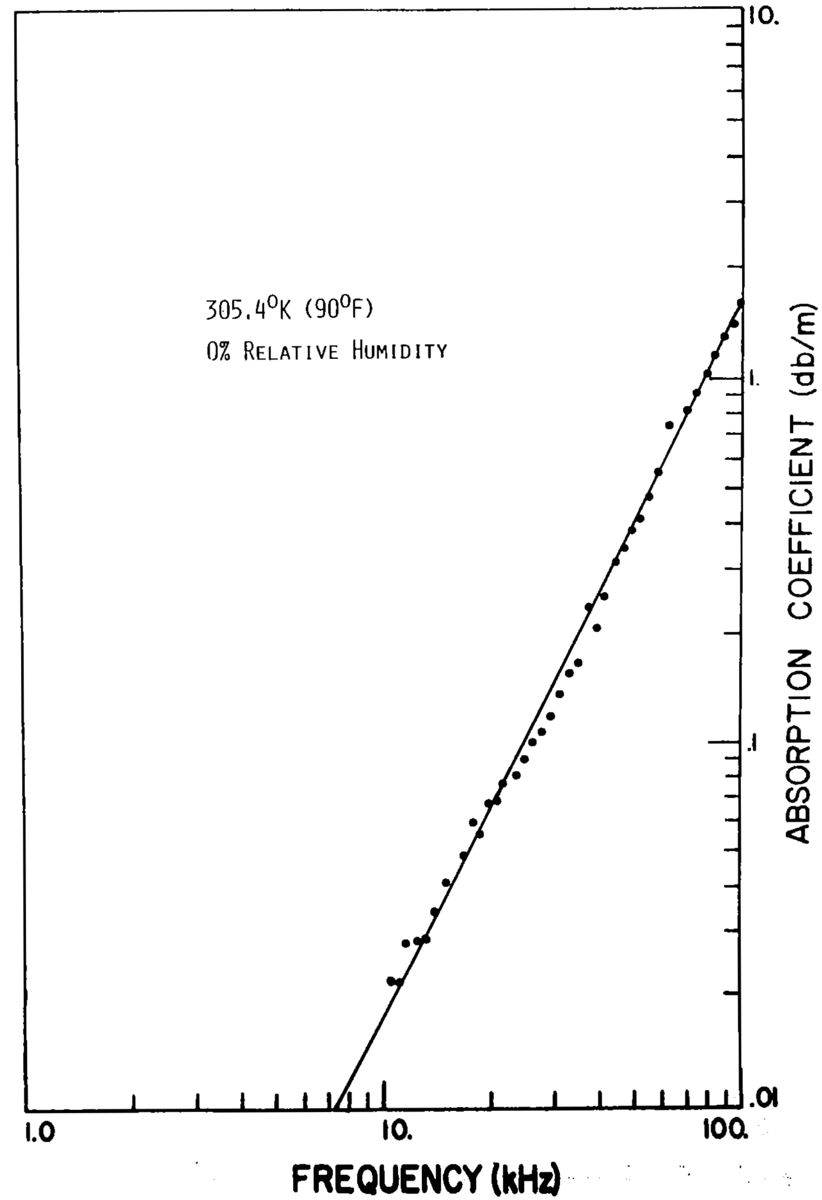
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	3.9037	4.4748
95.0	3.7077	4.1285
90.0	2.9717	3.7875
85.0	2.9081	3.4526
80.0	3.6610	3.1248
75.0	2.9856	2.8051
71.0	2.6719	2.5560
67.0	2.4628	2.3135
63.0	2.2234	2.0784
59.0	2.7272	1.8515
56.0	2.2073	1.6872
53.0	1.9660	1.5284
50.0	1.6478	1.3753
48.0	1.6372	1.2767
45.0	1.3452	1.1342
42.0	1.1321	0.9986
40.0	1.0312	0.9122
37.5	1.0048	0.8088
35.4	0.9079	0.7262
33.4	0.6858	0.6512
31.5	0.6172	0.5834
29.7	0.5449	0.5223
28.0	0.4997	0.4675
26.5	0.4155	0.4216
25.0	0.3891	0.3779
24.0	0.3730	0.3501
22.0	0.3304	0.2975
21.0	0.2854	0.2729
20.0	0.2680	0.2493
19.0	0.2313	0.2268
18.0	0.2497	0.2054
17.0	0.1958	0.1850
16.0	0.2452	0.1658
15.0	0.1665	0.1477
14.0	0.1416	0.1308
13.2	0.1324	0.1190
12.5	0.0951	0.1075
11.8	0.0979	0.0975
11.2	0.1002	0.0893
10.6	0.0944	0.0816
10.0	0.0787	0.0743
9.5	0.0658	0.0685
9.0	0.0768	0.0630
8.5	0.0701	0.0578
8.0	0.0574	0.0529



ABSORPTION OF SOUND IN AIR

TEMPERATURE =305.4 K RELATIVE HUMIDITY = 0.0 %

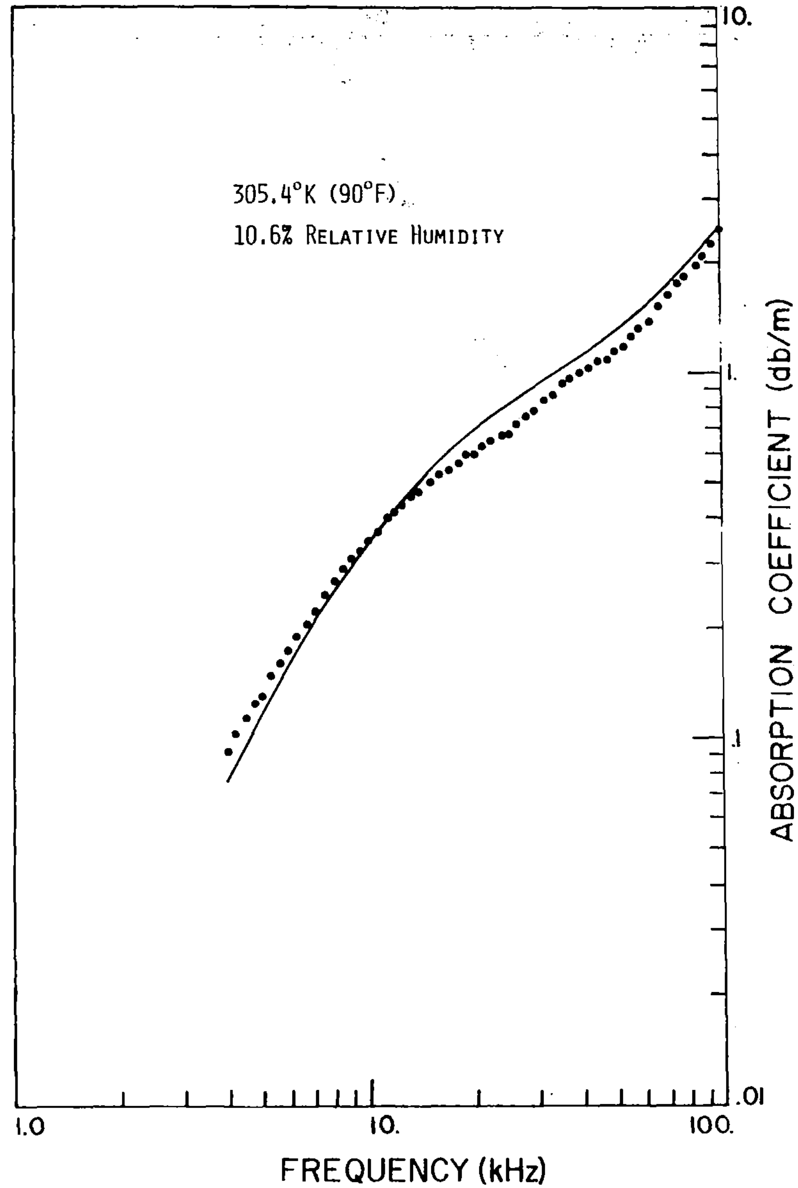
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	1.6173	1.6333
95.0	1.4203	1.4743
90.0	1.3087	1.3233
85.0	1.1719	1.1806
80.0	1.0480	1.0459
75.0	0.9281	0.9195
71.0	0.8222	0.8242
63.0	0.7578	0.6493
59.0	0.5677	0.5697
56.0	0.4815	0.5134
53.0	0.4158	0.4600
50.0	0.3908	0.4096
48.0	0.3500	0.3776
45.0	0.3218	0.3321
42.0	0.2588	0.2895
40.0	0.2125	0.2628
37.5	0.2427	0.2311
35.4	0.1688	0.2062
33.4	0.1591	0.1837
31.5	0.1388	0.1636
29.7	0.1218	0.1456
28.0	0.1099	0.1296
26.5	0.1033	0.1163
25.0	0.0914	0.1037
24.0	0.0832	0.0957
22.0	0.0796	0.0807
21.0	0.0700	0.0737
20.0	0.0703	0.0670
19.0	0.0578	0.0606
18.0	0.0621	0.0546
17.0	0.0501	0.0489
16.0	0.0530	0.0435
15.0	0.0420	0.0384
14.0	0.0351	0.0337
13.2	0.0295	0.0301
12.5	0.0293	0.0272
11.8	0.0289	0.0244
11.2	0.0224	0.0222
10.6	0.0227	0.0200



ABSORPTION OF SOUND IN AIR

TEMPERATURE =305.4 K   RELATIVE HUMIDITY = 10.6 %

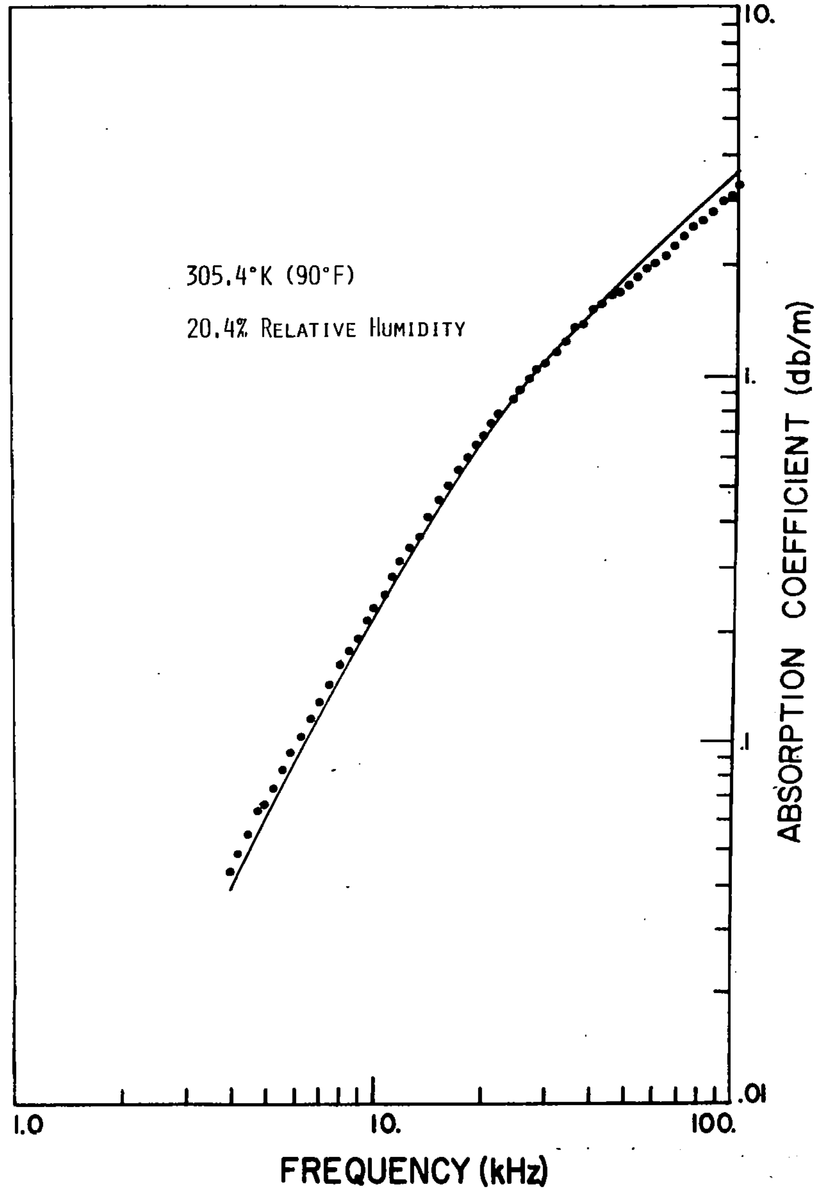
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	2.4529	2.5212
95.0	2.2465	2.3603
90.0	2.1437	2.2073
85.0	1.9795	2.0621
80.0	1.8642	1.9246
75.0	1.7241	1.7947
71.0	1.6123	1.6961
67.0	1.5250	1.6022
63.0	1.3802	1.5127
59.0	1.3021	1.4276
56.0	1.2663	1.3665
53.0	1.1831	1.3075
50.0	1.1197	1.2505
48.0	1.0781	1.2135
45.0	1.0717	1.1593
42.0	1.0035	1.1064
40.0	0.9698	1.0716
37.5	0.9425	1.0283
35.4	0.9063	0.9920
33.4	0.8525	0.9570
31.5	0.8162	0.9231
29.7	0.7880	0.8903
28.0	0.7505	0.8581
26.5	0.7181	0.8286
25.0	0.6799	0.7979
24.0	0.6748	0.7763
22.0	0.6415	0.7307
21.0	0.6255	0.7064
20.0	0.5960	0.6808
19.0	0.5952	0.6538
18.0	0.5655	0.6254
17.0	0.5405	0.5952
16.0	0.5226	0.5633
15.0	0.4968	0.5295
14.0	0.4736	0.4937
13.2	0.4504	0.4636
12.5	0.4323	0.4362
11.8	0.4115	0.4079
11.2	0.3916	0.3827
10.6	0.3619	0.3570
10.0	0.3407	0.3303
9.5	0.3269	0.3086
9.0	0.3006	0.2852
8.5	0.2881	0.2636
8.0	0.2671	0.2410
7.5	0.2424	0.2195
7.1	0.2259	0.2006
6.7	0.2090	0.1820
6.3	0.1899	0.1655
5.9	0.1736	0.1495
5.6	0.1593	0.1360
5.3	0.1456	0.1238
5.0	0.1297	0.1120
4.8	0.1253	0.1043
4.5	0.1123	0.0932
4.2	0.1008	0.0825
4.0	0.0907	0.075[illegible]



ABSORPTION OF SOUND IN AIR

TEMPERATURE =305.4 K   RELATIVE HUMIDITY = 20.4 %

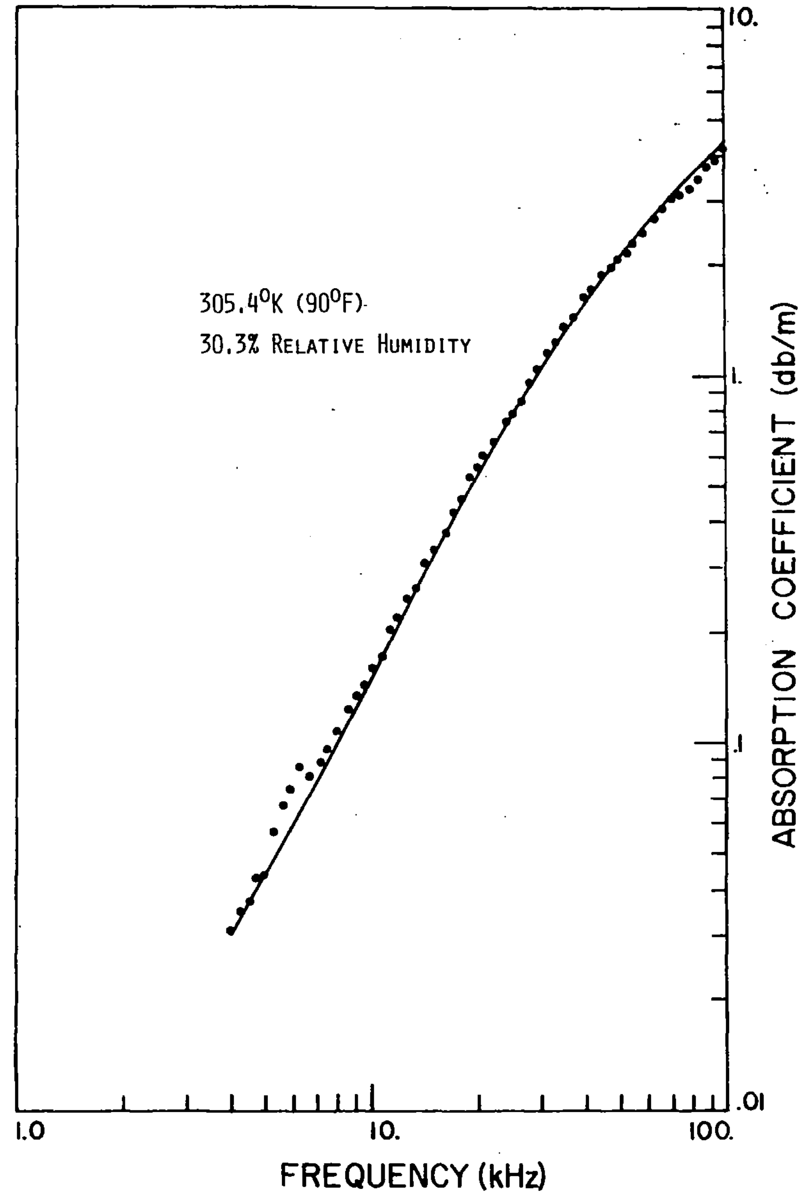
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	3.3052	3.5441
95.0	3.1040	3.3650
90.0	2.9735	3.1932
85.0	2.8133	3.0257
80.0	2.6703	2.8616
75.0	2.5266	2.7012
71.0	2.3936	2.5746
67.0	2.2846	2.4489
63.0	2.1337	2.3232
59.0	2.0331	2.1967
56.0	1.9579	2.1007
53.0	1.8512	2.0030
50.0	1.7640	1.9032
48.0	1.6999	1.8352
45.0	1.6732	1.7303
42.0	1.5575	1.6215
40.0	1.5063	1.5464
37.5	1.3850	1.4493
35.4	1.3541	1.3647
33.4	1.2235	1.2814
31.5	1.1585	1.1997
29.7	1.0891	1.1200
28.0	1.0360	1.0427
26.5	0.9763	0.9730
25.0	0.9248	0.9020
24.0	0.8749	0.8541
22.0	0.7864	0.7571
21.0	0.7394	0.7082
20.0	0.6925	0.6592
19.0	0.6522	0.6104
18.0	0.6054	0.5618
17.0	0.5580	0.5136
16.0	0.5045	0.4661
15.0	0.4633	0.4194
14.0	0.4174	0.3733
13.2	0.3612	0.3383
12.5	0.3436	0.3091
11.8	0.3164	0.2797
11.2	0.2885	0.2543
10.6	0.2529	0.2307
10.0	0.2371	0.2079
9.5	0.2164	0.1896
9.0	0.1916	0.1720
8.5	0.1779	0.1551
8.0	0.1617	0.1389
7.5	0.1427	0.1235
7.1	0.1300	0.1117
6.7	0.1177	0.1005
6.3	0.1034	0.0899
5.9	0.0945	0.0798
5.6	0.0840	0.0726
5.3	0.0755	0.0657
5.0	0.0667	0.0592
4.8	0.0653	0.0551
4.5	0.0560	0.0492
4.2	0.0497	0.0436
4.0	0.0445	0.0401



ABSORPTION OF SOUND IN AIR

TEMPERATURE =305.4 K RELATIVE HUMIDITY = 30.3 %

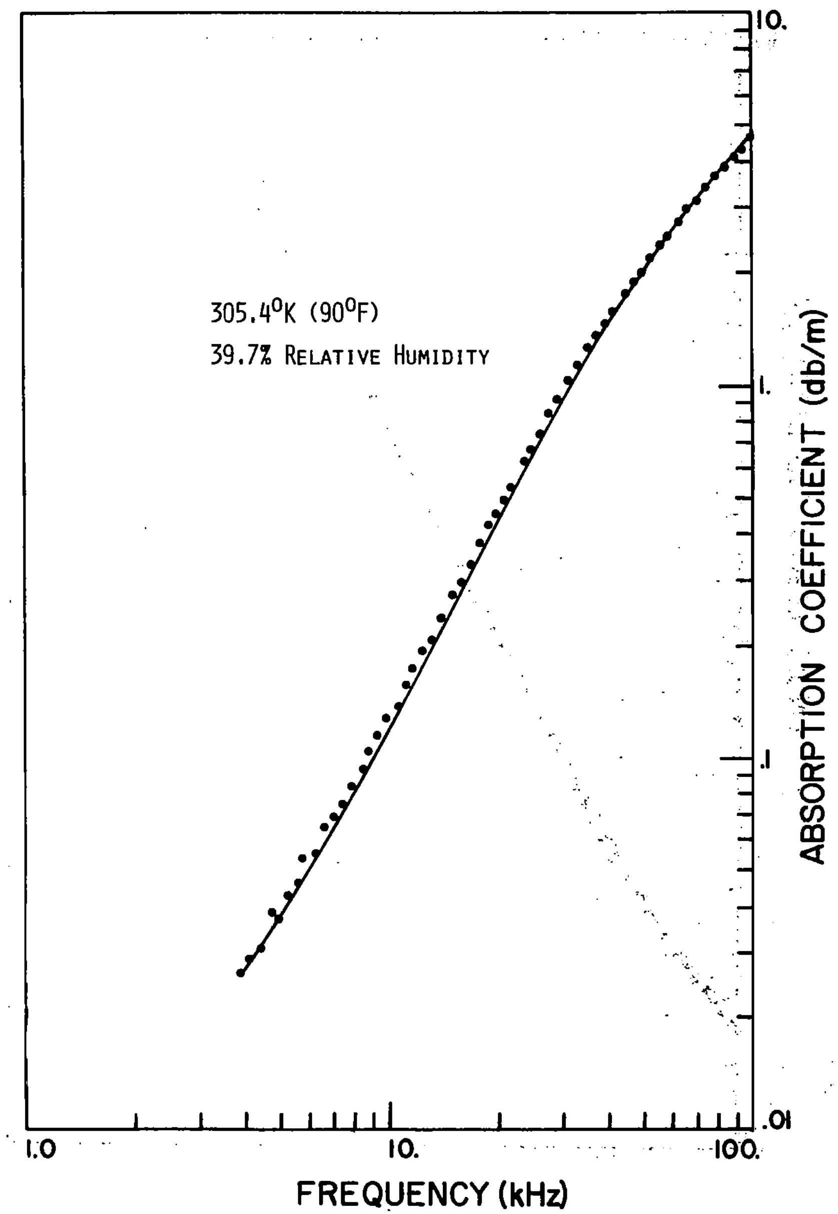
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	4.0986	4.3151
95.0	3.8683	4.0964
90.0	3.7160	3.8789
85.0	3.4919	3.6617
80.0	3.2976	3.4438
75.0	3.1373	3.2240
71.0	3.0166	3.0459
67.0	2.8529	2.8653
63.0	2.6373	2.6813
59.0	2.4717	2.4934
56.0	2.3676	2.3496
53.0	2.2040	2.2032
50.0	2.0655	2.0540
48.0	1.9754	1.9530
45.0	1.8786	1.7993
42.0	1.7091	1.6432
40.0	1.6211	1.5381
37.5	1.4669	1.4057
35.4	1.3829	1.2941
33.4	1.2207	1.1878
31.5	1.1379	1.0872
29.7	1.0393	0.9926
28.0	0.9591	0.9043
26.5	0.8561	0.8275
25.0	0.7907	0.7520
24.0	0.7407	0.7026
22.0	0.6592	0.6063
21.0	0.6089	0.5597
20.0	0.5641	0.5142
19.0	0.5140	0.4699
18.0	0.4673	0.4270
17.0	0.4206	0.3856
16.0	0.3766	0.3457
15.0	0.3386	0.3076
14.0	0.3006	0.2713
13.2	0.2638	0.2436
12.5	0.2476	0.2204
11.8	0.2196	0.1983
11.2	0.2008	0.1801
10.6	0.1767	0.1628
10.0	0.1604	0.1463
9.5	0.1436	0.1332
9.0	0.1336	0.1207
8.5	0.1216	0.1087
8.0	0.1083	0.0974
7.5	0.0947	0.0868
7.1	0.0876	0.0787
6.7	0.0816	0.0710
6.3	0.0896	0.0638
5.9	0.0774	0.0570
5.6	0.0685	0.0521
5.3	0.0576	0.0475
5.0	0.0447	0.0432
4.8	0.0446	0.0404
4.5	0.0377	0.0365
4.2	0.0353	0.0323
4.0	0.0311	0.0304



ABSORPTION OF SOUND IN AIR

TEMPERATURE =305.4 K   RELATIVE HUMIDITY = 39.7 %

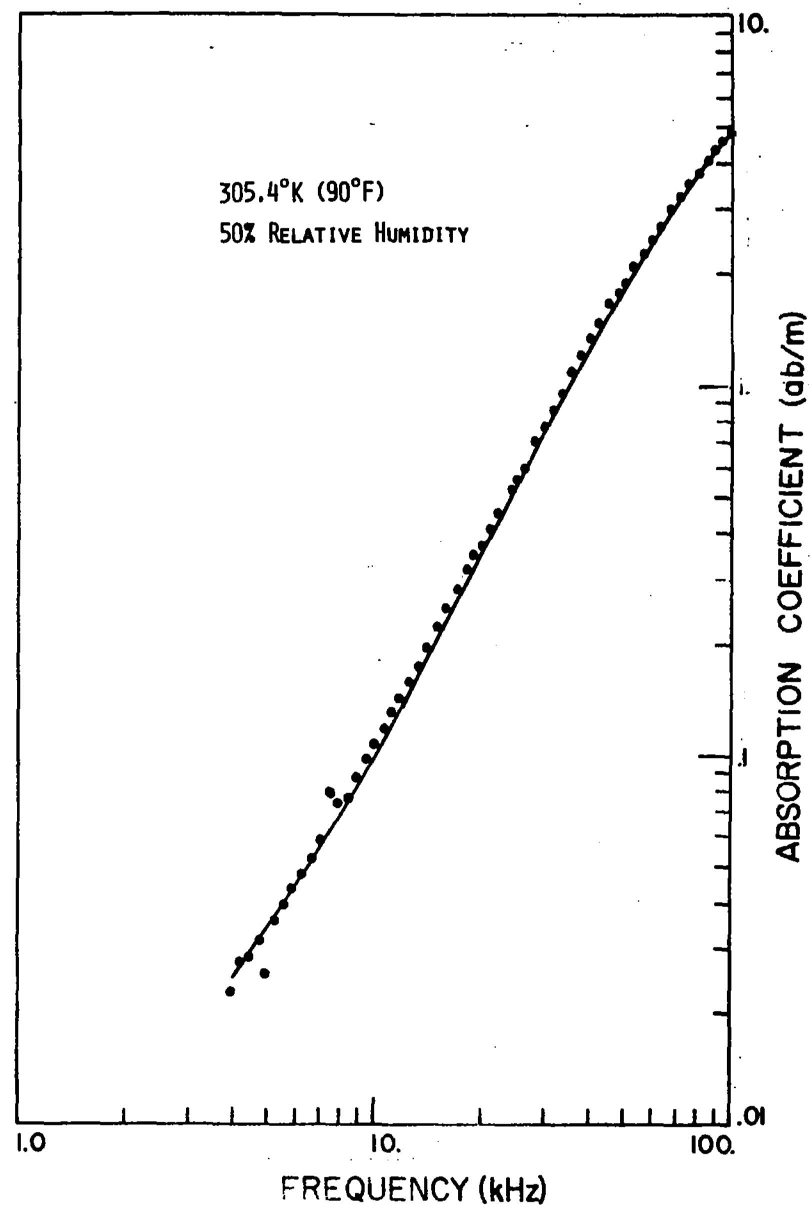
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	4.5651	4.7341
95.0	4.2980	4.4674
90.0	4.0913	4.1995
85.0	3.8390	3.9298
80.0	3.6189	3.6577
75.0	3.3616	3.3827
71.0	3.1937	3.1604
67.0	2.9812	2.9358
63.0	2.7077	2.7092
59.0	2.5173	2.4807
56.0	2.3644	2.3084
53.0	2.1797	2.1356
50.0	2.0093	1.9629
48.0	1.8958	1.8479
45.0	1.7687	1.6763
42.0	1.5751	1.5064
40.0	1.4606	1.3944
37.5	1.3799	1.2566
35.4	1.2750	1.1431
33.4	1.1310	1.0372
31.5	1.0266	0.9391
29.7	0.9179	0.8487
28.0	0.8424	0.7659
26.5	0.7448	0.6952
25.0	0.6737	0.6263
24.0	0.6236	0.5826
22.0	0.5336	0.4979
21.0	0.4972	0.4575
20.0	0.4512	0.4185
19.0	0.4278	0.3809
18.0	0.3794	0.3449
17.0	0.3337	0.3104
16.0	0.2971	0.2775
15.0	0.2745	0.2463
14.0	0.2379	0.2168
13.2	0.2078	0.1945
12.5	0.1943	0.1760
11.8	0.1749	0.1583
11.2	0.1587	0.1439
10.6	0.1390	0.1303
10.0	0.1297	0.1173
9.5	0.1171	0.1070
9.0	0.1038	0.0972
8.5	0.0955	0.0879
8.0	0.0850	0.0791
7.5	0.0762	0.0708
7.1	0.0705	0.0645
6.7	0.0657	0.0586
6.3	0.0562	0.0530
5.9	0.0548	0.0477
5.6	0.0475	0.0440
5.3	0.0433	0.0405
5.0	0.0372	0.0371
4.8	0.0395	0.0350
4.5	0.0309	0.0319
4.2	0.0293	0.0291
4.0	0.0268	0.0273



ABSORPTION OF SOUND IN AIR

TEMPERATURE =305.4 K   RELATIVE HUMIDITY = 50.0 %

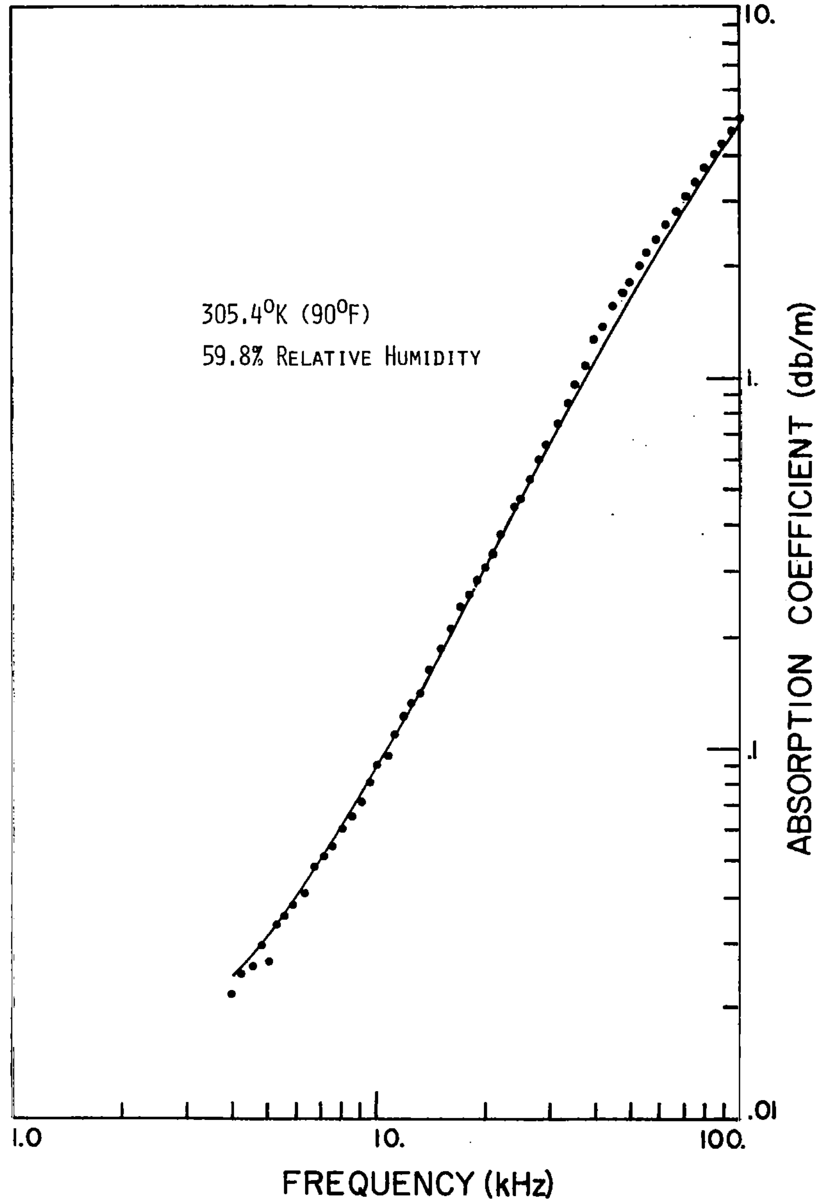
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	4.8754	4.9113
95.0	4.5449	4.5982
90.0	4.2958	4.2843
85.0	3.9850	3.9697
80.0	3.7180	3.6546
75.0	3.4797	3.3393
71.0	3.2186	3.0873
67.0	2.9731	2.8362
63.0	2.6607	2.5865
59.0	2.4353	2.3391
56.0	2.2787	2.1557
53.0	2.0750	1.9747
50.0	1.8947	1.7966
48.0	1.7821	1.6799
45.0	1.6488	1.5082
42.0	1.4472	1.3414
40.0	1.3413	1.2333
37.5	1.2032	1.1020
35.4	1.0781	0.9956
33.4	0.9448	0.8976
31.5	0.8534	0.8080
29.7	0.7723	0.7263
28.0	0.7068	0.6524
26.5	0.5956	0.5893
25.0	0.5521	0.5293
24.0	0.5148	0.4913
22.0	0.4427	0.41[illegible]
21.0	0.4014	0.3836
20.0	0.3657	0.3504
19.0	0.3431	0.3186
18.0	0.3123	0.2892
17.0	0.2785	0.2592
16.0	0.2453	0.2317
15.0	0.2180	0.2058
14.0	0.1914	0.1813
13.2	0.1739	0.1629
12.5	0.1557	0.1476
11.8	0.1408	0.1331
11.2	0.1305	0.1213
10.6	0.1165	0.1101
10.0	0.1053	0.0995
9.5	0.0969	0.0911
9.0	0.0865	0.0831
8.5	0.0770	0.0755
8.0	0.0737	0.0694
7.5	0.0784	0.0617
7.1	0.0583	0.0566
6.7	0.0527	0.0518
6.3	0.0477	0.0472
5.9	0.0436	0.0429
5.6	0.0394	0.0399
5.3	0.0352	0.0370
5.0	0.0255	0.0343
4.8	0.0313	0.0325
4.5	0.0283	0.0300
4.2	0.0276	0.0277
4.0	0.0228	0.0262



ABSORPTION OF SOUND IN AIR

TEMPERATURE =305.4 K RELATIVE HUMIDITY .. 59.8 %

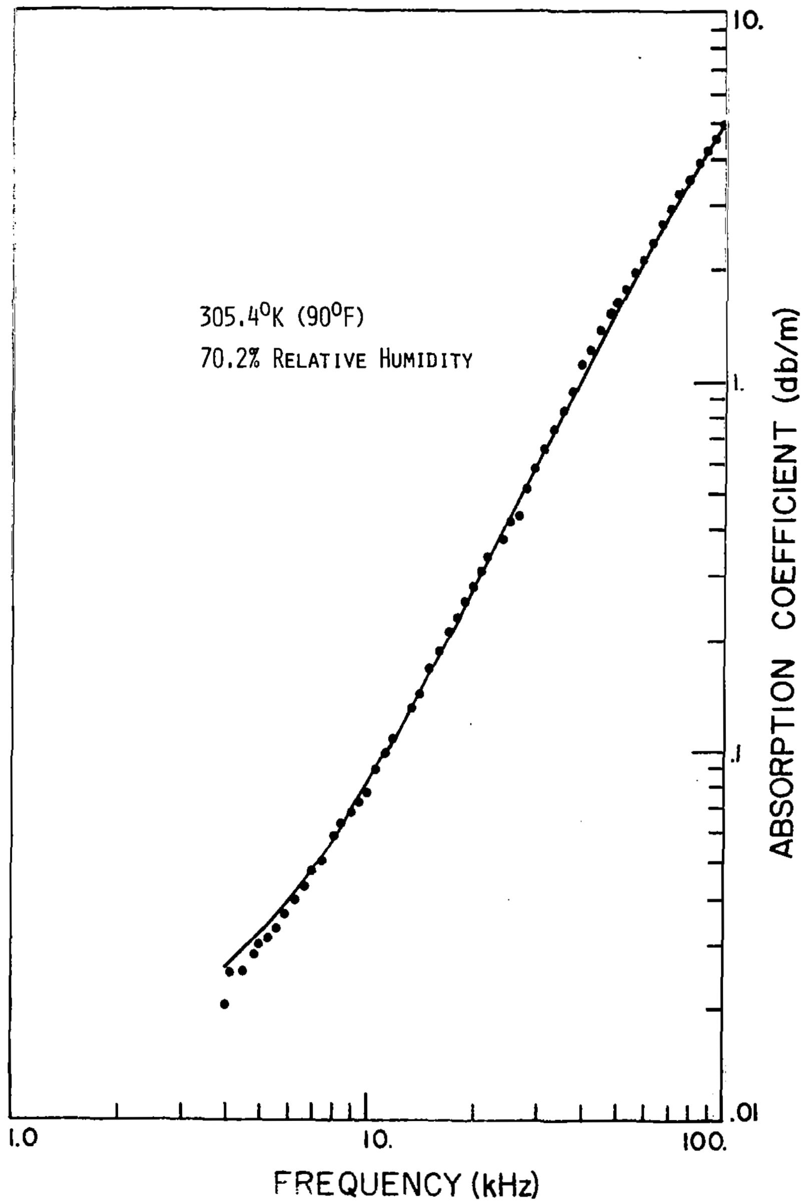
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	4.9913	4.9038
95.0	4.6216	4.5558
90.0	4.3401	4.2173
85.0	4.0104	3.8769
80.0	3.7126	3.5391
75.0	3.3978	3.2052
71.0	3.1108	2.9414
67.0	2.8461	2.6816
63.0	2.5877	2.4264
59.0	2.3543	2.1770
56.0	2.1935	1.9942
53.0	1.9889	1.8159
50.0	1.8154	1.6422
48.0	1.6975	1.5294
45.0	1.5595	1.3652
42.0	1.3741	1.2073
40.0	1.2689	1.1060
37.5	1.0863	0.9849
35.4	0.9619	0.8859
33.4	0.8517	0.7962
31.5	0.7616	0.7147
29.7	0.6614	0.6410
28.0	0.6013	0.5745
26.5	0.5238	0.5186
25.0	0.4711	0.4652
24.0	0.4494	0.4312
22.0	0.3849	0.3666
21.0	0.3357	0.3362
20.0	0.3099	0.3071
19.0	0.2894	0.2793
18.0	0.2610	0.2527
17.0	0.2422	0.2275
16.0	0.2116	0.2036
15.0	0.1856	0.1811
14.0	0.1620	0.1600
13.2	0.1430	0.1441
12.5	0.1342	0.1309
11.8	0.1218	0.1184
11.2	0.1106	0.1082
10.6	0.0972	0.0986
10.0	0.0915	0.0894
9.5	0.0829	0.0822
9.0	0.0715	0.0753
8.5	0.0673	0.0688
8.0	0.0636	0.0627
7.5	0.0562	0.0569
7.1	0.0528	0.0525
6.7	0.0488	0.0484
6.3	0.0417	0.0445
5.9	0.0392	0.0408
5.6	0.0361	0.0382
5.3	0.0336	0.0357
5.0	0.0270	0.0333
4.8	0.0303	0.0318
4.5	0.0264	0.0296
4.2	0.0248	0.0275
4.0	0.0221	0.0262



ABSORPTION OF SOUND IN AIR

TEMPERATURE =305.4 K   RELATIVE HUMIDITY = 70.2 %

FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	4.8065	4.7941
95.0	4.4469	4.4312
90.0	4.1405	4.0728
85.0	3.7813	3.7197
80.0	3.4793	3.3729
75.0	3.1562	3.0336
71.0	2.9243	2.7684
67.0	2.6658	2.5095
63.0	2.3498	2.2579
59.0	2.1319	2.0144
56.0	1.9660	1.8376
53.0	1.7588	1.6664
50.0	1.5948	1.5011
48.0	1.5020	1.3944
45.0	1.3724	1.2401
42.0	1.1956	1.0929
40.0	1.1086	0.9989
37.5	0.9322	0.8865
35.4	0.8133	0.7965
33.4	0.7274	0.7147
31.5	0.6468	0.6407
29.7	0.5696	0.5739
28.0	0.5086	0.5140
26.5	0.4324	0.4637
25.0	0.4115	0.4159
24.0	0.3717	0.3854
22.0	0.3298	0.3279
21.0	0.3020	0.3008
20.0	0.2767	0.2749
19.0	0.2528	0.2502
18.0	0.2318	0.2267
17.0	0.2095	0.2044
16.0	0.1843	0.1833
15.0	0.1648	0.1634
14.0	0.1417	0.1449
13.2	0.1299	0.1308
11.8	0.1094	0.1092
11.2	0.0987	0.0992
10.6	0.0893	0.0909
10.0	0.0773	0.0827
9.5	0.0730	0.0764
9.0	0.0684	0.0703
8.5	0.0630	0.0646
8.0	0.0583	0.0592
7.5	0.0512	0.0541
7.1	0.0470	0.0503
6.7	0.0426	0.0466
6.3	0.0394	0.0431
5.9	0.0357	0.0399
5.6	0.0335	0.0375
5.3	0.0312	0.0353
5.0	0.0201	0.0332
4.8	0.0282	0.031[illegible]
4.5	0.0251	0.029[illegible]
4.2	0.0251	0.0290
4.0	0.0204	0.026[illegible]



ABSORPTION OF SOUND IN AIR

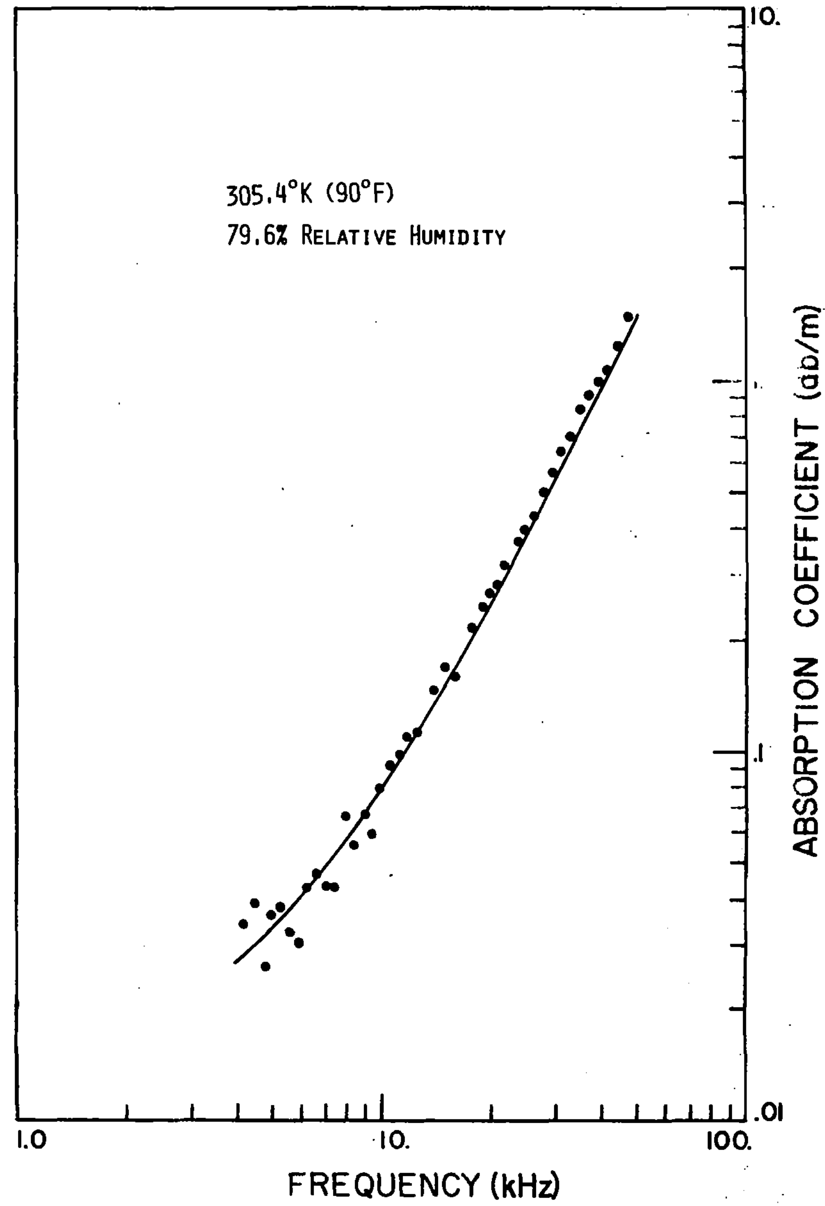
TEMPERATURE =305.4 K RELATIVE HUMIDITY = 79.6 %

FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
48.0	1.4780	1.2937
45.0	1.2266	1.1491
42.0	1.0641	1.0099
40.0	0.9854	0.9221
37.5	0.9144	0.8173
35.4	0.8234	0.7336
33.4	0.7002	0.6578
31.5	0.6366	0.5894
29.7	0.5594	0.5278
28.0	0.4903	0.4727
26.5	0.4305	0.4265
25.0	0.3948	0.3826
24.0	0.3668	0.3547
22.0	0.3177	0.3020
21.0	0.2796	0.2773
20.0	0.2680	0.2537
19.0	0.2463	0.2312
18.0	0.2140	0.2098
16.0	0.1589	0.1702
15.0	0.1673	0.1522
14.0	0.1478	0.1352
12.5	0.1109	0.1119
11.8	0.1103	0.1020
11.2	0.0979	0.0939
10.6	0.0911	0.0861
10.0	0.0782	0.0788
9.5	0.0591	0.0731
9.0	0.0682	0.0676
8.5	0.0552	0.0624
8.0	0.0669	0.0574
7.5	0.0428	0.0528
7.1	0.0434	0.0493
6.7	0.0474	0.0459
6.3	0.0433	0.0428
5.9	0.0303	0.0398
5.6	0.0322	0.0376
5.3	0.0383	0.0355
5.0	0.0365	0.0336
4.8	0.0260	0.0323
4.5	0.0393	0.0304
4.2	0.0343	0.0287

STANDARD DEVIATION = 0.116511

PARAMETER A = 24.00 HZ B = 18.40

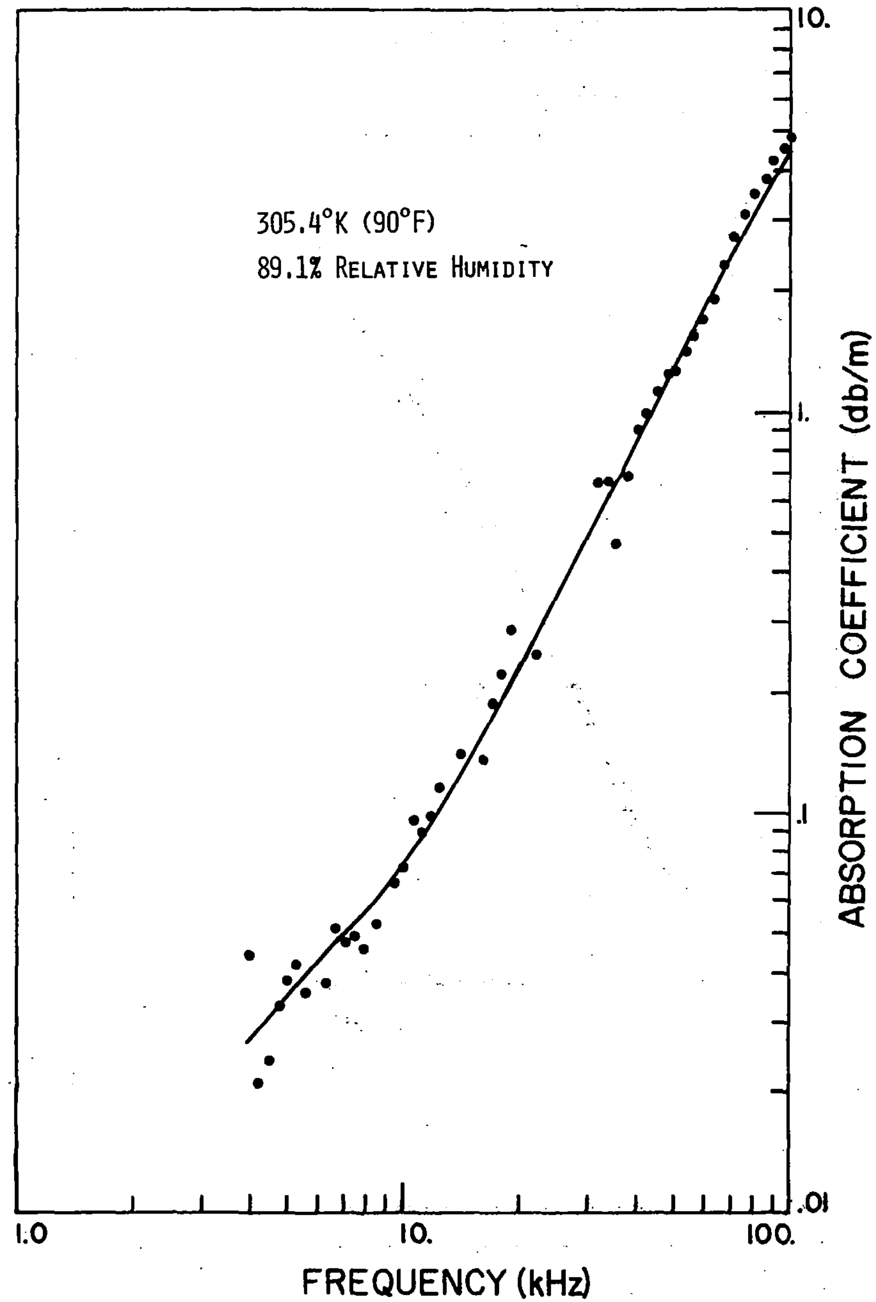
ABSOLUTE HUMIDITY = 0.378449E+01



ABSORPTION OF SOUND IN AIR

TEMPERATURE =305.4 K RELATIVE HUMIDITY = 89.1 %

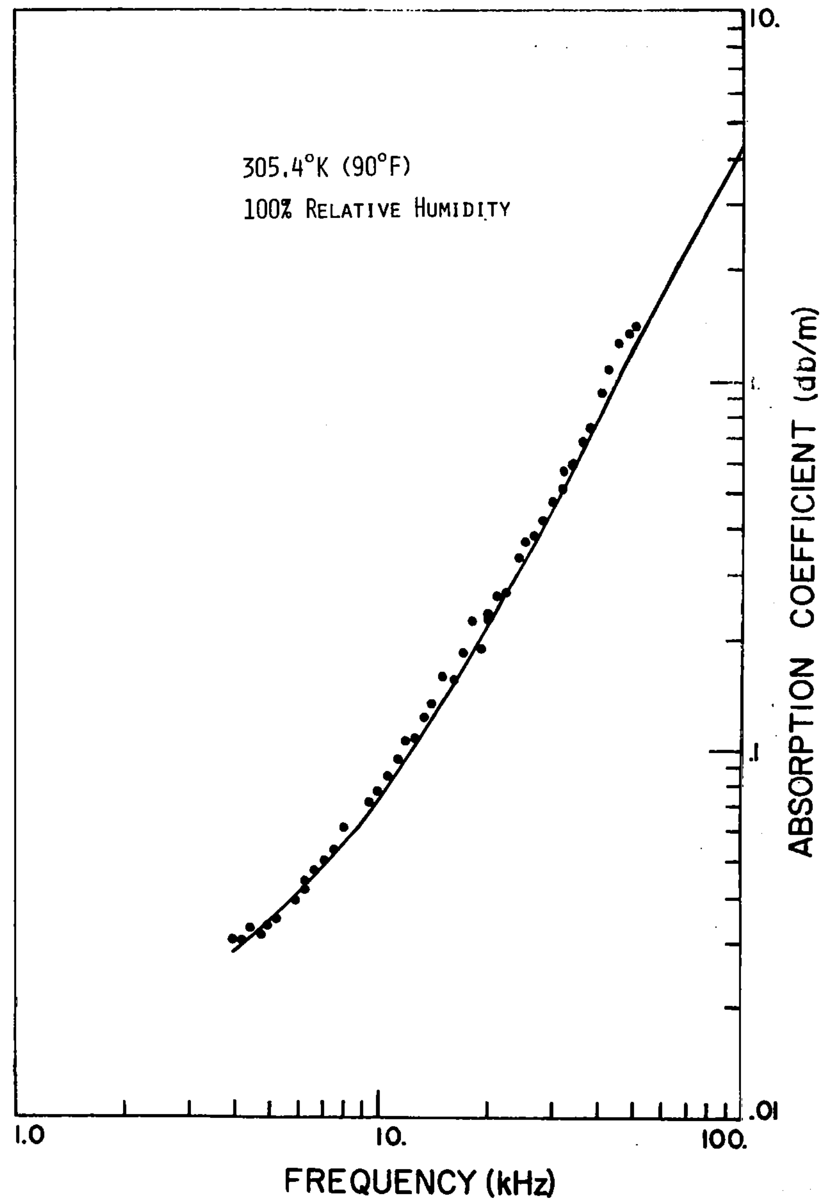
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	4.8872	4.4946
95.0	4.5167	4.1227
90.0	4.2406	3.7598
85.0	3.8331	3.4068
80.0	3.4900	3.0647
75.0	3.1018	2.7346
71.0	2.7384	2.4799
67.0	2.3350	2.2341
63.0	1.9209	1.9980
59.0	1.7105	1.7721
56.0	1.5677	1.6099
53.0	1.4243	1.4540
50.0	1.2589	1.3048
48.0	1.2397	1.2091
45.0	1.1195	1.0717
42.0	0.9757	0.9416
40.0	0.9082	0.8592
37.5	0.6872	0.7610
35.4	0.4741	0.6828
33.4	0.6688	0.6121
31.5	0.6748	0.5484
22.0	0.2507	0.2820
19.0	0.2866	0.2166
18.0	0.2175	0.1968
17.0	0.1888	0.1781
16.0	0.1375	0.1604
14.0	0.1407	0.1282
13.2	0.1127	0.1165
12.5	0.1157	0.1067
11.8	0.0995	0.0975
11.2	0.0891	0.0901
10.6	0.0962	0.0830
10.0	0.0733	0.0762
9.5	0.0667	0.0709
9.0	0.0666	0.0659
8.5	0.0532	0.0611
8.0	0.0464	0.0565
7.5	0.0494	0.0522
7.1	0.0482	0.0489
6.7	0.0515	0.0458
6.3	0.0376	0.0429
5.9	0.0401	0.0400
5.6	0.0351	0.0380
5.3	0.0421	0.0361
5.0	0.0381	0.0342
4.8	0.0330	0.0330
4.5	0.0241	0.0312
4.2	0.0214	0.0294
4.0	0.0447	0.0283



ABSORPTION OF SOUND IN AIR

TEMPERATURE =305.4 K   RELATIVE HUMIDITY =100.0 %

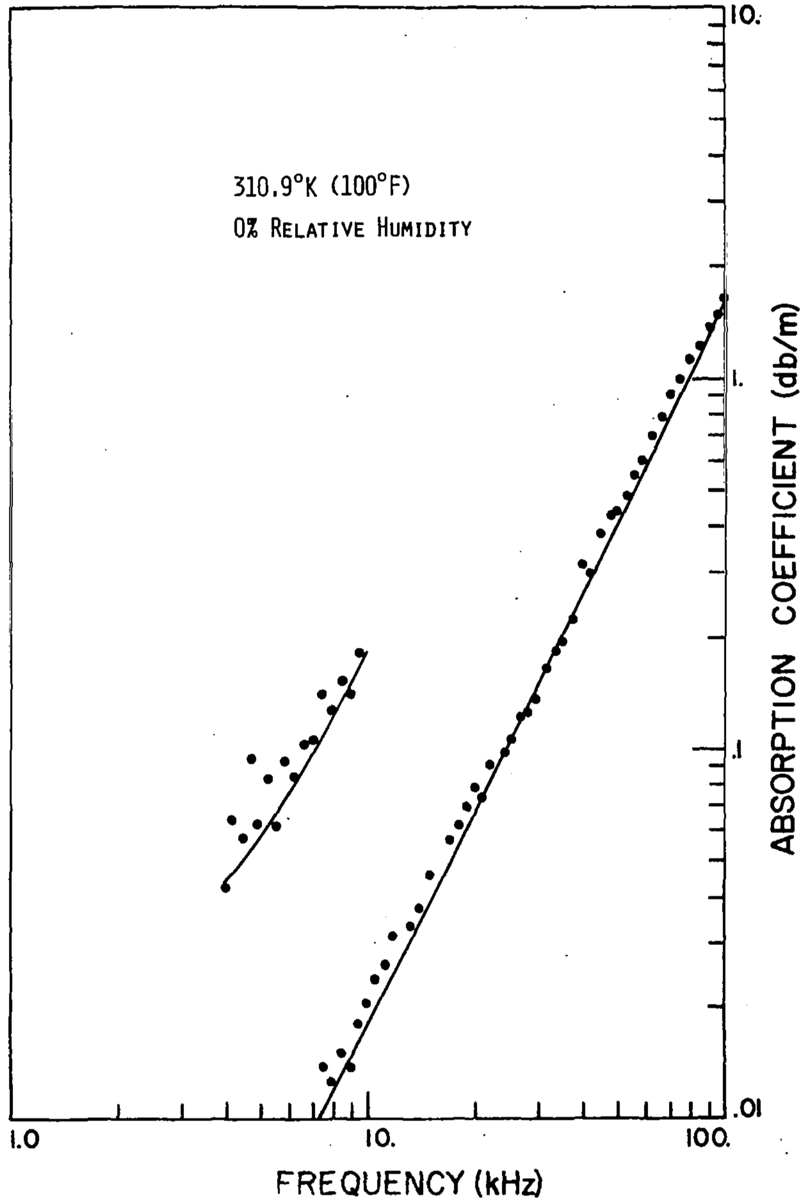
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
50.0	1.4010	1.2193
48.0	1.3331	1.1292
45.0	1.2374	1.0000
42.0	1.0856	0.8780
40.0	0.9603	0.8009
37.5	0.7641	0.7091
35.4	0.6910	0.6363
33.4	0.5986	0.5704
31.5	0.5677	0.5112
29.7	0.4771	0.4581
28.0	0.4222	0.4106
26.5	0.3851	0.3709
25.0	0.3733	0.3333
24.0	0.3347	0.3094
22.0	0.2674	0.2644
21.0	0.2629	0.2433
20.0	0.2355	0.2231
19.0	0.1907	0.2039
18.0	0.2289	0.1857
17.0	0.1855	0.1684
16.0	0.1572	0.1521
15.0	0.1606	0.1369
14.0	0.1336	0.1224
13.2	0.1237	0.1115
12.5	0.1097	0.1026
11.8	0.1071	0.0941
11.2	0.0961	0.0872
10.6	0.0847	0.0806
10.0	0.0784	0.0744
9.5	0.0733	0.0695
9.0	0.0614	0.0648
8.5	0.0591	0.0604
8.0	0.0619	0.0561
7.5	0.0541	0.0521
7.1	0.0502	0.0491
6.7	0.0476	0.0461
6.3	0.0443	0.0434
5.9	0.0394	0.0407
5.6	0.0381	0.0388
5.3	0.0349	0.0369
5.0	0.0338	0.0351
4.8	0.0318	0.0339
4.5	0.0335	0.0321
4.2	0.0305	0.0304
4.0	0.0306	0.0292



ABSORPTION OF SOUND IN AIR

TEMPERATURE =310.9 K   RELATIVE HUMIDITY = 0.0 %

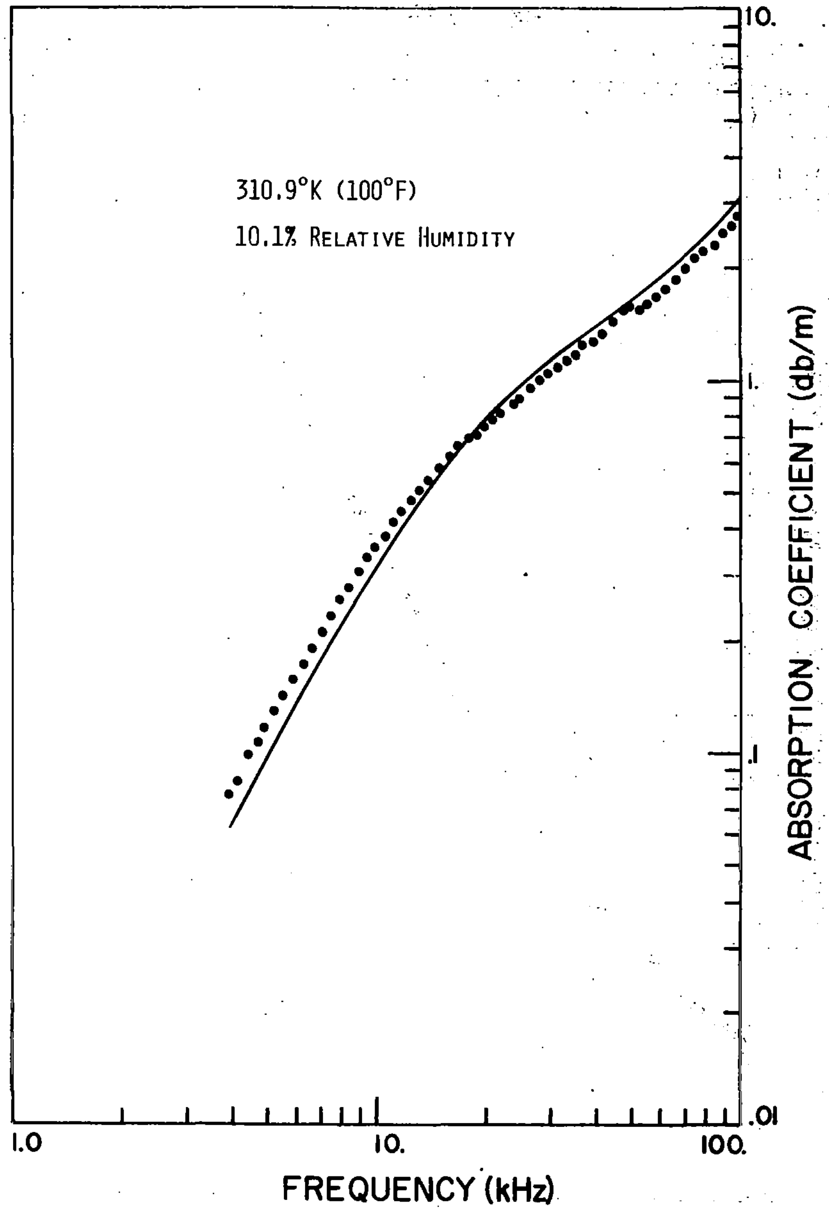
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	1.6693	1.6487
95.0	1.4947	1.4877
90.0	1.3581	1.3355
85.0	1.2294	1.1914
80.0	1.1433	1.0556
75.0	0.9997	0.9290
71.0	0.9208	0.8319
67.0	0.7866	0.7400
63.0	0.7013	0.6553
59.0	0.6022	0.5750
56.0	0.5485	0.5192
53.0	0.4766	0.4643
50.0	0.4386	0.4135
48.0	0.4332	0.3812
45.0	0.3831	0.3353
42.0	0.3003	0.2923
40.0	0.3143	0.2653
37.5	0.2316	0.2374
35.4	0.1972	0.2092
33.4	0.1844	0.1856
31.5	0.1671	0.1652
29.7	0.1363	0.1471
28.0	0.1266	0.1309
26.5	0.1240	0.1175
25.0	0.1087	0.1043
24.0	0.0976	0.0967
22.0	0.0908	0.0815
21.0	0.0738	0.0745
20.0	0.0790	0.0677
19.0	0.0702	0.0613
18.0	0.0635	0.0552
17.0	0.0572	0.0494
16.0	0.0603	0.0440
15.0	0.0463	0.0385
14.0	0.0377	0.0341
13.2	0.0330	0.0305
12.5	0.0297	0.0276
11.8	0.0317	0.0242
11.2	0.0261	0.0225
10.6	0.0245	0.0204
10.0	0.0210	0.0182
9.5	0.0185	0.0167
9.0	0.0140	0.0152
8.5	0.0153	0.0139
8.0	0.0128	0.0124
7.5	0.0143	0.0111
7.1	0.0107	0.0102
6.7	0.0103	0.0093
6.3	0.0086	0.0084
5.9	0.0195	0.0076
5.6	0.0062	0.0072
5.3	0.0084	0.0065
5.0	0.0063	0.0060
4.8	0.0095	0.0057
4.5	0.0059	0.0052
4.2	0.0065	0.0048
4.0	0.0042	0.0045



ABSORPTION OF SOUND IN AIR

TEMPERATURE =310,9 K RELATIVE HUMIDITY = 10,1 %

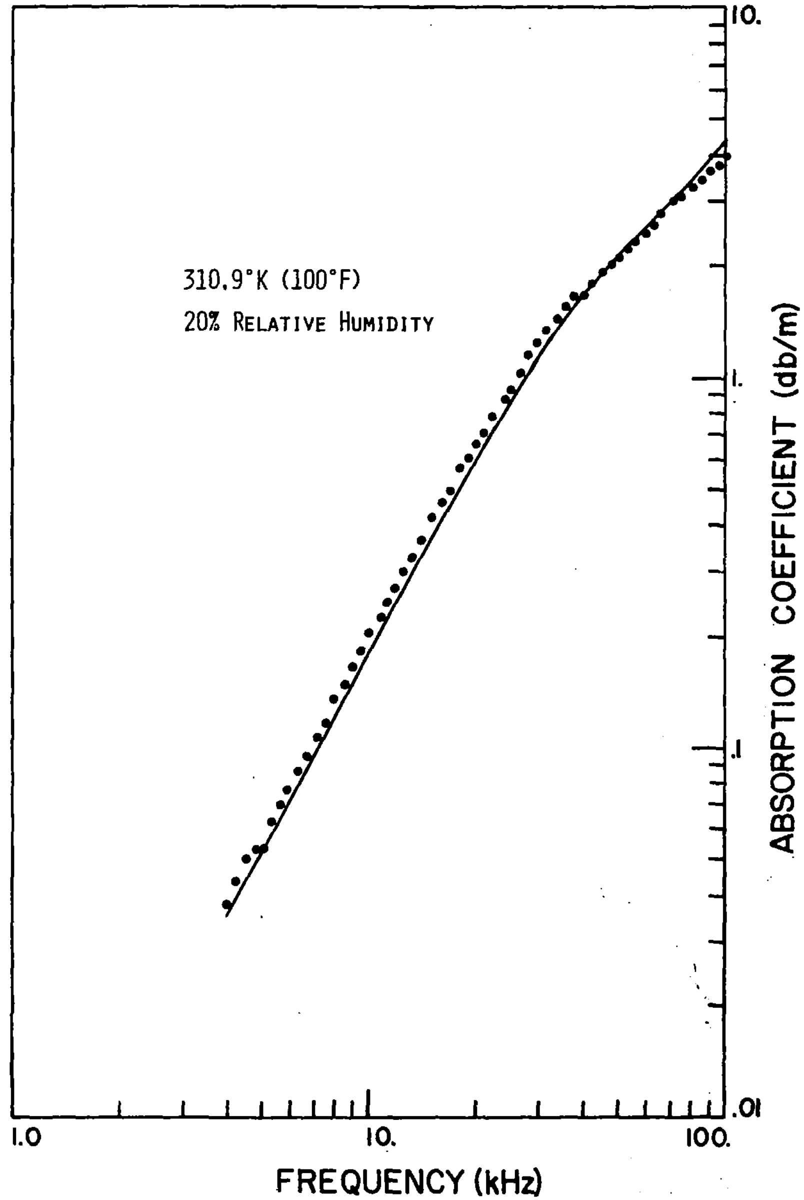
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100,0	2,7381	2.9874
95,0	2,5353	2.8216
90,0	2,4484	2.6632
85,0	2,2757	2.5121
80,0	2,1829	2.3679
75,0	2,1066	2.2303
71,0	1,9759	2.1249
67,0	1,8673	2.0230
63,0	1,7399	1.9245
59,0	1,6622	1.8289
56,0	1,5863	1.7583
53,0	1,5120	1.6897
50,0	1,5834	1.6212
48,0	1,5494	1.5757
45,0	1,4373	1.5071
42,0	1,3264	1.4376
40,0	1,2607	1.3903
37,5	1,2284	1.3297
35,4	1,1689	1.2770
33,4	1,1189	1.2243
31,5	1,0807	1.1729
29,8	1,0354	1.1214
28,0	0,9942	1.0701
26,5	0,9330	1.0226
25,0	0,8797	0.9725
24,0	0,8552	0.9376
22,0	0,8112	0.8633
21,0	0,7766	0.8248
20,0	0,7486	0.7844
19,0	0,7115	0.7424
18,0	0,6897	0.6989
17,0	0,6605	0.6539
16,0	0,6179	0.6076
15,0	0,5785	0.5599
14,0	0,5303	0.5112
13,2	0,5017	0.4716
12,5	0,4649	0.4366
11,8	0,4404	0.4015
11,2	0,4105	0.3714
10,6	0,3735	0.3414
10,0	0,3511	0.3117
9,5	0,3243	0.2872
9,0	0,3031	0.2630
8,5	0,2749	0.2394
8,0	0,2513	0.2162
7,5	0,2288	0.1937
7,1	0,2086	0.1763
6,7	0,1887	0.1593
6,3	0,1713	0.1430
5,9	0,1533	0.1273
5,6	0,1414	0.1160
5,3	0,1284	0.1051
5,0	0,1140	0.0947
4,8	0,1059	0.0880
4,5	0,0974	0.0784
4,2	0,0843	0.0692
4,0	0,0771	0.0634



ABSORPTION OF SOUND IN AIR

TEMPERATURE =310.9 K   RELATIVE HUMIDITY = 20.0 %

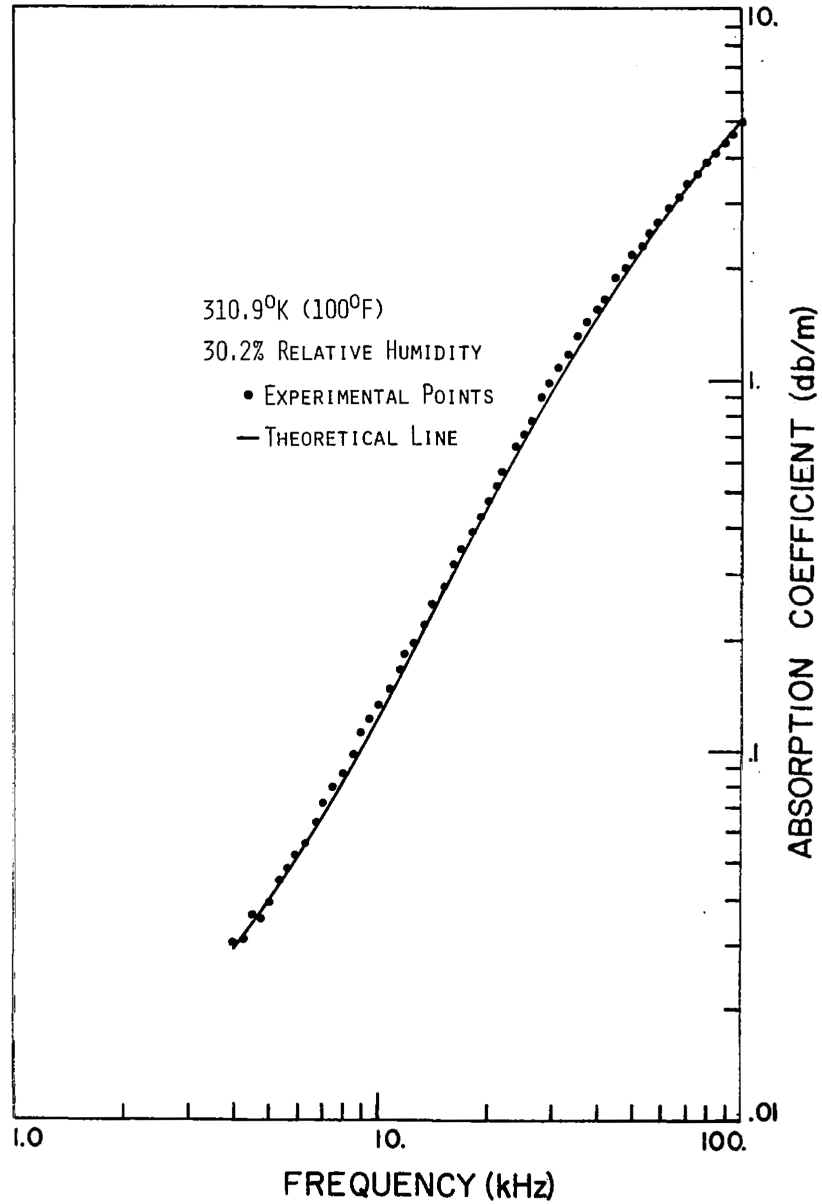
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	3.9802	4.3490
95.0	3.7412	4.1385
90.0	3.6434	3.9311
85.0	3.4063	3.7247
80.0	3.2698	3.5184
75.0	3.0934	3.3108
71.0	2.9424	3.1428
67.0	2.7688	2.9723
63.0	2.5719	2.7984
59.0	2.4579	2.6201
56.0	2.3367	2.4829
53.0	2.2040	2.3425
50.0	2.0954	2.1983
48.0	2.0111	2.1001
45.0	1.8936	1.9493
42.0	1.7517	1.7945
40.0	1.6395	1.6891
37.5	1.6443	1.5550
35.4	1.5424	1.4406
33.4	1.4112	1.3305
31.5	1.3217	1.2251
29.7	1.2195	1.1250
28.0	1.1480	1.0305
26.5	1.0228	0.9475
25.0	0.9183	0.8652
24.0	0.8706	0.8100
22.0	0.7803	0.7042
21.0	0.7085	0.6520
20.0	0.6624	0.6007
19.0	0.6082	0.5506
18.0	0.5669	0.5017
17.0	0.4973	0.4542
16.0	0.4629	0.4083
15.0	0.4172	0.3642
14.0	0.3653	0.3219
13.2	0.3272	0.2895
12.5	0.2964	0.2673
11.8	0.2695	0.2362
11.2	0.2478	0.2143
10.6	0.2264	0.1943
10.0	0.2024	0.1746
9.5	0.1809	0.1590
9.0	0.1671	0.1441
8.5	0.1488	0.1290
8.0	0.1356	0.1164
7.5	0.1178	0.1034
7.1	0.1084	0.0939
6.7	0.0953	0.0847
6.3	0.0856	0.0760
5.9	0.0775	0.0673
5.6	0.0700	0.0620
5.3	0.0629	0.0555
5.0	0.0543	0.0512
4.8	0.0525	0.0472
4.5	0.0499	0.0431
4.2	0.0428	0.0396
4.0	0.0376	0.0359



ABSORPTION OF SOUND IN AIR

TEMPERATURE =310.9 K   RELATIVE HUMIDITY = 30.2 %

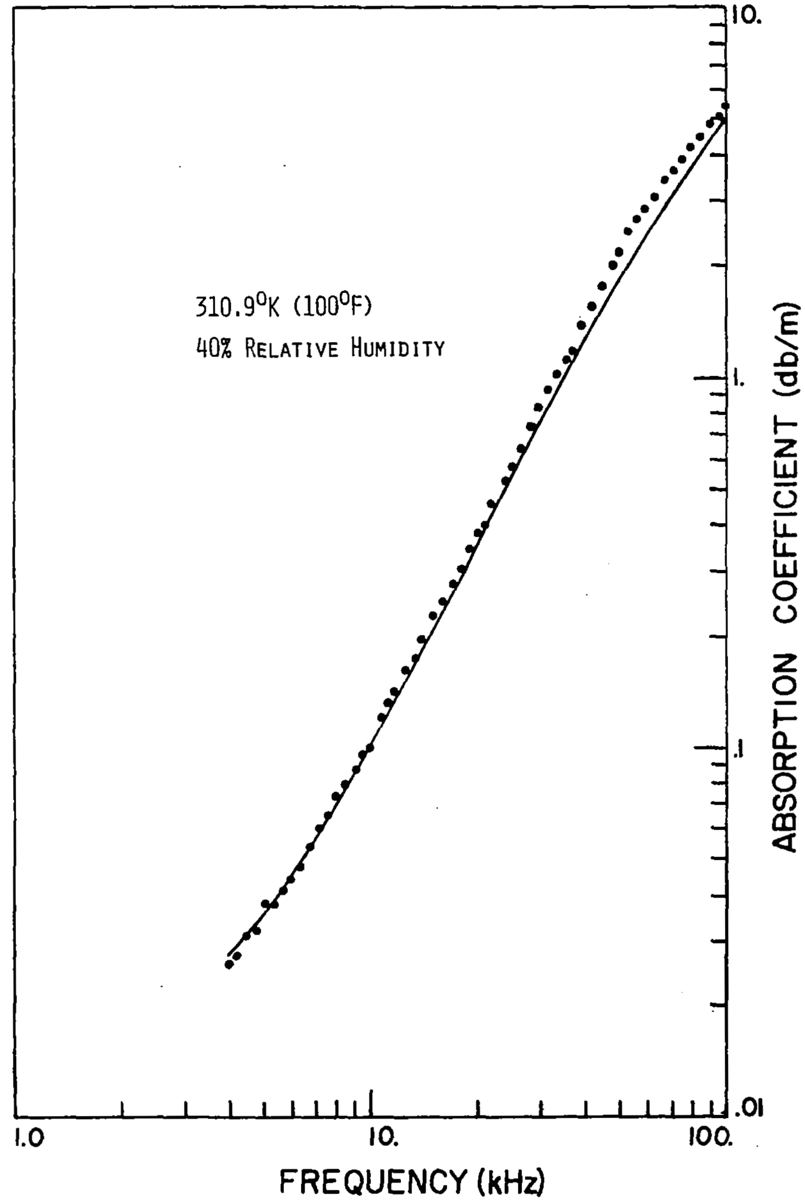
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	4.9124	5.0699
95.0	4.6169	4.7947
90.0	4.4078	4.4974
85.0	4.1375	4.2075
80.0	3.8976	3.9144
75.0	3.6196	3.6176
71.0	3.3916	3.3774
67.0	3.1796	3.1348
63.0	2.9110	2.8966
59.0	2.6627	2.6431
56.0	2.5069	2.4572
53.0	2.3086	2.2709
50.0	2.1635	2.0849
47.0	2.0513	1.9613
45.0	1.8860	1.7779
42.0	1.6929	1.5949
40.0	1.5576	1.4792
37.5	1.4541	1.3230
35.4	1.3193	1.2070
33.4	1.2004	1.0944
31.5	1.0924	0.9992
29.7	0.9875	0.8943
28.0	0.8966	0.8066
26.5	0.7866	0.7318
25.0	0.7150	0.6595
24.0	0.6682	0.6129
22.0	0.5735	0.5236
21.0	0.5224	0.4811
20.0	0.4794	0.4401
19.0	0.4323	0.4006
18.0	0.3997	0.3627
17.0	0.3555	0.3265
16.0	0.3218	0.2921
15.0	0.2806	0.2594
14.0	0.2502	0.2295
13.2	0.2204	0.2051
12.5	0.1997	0.1857
11.8	0.1860	0.1673
11.2	0.1683	0.1522
10.6	0.1495	0.1379
10.0	0.1342	0.1243
9.5	0.1238	0.1136
9.0	0.1106	0.1033
8.5	0.0995	0.0936
8.0	0.0887	0.0844
7.5	0.0808	0.0758
7.1	0.0735	0.0692
6.7	0.0652	0.0631
6.3	0.0576	0.0572
5.9	0.0529	0.0517
5.6	0.0494	0.0478
5.3	0.0452	0.0441
5.0	0.0394	0.0406
4.8	0.0358	0.0384
4.5	0.0376	0.0352
4.2	0.0313	0.0322
4.0	0.0301	0.0303



ABSORPTION OF SOUND IN AIR

TEMPERATURE =310.9 K   RELATIVE HUMIDITY = 40.0 %

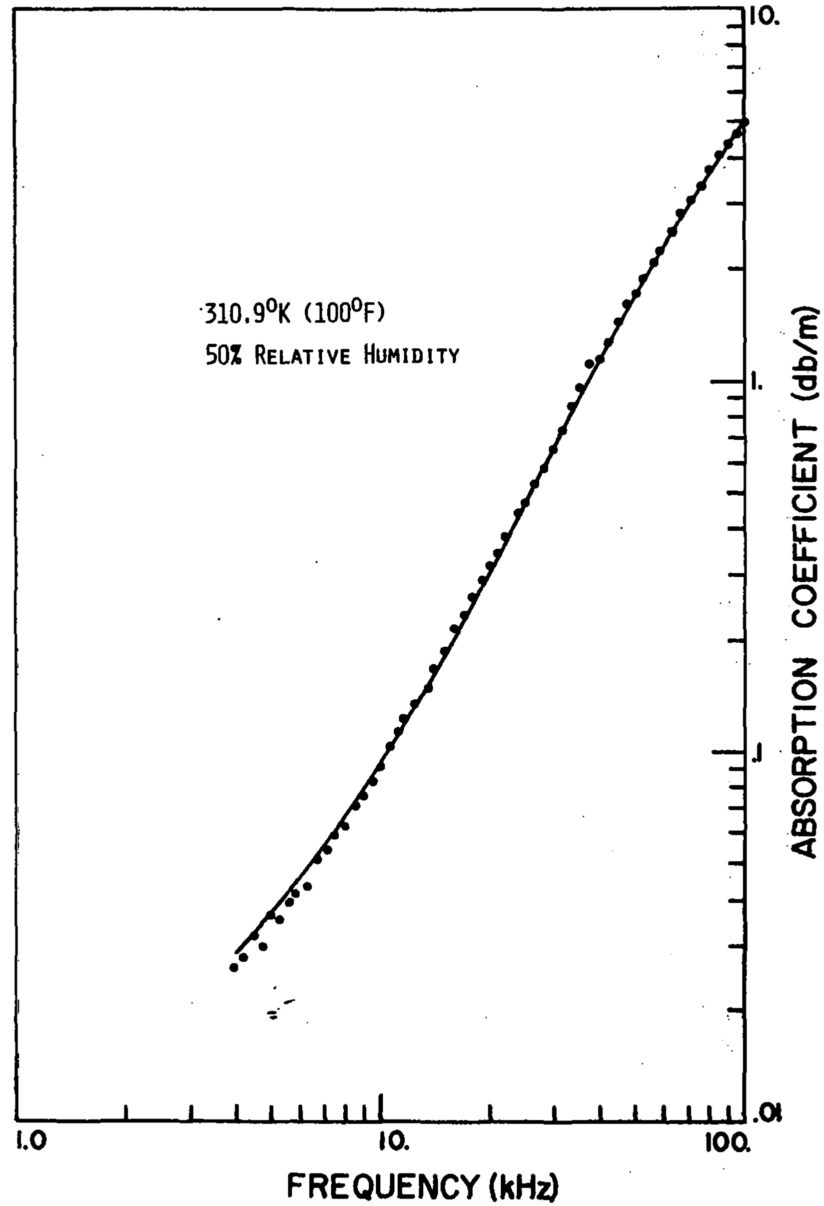
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	5.4247	5.2354
95.0	5.0662	4.8901
90.0	4.8194	4.5443
85.0	4.4683	4.1983
80.0	4.1981	3.8525
75.0	3.9016	3.5073
71.0	3.6431	3.2334
67.0	3.3945	2.9610
63.0	3.0806	2.6915
59.0	2.8512	2.4259
56.0	2.6602	2.2299
53.0	2.4545	2.0373
50.0	2.1693	1.8483
48.0	2.0180	1.7256
45.0	1.7588	1.5454
42.0	1.5475	1.3710
40.0	1.3902	1.2585
37.5	1.1819	1.1225
35.4	1.1250	1.0125
33.4	1.0202	0.9117
31.5	0.9315	0.8197
29.7	0.8305	0.7362
28.0	0.7417	0.6608
26.5	0.6462	0.5971
25.0	0.5828	0.5362
24.0	0.5344	0.4972
22.0	0.4584	0.4232
21.0	0.4015	0.3883
20.0	0.3844	0.3549
19.0	0.3480	0.3227
18.0	0.3085	0.2921
17.0	0.2815	0.2630
16.0	0.2539	0.2354
15.0	0.2308	0.2094
14.0	0.1971	0.1849
13.2	0.1736	0.1664
12.5	0.1639	0.1511
11.8	0.1448	0.1365
11.2	0.1349	0.1249
10.6	0.1207	0.1136
10.0	0.1010	0.1030
9.5	0.0997	0.0946
9.0	0.0897	0.0866
8.5	0.0808	0.0791
8.0	0.0756	0.0719
7.5	0.0665	0.0652
7.1	0.0622	0.0601
6.7	0.0552	0.0553
6.3	0.0488	0.0507
5.9	0.0454	0.0464
5.6	0.0429	0.0434
5.3	0.0389	0.0405
5.0	0.0391	0.0379
4.8	0.0331	0.0360
4.5	0.0324	0.0335
4.2	0.0283	0.0311
4.0	0.0270	0.0296



ABSORPTION OF SOUND IN AIR

TEMPERATURE =310.9 K   RELATIVE HUMIDITY = 50.0 %

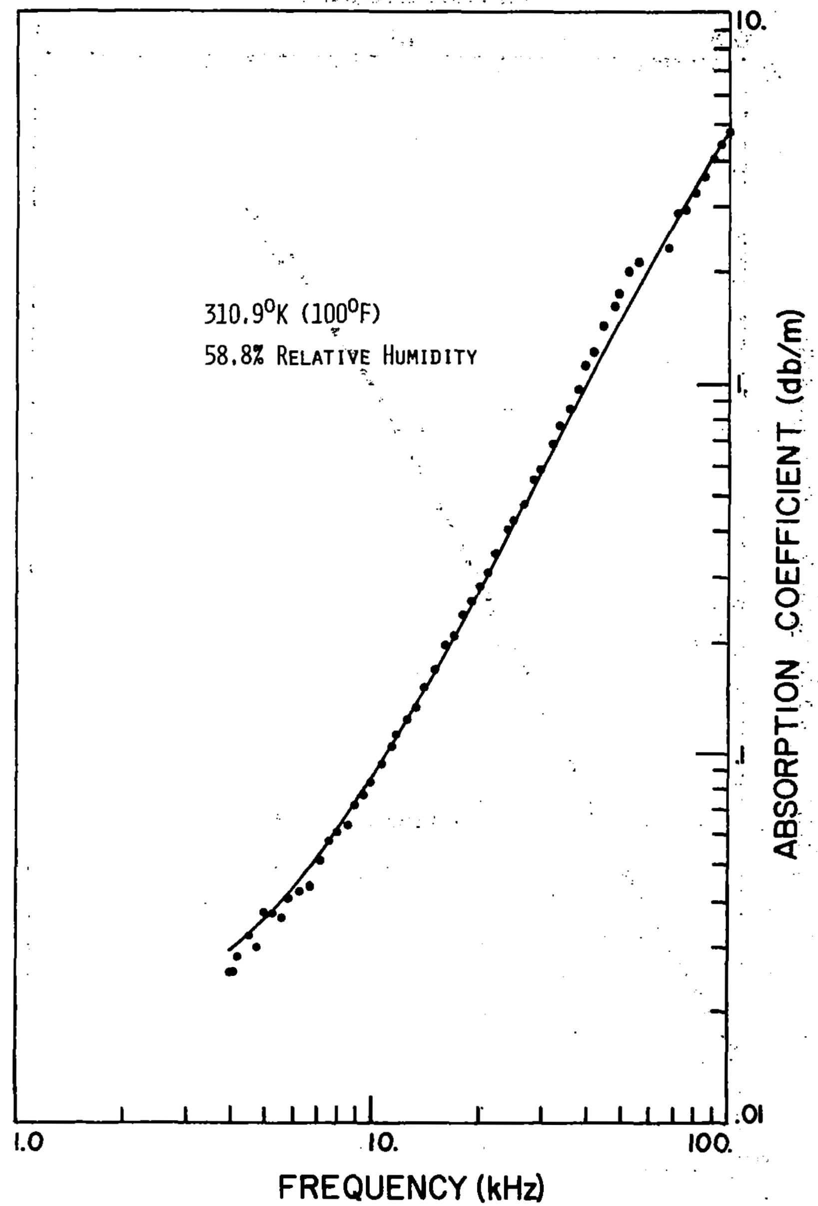
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M).
100.0	5.1758	5.1260
95.0	4.7785	4.7466
90.0	4.4785	4.3703
85.0	4.0691	3.9994
80.0	3.7529	3.6334
75.0	3.4247	3.2749
71.0	3.1346	2.9924
67.0	2.8506	2.7167
63.0	2.5420	2.4480
59.0	2.2866	2.1672
56.0	2.1062	1.9975
53.0	1.9030	1.8133
50.0	1.7403	1.6352
48.0	1.6320	1.5209
45.0	1.4609	1.3532
42.0	1.2819	1.1937
40.0	1.1618	1.0919
37.5	1.1116	0.9659
35.4	0.9754	0.8719
33.4	0.8629	0.7829
31.5	0.7466	0.7022
29.7	0.6601	0.6294
28.0	0.5969	0.5641
26.5	0.5351	0.5091
25.0	0.4799	0.4569
24.0	0.4418	0.4236
22.0	0.3841	0.3606
21.0	0.3426	0.3319
20.0	0.3196	0.3026
19.0	0.2923	0.2755
18.0	0.2639	0.2498
17.0	0.2362	0.2254
16.0	0.2141	0.2023
15.0	0.1892	0.1805
14.0	0.1707	0.1609
13.2	0.1503	0.1447
12.5	0.1368	0.1319
11.8	0.1240	0.1198
11.2	0.1146	0.1100
10.6	0.1030	0.1007
10.0	0.0922	0.0919
9.5	0.0847	0.0849
9.0	0.0782	0.0783
8.5	0.0719	0.0720
8.0	0.0624	0.0661
7.5	0.0602	0.0605
7.1	0.0542	0.0562
6.7	0.0506	0.0522
6.3	0.0434	0.0484
5.9	0.0422	0.0448
5.6	0.0394	0.0423
5.3	0.0354	0.0398
5.0	0.0360	0.0375
4.8	0.0308	0.0360
4.5	0.0322	0.0338
4.2	0.0289	0.0317
4.0	0.0262	0.0304



ABSORPTION OF SOUND IN AIR

TEMPERATURE =310.9 K RELATIVE HUMIDITY = 58.8 %

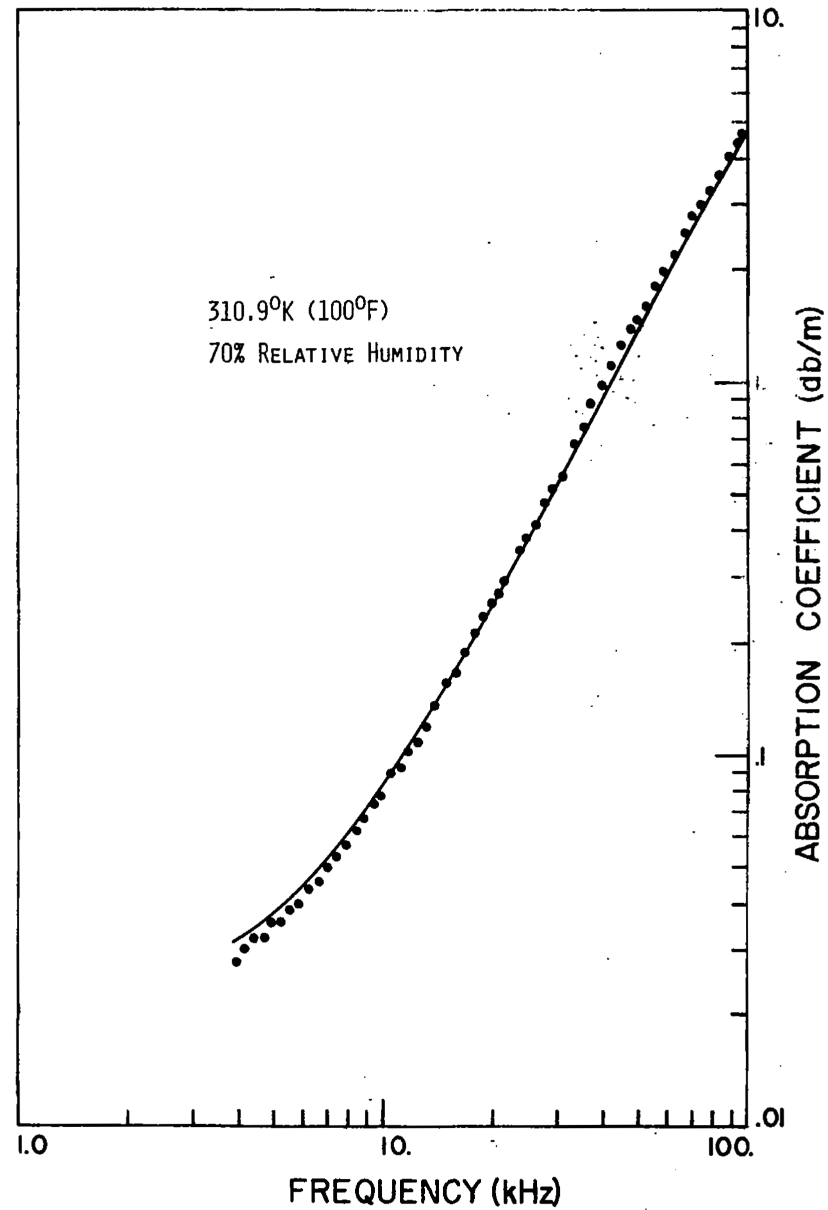
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	4.8269	4.9342
95.0	4.3879	4.5432
90.0	4.0261	4.1592
85.0	3.6266	3.7832
80.0	3.2821	3.4163
75.0	2.9044	3.0598
71.0	2.8636	2.7831
67.0	2.3214	2.5146
56.0	2.1323	1.8257
53.0	2.0176	1.6520
50.0	1.7550	1.4852
48.0	1.6002	1.3779
45.0	1.4224	1.2233
42.0	1.2140	1.0765
40.0	1.1158	0.9831
37.5	0.9761	0.8717
35.4	0.8479	0.7829
33.4	0.7773	0.7023
31.5	0.6460	0.6295
29.7	0.5954	0.5641
28.0	0.5250	0.5055
26.5	0.4709	0.4563
25.0	0.4281	0.4097
24.0	0.3980	0.3800
22.0	0.3467	0.3240
21.0	0.3090	0.2977
20.0	0.2845	0.2726
19.0	0.2568	0.2496
18.0	0.2369	0.2259
17.0	0.2068	0.2042
16.0	0.1928	0.1832
15.0	0.1678	0.1646
14.0	0.1508	0.1466
13.2	0.1327	0.1330
12.5	0.1236	0.1218
11.8	0.1131	0.1112
11.2	0.1055	0.1025
10.6	0.0944	0.0943
10.0	0.0841	0.0865
9.5	0.0774	0.0804
9.0	0.0728	0.0745
8.5	0.0651	0.0690
8.0	0.0615	0.0637
7.5	0.0561	0.0593
7.1	0.0518	0.0550
6.7	0.0473	0.0514
6.3	0.0424	0.0480
5.9	0.0412	0.0448
5.6	0.0365	0.0425
5.3	0.0375	0.0403
5.0	0.0373	0.0382
4.8	0.0302	0.0363
4.5	0.0320	0.0343
4.2	0.0287	0.0323
4.0	0.0259	0.0315



ABSORPTION OF SOUND IN AIR

TEMPERATURE =310.9 K RELATIVE HUMIDITY = 70.0 %

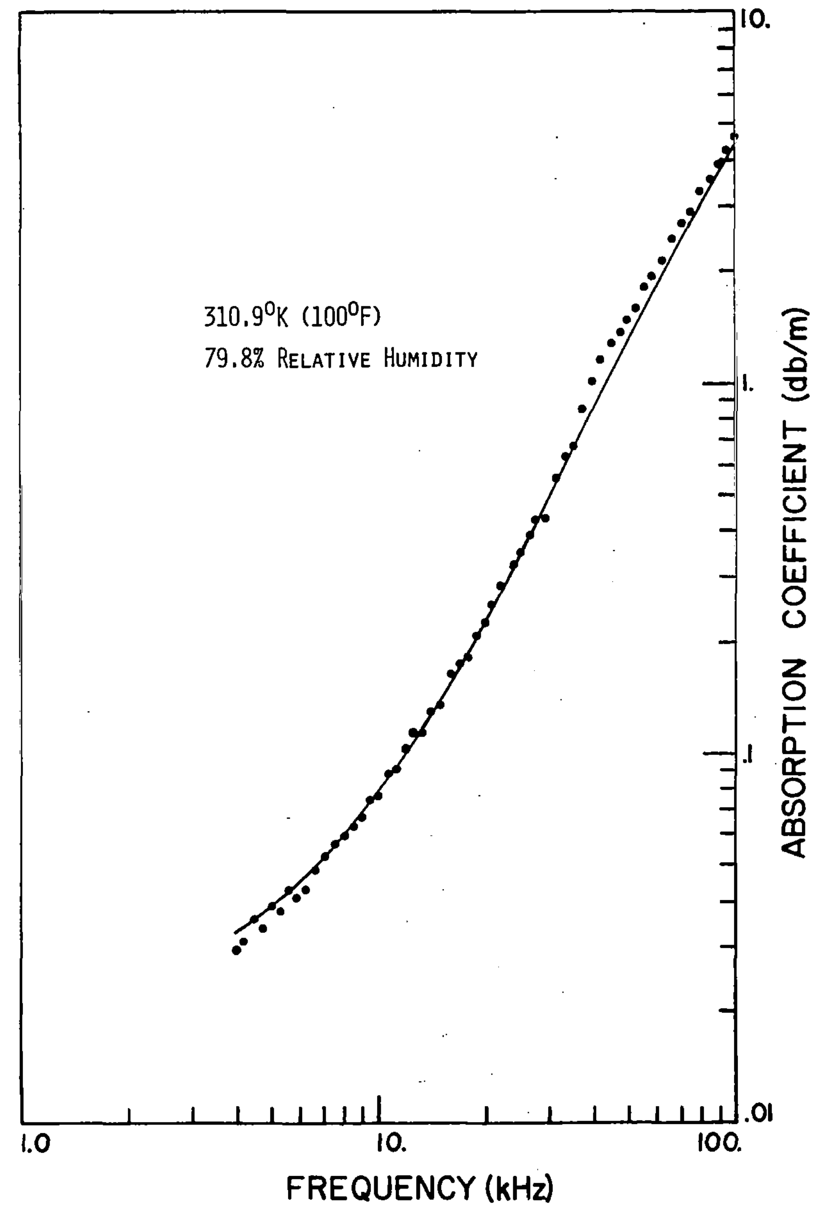
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	4.7556	4.6572
95.0	4.3315	4.2669
90.0	4.0138	3.8861
85.0	3.6320	3.5166
80.0	3.3300	3.1594
75.0	2.9657	2.8156
71.0	2.7458	2.5502
67.0	2.4827	2.2961
63.0	2.1634	2.0517
59.0	1.9550	1.8194
56.0	1.7879	1.6511
53.0	1.5908	1.4997
50.0	1.4637	1.3373
48.0	1.3601	1.2391
45.0	1.2346	1.0982
42.0	1.0920	0.9650
40.0	0.9656	0.8606
37.5	0.8682	0.7822
35.4	0.7657	0.7204
33.4	0.6792	0.6283
31.5	0.5528	0.5633
29.7	0.5212	0.5050
28.0	0.4649	0.4529
26.5	0.4133	0.4093
25.0	0.3763	0.3679
24.0	0.3502	0.3416
22.0	0.2919	0.2971
21.0	0.2687	0.2689
20.0	0.2516	0.2467
19.0	0.2343	0.2256
18.0	0.2101	0.2055
17.0	0.1890	0.1865
16.0	0.1657	0.1686
15.0	0.1566	0.1517
14.0	0.1344	0.1358
13.2	0.1181	0.1239
12.5	0.1083	0.1140
11.8	0.1035	0.1047
11.2	0.0913	0.0970
10.5	0.0887	0.0898
10.0	0.0777	0.0830
9.5	0.0744	0.0775
9.0	0.0674	0.0724
8.5	0.0618	0.0675
8.0	0.0569	0.0628
7.5	0.0534	0.0584
7.1	0.0495	0.0550
6.7	0.0451	0.0518
6.3	0.0428	0.0487
5.9	0.0396	0.0458
5.6	0.0384	0.0437
5.3	0.0358	0.0416
5.0	0.0357	0.0396
4.8	0.0323	0.0383
4.5	0.0323	0.0363
4.2	0.0302	0.0344
4.0	0.0276	0.0332



ABSORPTION OF SOUND IN AIR

TEMPERATURE =310.9 K   RELATIVE HUMIDITY = 79.8 %

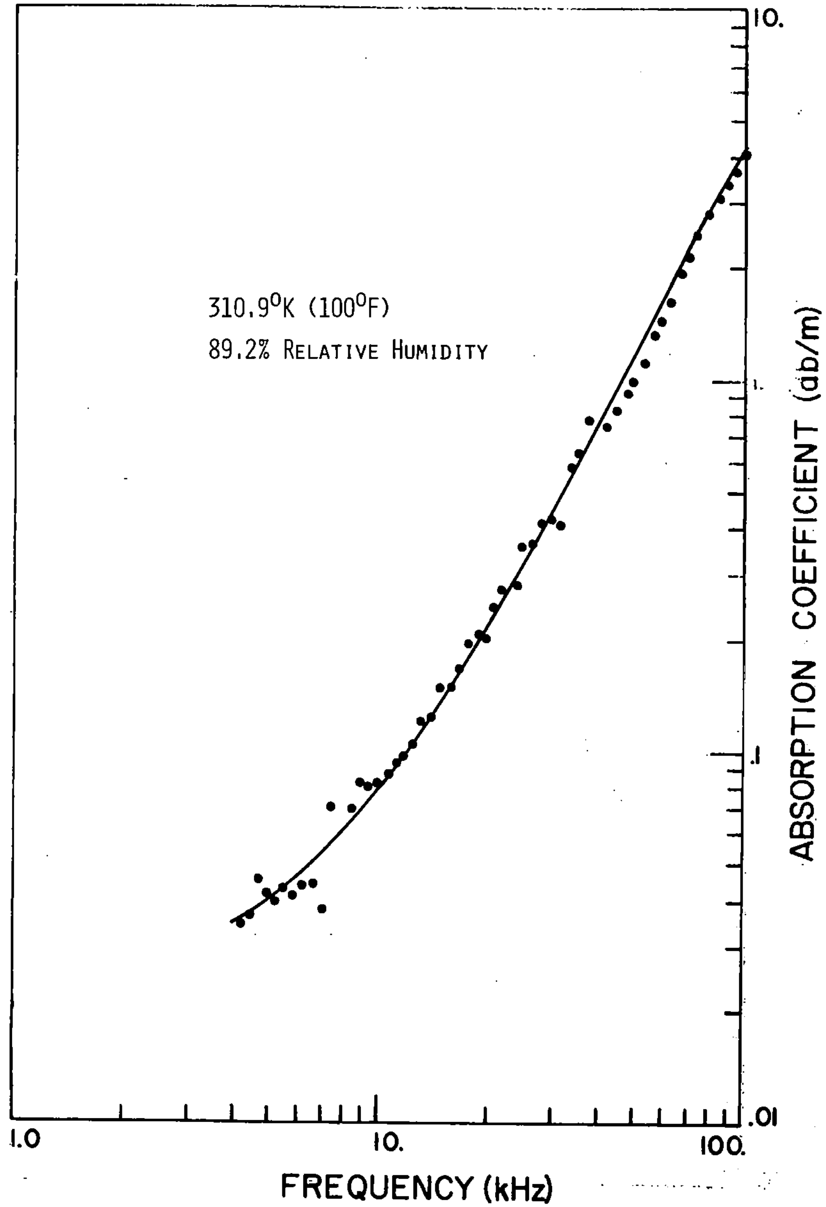
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	4.5815	4.4237
95.0	4.1879	4.0358
90.0	3.8859	3.6681
85.0	3.5126	3.3094
80.0	3.2574	2.9646
75.0	2.8822	2.6346
71.0	2.6665	2.3818
67.0	2.4176	2.1395
63.0	2.1229	1.9082
59.0	1.9322	1.6833
56.0	1.7971	1.5311
53.0	1.5882	1.3808
50.0	1.4755	1.2376
48.0	1.3811	1.1462
45.0	1.2675	1.0151
42.0	1.1435	0.8916
40.0	1.0074	0.8136
37.5	0.8415	0.7209
35.4	0.6583	0.6474
33.4	0.6293	0.5809
31.5	0.5470	0.5212
29.7	0.4281	0.4677
28.0	0.4253	0.4198
26.5	0.3873	0.3792
25.0	0.3483	0.3420
24.0	0.3224	0.3180
22.0	0.2613	0.2727
21.0	0.2485	0.2515
20.0	0.2228	0.2312
19.0	0.2058	0.2120
18.0	0.1786	0.1936
17.0	0.1744	0.1763
16.0	0.1628	0.1599
15.0	0.1337	0.1444
14.0	0.1296	0.1300
13.2	0.1142	0.1191
12.5	0.1137	0.1101
11.8	0.1013	0.1015
11.2	0.0905	0.0945
10.6	0.0887	0.0879
10.0	0.0763	0.0816
9.5	0.0746	0.0767
9.0	0.0673	0.0719
8.5	0.0637	0.0674
8.0	0.0598	0.0630
7.5	0.0565	0.0589
7.1	0.0515	0.0556
6.7	0.0480	0.0529
6.3	0.0433	0.0499
5.9	0.0415	0.0470
5.6	0.0429	0.0450
5.3	0.0376	0.0430
5.0	0.0367	0.0410
4.8	0.0341	0.0397
4.5	0.0355	0.0372
4.2	0.0315	0.0353
4.0	0.0290	0.0345



ABSORPTION OF SOUND IN AIR

TEMPERATURE = 310.9 K   RELATIVE HUMIDITY = 89.2 %

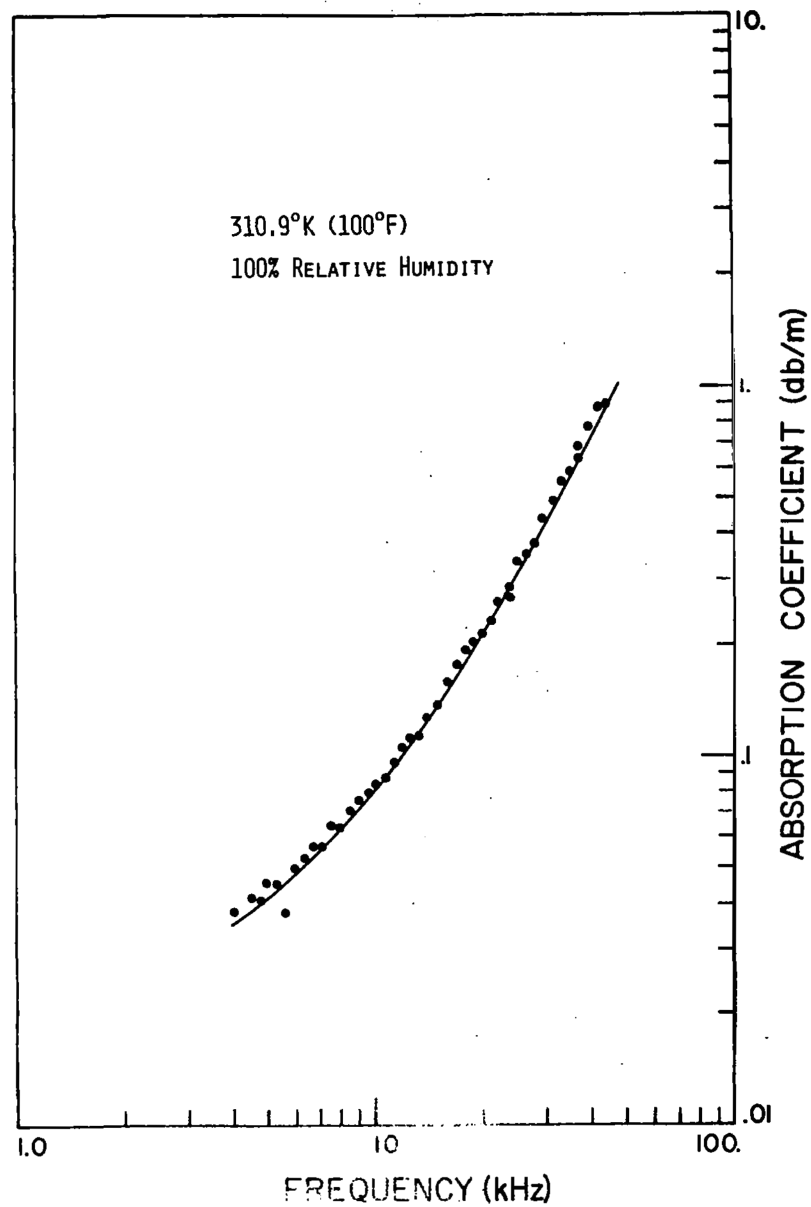
FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
100.0	4.0305	4.2152
95.0	3.6237	3.8440
90.0	3.3609	3.4571
85.0	3.0521	3.1362
80.0	2.7700	2.8041
75.0	2.4235	2.4874
71.0	2.1555	2.2457
67.0	1.9264	2.0147
63.0	1.6064	1.7946
59.0	1.4061	1.5874
56.0	1.2792	1.4272
53.0	1.0693	1.2969
50.0	0.9857	1.1611
48.0	0.9031	1.0751
45.0	0.8210	0.9521
42.0	0.7360	0.8343
40.0	0.7546	0.7633
37.5	0.7700	0.6764
35.4	0.6362	0.6079
33.4	0.5777	0.5459
31.5	0.3986	0.4907
29.7	0.4189	0.4402
28.0	0.4118	0.3958
26.5	0.3604	0.3556
25.0	0.3526	0.3234
24.0	0.2758	0.3041
22.0	0.2696	0.2599
21.0	0.2427	0.2393
20.0	0.1991	0.2205
19.0	0.2045	0.2025
18.0	0.1945	0.1855
17.0	0.1667	0.1694
16.0	0.1486	0.1542
15.0	0.1483	0.1398
14.0	0.1223	0.1264
13.2	0.1198	0.1163
12.5	0.1043	0.1079
11.8	0.0969	0.0999
11.2	0.0929	0.0934
10.6	0.0875	0.0872
10.0	0.0826	0.0813
9.5	0.0802	0.0767
9.0	0.0831	0.0722
8.5	0.0702	0.0679
7.5	0.0704	0.0599
7.1	0.0373	0.0569
6.7	0.0440	0.0540
6.3	0.0435	0.0512
5.9	0.0412	0.0484
5.6	0.0428	0.0464
5.3	0.0394	0.0444
5.0	0.0422	0.0424
4.8	0.0450	0.0411
4.5	0.0365	0.0391
4.2	0.0347	0.0370
4.0	0.0349	0.0356



ABSORPTION OF SOUND IN AIR

TEMPERATURE =310.9 K   RELATIVE HUMIDITY =100.0 %

FREQUENCY (KHZ)	MEASURED ABS (DB/M)	PREDICTED (DB/M)
45.0	0.8887	0.8944
42.0	0.8744	0.7860
40.0	0.7538	0.7176
37.5	0.6874	0.6366
35.4	0.5862	0.5724
33.4	0.5449	0.5146
31.5	0.4823	0.4627
29.7	0.4388	0.4162
28.0	0.3738	0.3747
26.5	0.3473	0.3401
25.0	0.3327	0.3073
24.0	0.2666	0.2865
22.0	0.2598	0.2473
21.0	0.2301	0.2290
20.0	0.2143	0.2115
19.0	0.2021	0.1948
18.0	0.1911	0.1790
17.0	0.1733	0.1640
16.0	0.1584	0.1499
15.0	0.1364	0.1365
14.0	0.1272	0.1239
13.2	0.1140	0.1145
12.5	0.1126	0.10[illegible]
11.8	0.1039	0.0992
11.2	0.0973	0.0931
10.6	0.0867	0.0873
10.0	0.0840	0.0818
9.5	0.0802	0.077[illegible]
9.0	0.0764	0.0731
8.5	0.0709	0.0690
8.0	0.0647	0.0651
7.5	0.0655	0.0614
7.1	0.0572	0.0584
6.7	0.0570	0.0556
6.3	0.0536	0.0523
5.9	0.0504	0.0500
5.6	0.0373	0.0480
5.3	0.0455	0.0450
5.0	0.0460	0.0437
4.8	0.0406	0.0425
4.5	0.0421	0.0404
4.2	0.0368	0.0[illegible]
4.0	0.0382	0.0367



A.2 A Point by Point Comparison of Measured Values of Total Absorption in Original Runs and Check Runs

Table A.2.1 Comparison of Measured Values of Total Absorption In Dry Air. The comparison is between an original run made at top date and a check run made on a different gas sample on the bottom date. Values are in db/m.

Temp. (°K)	255.4	260.9	266.5	272.1	277.6	283.2	294.3	299.8	310.9
Dates (top)	12/17/75	12/16/75	12/15/75	12/13/75	12/12/75	12/10/75	12/5/75	12/18/75	1/2/76
Freq. in kHz / Dates (bottom)	3/1/76	2/23/76	2/19/76	2/5/76	1/26/76	5/18/76	12/8/75	3/22/76	4/5/76
4	.132	.130	.127	.128	.127	.131	.131	.144	.145
	.126	.122	.130	.127	.134	.129	.135	.135	.135
5	.139	.143	.142	--	.145	.148	.149	.152	.162
	.137	.143	.139	--	.148	.152	.152	.153	.153
8	.190	.190	.186	.194	.191	.189	.195	.207	.210
	.185	.186	.188	.194	.194	.188	.196	.198	.201
10	.217	.213	.218	.221	.217	.227	.230	.238	.242
	.214	.220	.221	.214	.219	.227	.220	.229	.233
14	.277	.273	.273	.277	.280	.275	.286	.288	.299
	.262	.271	.270	.276	.274	.289	.280	.291	.295
18	.326	.324	.325	.331	.336	.340	.341	.357	.362
	.323	.324	.333	.331	.332	.340	.349	.345	.362
22	.381	.387	.389	.395	.404	.396	--	.418	.429
	.388	.389	.388	.396	.397	.388	--	.415	.430
28	.481	.482	.486	.488	.508	--	--	.523	.524
	.493	.487	.508	.501	.488	--	--	.527	.551
35.4	.649	.637	.627	.632	.674	--	--	.676	.669
	.660	.642	.657	.676	.639	--	--	.686	.726
45	.864	--	.897	--	.877	--	--	--	.954
	.801	--	.882	--	.849	--	--	--	1.01
56	1.11	--	1.17	1.12	1.27	--	--	1.28	1.24
	1.10	--	1.18	1.16	1.16	--	--	1.25	1.29
71	1.58	--	1.62	1.63	1.68	--	--	1.69	1.77
	1.56	--	1.63	1.73	1.65	--	--	1.89	1.82
90	2.16	--	2.19	2.26	2.20	--	--	2.41	2.38
	2.12	--	2.17	2.33	2.25	--	--	2.40	2.49
100	--	--	2.54	2.63	2.54	--	--	2.67	2.72
	--	--	2.53	2.55	2.58	--	--	2.77	2.84
Avg. Abs. Difference (%)	2.29	1.64	1.73	2.46	3.02	2.49	2.40	3.11	4.08
Average Arithmetic Difference (%)	1.38	.41	-.81	-1.22	1.06	.58	-.21	.22	-.88

Table A.2.2 Comparison of Two Runs Made on Air at 299°K and 10% RH. The absorption values are in db/m.

Frequency in kHz	Measured Total Absorption	
	3/22/76	5/21/76
6.7	.374	.377
7.1	.391	.395
7.5	.405	.412
8	.425	.427
8.5	.442	.444
9	.461	.465
9.5	.475	.480
10	.489	.502
10.6	.511	.513
11.2	.521	.530
11.8	.539	.550
12.5	.557	.566
13.2	.573	.575
14	.593	.598
15	.616	.627
16	.631	.637
17	.655	.660
18	.678	.682
19	.701	.698
20	.719	.734
21	.727	.739
22	.753	.772
24	.791	.774
25	.810	.812
26.5	.832	.851
28	.879	.901
29.7	.926	.924
31.5	.973	.997

kHz	3/22/76	5/21/76
33.4	1.02	1.03
35.4	1.08	1.07
37.5	1.14	1.15
40	1.15	1.19
42	1.20	1.24
45	1.30	1.32
48	1.36	1.38
50	1.38	1.42
53	1.51	1.53
56	1.62	1.61
59	1.70	1.70
63	1.84	1.84
67	1.86	1.99
71	2.10	2.10
75	2.28	2.27
80	2.44	2.39
85	2.57	2.54
90	2.75	2.70
95	2.91	2.84
100	3.04	3.05
Average Absolute Difference	1.43%	
Average Arithmetic Difference	-0.92%	

APPENDIX B COMPUTER PROGRAMS USED IN THE STUDY

The symbols used in the following programs differ from those used in the body of the text due to the limitations on symbols available in FORTRAN and BASIC. Whenever possible, the variables in the programs are simply the upper case equivalent of the terms in the text. When the text uses Greek symbols, variable names were selected which correspond to the meaning of the Greek symbol. When the transformation to capital letters did not seem obvious, the symbol is either defined in the program by means of a comment card or is defined in the writeup preceeding the program in this appendix.

List of Programs

B.1 Program Used to Acquire and Analyze Experimental Data

```
2 PRINT "PRESURE(TI'S READING)";\INPUT O\PRINT "K-H'S GAIN";\INPUT O
3 GOSUB 36
4 DIM V(5)\GOSUB 17
5 GOSUB 11 \Y2=INT(O)\Y3=(O-Y2)*100
6 GOSUB 10 \O=O+1.00000E-04\U1=INT(O)\U2=INT((O-U1)*100)
7 GOSUB 13 \GOSUB 15
8 PRINT \I3=1\GO TO 20016
9 GO TO 32175
10 PRINT "*WHAT TIME IT IS ";\INPUT O\RETURN
11 PRINT "DATE:";\INPUT V$\RETURN
13 PRINT "*INPUT TEMP. OF THE SYSTEM:";\INPUT H0\RETURN
15 PRINT "* REL. HUMILITY(%)=";\INPUT H1\RETURN
17 PRINT \PRINT "* D.P. (        F), BEGINNING:        F,   FINAL:        F"
19 PRINT \RETURN
20 GOSUB 19120 \GO TO 32180
30 PRINT "*UNLOCK MIC & CLOSE B BEFORE CIRCULATION.  ";
32 PRINT "CONTI. '0'";\INPUT O
34 RETURN
36 PRINT "* OPEN VALVE-B , LOCK THE MIC, THEN '0'";\INPUT O
38 RETURN
396 /195
18008 IF F3*D2↑.7<F5 THEN 28010 \G9=1\GO TO 28012
19000 REM
19010 PRINT "RESET FOR TEMP. READING,THEN #CHVS"
19012 INPUT J
19020 GOSUB 19060
19021 I1=800
19022 IF H0>=32 THEN 19024 \A=-1\GO TO 19025
19024 A=1
19025 FOR I=1 TO J\GOSUB 19120
19026 A=1\IF I<>12 THEN 19030
19028 A=-1
19030 F0=A*F1*10↑(3-F2)
19040 T=(182519+F0/4.50000E-05)↑.5-427.222
19045 T1=T*1.8+32\PRINT T;" C ",T1;" F"
19050 NEXT I\RETURN
19060 CALL "XMIT""B"\CALL "XMIT""R"\CALL "XMIT""S"\CALL "XMIT""A"
19065 CALL "RCV"(F0,E)
19070 FOR I=1 TO 1000\O=1.2345*2.3456\NEXT I
19080 RETURN
19120 CALL "XMIT""B"\CALL "XMIT""R"\CALL "XMIT""S"
19125 CALL "XMIT""A"\CALL "RCV"(F0,E)
19130 F1=INT(F0/10)\F2=F0-F1*10
19135 FOR I0=1 TO I1\O=1.2345*2.3456\NEXT I0
19140 IF F1>3000 THEN 19150
19142 A=A1
19143 GO TO 19150
19145 IF I<10 THEN 19150 \A=+1\IF I=10 THEN 19150 \A=-1
19150 RETURN
19160 PRINT "HOW MANY PEAKS TO BE USED";\INPUT P9\RETURN
19200 PRINT " *ADJ PULSER* THEN '0'";\RETURN
20008 PRINT "TYPE ENTRY POINT I3=";
20009 INPUT I3
20010 IF I3>1 THEN 20014 \PRINT "I3=";I3;"? START OVER?"
20014 GO TO 32180
20016 P9=10\F9=13
20030 DIM P(25),Q(25)
20035 DIM Y(1024),Z(60)
20040 DIM V(3,245)\V9=245
20041 FOR I=0 TO 3\FOR J=1 TO V9
20042 V(I,J)=0
20043 NEXT J\NEXT I
20045 GO TO 20200
20050 REM
20100 GOSUB 30
20200 PRINT "MOVE TRANS.,TYPE SEPARATION IN METER";
20210 INPUT D2
20220 GOSUB 19010
20240 PRINT \PRINT "RESET FOR FREQ. TAKING"
20250 GOSUB 36
20265 G9=0\G8=0\GOSUB 19200
20270 INPUT O
21010 PRINT "*GN";
21020 INPUT F
21021 IF F<>6 THEN 21022 \GOSUB 19160 \GO TO 32180
21022 GOSUB 19060 \GOSUB 19120
21024 F0=F1*10↑(-F2)
21026 F3=INT(F0*10+.49)
21027 F3=F3/10
21028 PRINT "F:";F3;
25131 CALL "CONT""A00XB"\CALL "WAIT"
25132 CALL "CONT""A00LB"
25134 CALL "WAIT"
25135 GO TO 28000
27500 REM LEAST SQR
27510 X=0\X2=0\S1=0\S2=0
27520 FOR J=1 TO M
27530 X=X+Q(J)\X2=X2+Q(J)*Q(J)
```

```
27540 S1=S1+Z(J+20)
27550 S2=S2+Q(J)*Z(J+20)
27560 NEXT J
27570 Z3=(M*S2-X*S1)/(M*X2-X*X)
27572 IF Z3>0 THEN 27580
27574 Z3=-Z3
27580 RETURN
28000 C0=15+INT(700/(F3*D2))
28001 FOR I=1 TO P9+9
28002 P(I)=0\Q(I)=0
28004 NEXT I
28006 F5=15
28008 IF F3*D2↑.5<F9 THEN 28010 \G9=1\GO TO 28012
28010 G9=0
28012 IF G9=G8 THEN 28014 \GOSUB 19200 \INPUT O
28014 G8=G9\IF G9=1 THEN 28018
28015 IF F3*D2↑.3>5.2 THEN 28016 \CALL "CONT""A90AE"\GO TO 28020
28016 CALL "CONT""A60AB"
28017 GO TO 28020
28018 CALL "CONT""A20AE"
28020 CALL "WAIT"\CALL "CONT""A001E"
28022 PPINT " *SET FPEQ. * I3=";I3
28030 FOP K=0 TO C0
28032 CALL "DATI"(O)
28034 NEXT K
28040 FOP K=C0+1 TO 1023
28050 CALL "DATI"(Y(1024-K))
28052 NEXT K
28060 CALL "CONT""A00FE"
28070 CALL "WAIT"
28100 A9=1.8
28110 G1=.3\J3=0
28205 IF F4=4 THEN 29000
28210 J3=4\C0=C0+4
28215 Y(0)=Y(2)+Y(3)+Y(4)+Y(5)+Y(6)
28220 FOP K=1 TO 1021-C0
28230 Y(K)=Y(K-1)+Y(K+6)-Y(K+1)
28240 NEXT K
29000 REM END OF SMOOTH FUNCTIO
29005 A0=0\A1=0
29010 FOP I=0 TO 1021-C0\A0=A0+Y(I)\NEXT I
29012 A0=A9*F3↑.3*A0/F4/(900-C0)
29015 K=1
29020 Q(1)=A0\A1=A0
29030 FOP M=1 TO P9+7
29040 FOP J=K TO 1021-C0
29049 P(0)=0
29050 IF Y(J)>A0 THEN 29060 \IF Y(J-1)>A0 THEN 29320
29055 GO TO 29300
29060 IF Y(J)<=Q(M) THEN 29300
29070 Q(M)=Y(J)
29080 P(M)=1024-J-J3
29300 NEXT J
29305 M=M-1\GO TO 29400
29320 K=J+1
29340 NEXT M
29400 A0=0\I=1
29402 FOP J=1 TO M\A0=A0+Q(J)\NEXT J\A0=A0/M
29404 FOP J=1 TO M\IF Q(J)-.5*A1<G1*A0 THEN 29406
29405 P(I)=P(J)\I=I+1
29406 NEXT J
29407 G2=0
29408 M=I-1\IF M<P9 THEN 29409 \M=P9
29409 P(0)=2*P(1)\IF P(1)>390 THEN 29410 \PPINT "* 1ST PKh. UNDEP 390 *"
29410 FOP J=1 TO M
29412 P0=P(J-1)-P(J)
29414 PPINT P0;\IF P0>13 THEN 29420
29415 IF J=M THEN 29420
29416 PPINT "DOUELE PEAKS!!";\G2=1
29420 O=P(J)/F\Z(20+J)=8.68589*LOG(O)
29422 IF J=1 THEN 29430
29424 IF P0-P(J-2)+P(J-1)<15 THEN 29430
29425 G2=1
29426 PPINT "(CHK PKS AT";P(J-1);P(J);")";
29430 NEXT J
29435 IF G2<>1 THEN 29440 \PPINT
29436 PPINT "Q(1),A1:";Q(1);A1\PRINT "28100 A9=";A9
29440 Z1=2*Z(21)
29450 IF M>1 THEN 32120 \Z3=F3+.01*D2\GO TO 32140
32120 FOR J=1 TO M
32122 Q(J)=J
32124 NEXT J
32126 GOSUB 27500
32140 PEM
32142 IF ABS(F3-66.5/D2↑.5)>1 THEN 32150
32144 PRINT "*CHK MAG. PICKUP THEN '0'";\INPUT O
32150 V(0,I3)=F3
32155 V(1,I3)=Z1
32160 V(2,I3)=Z3
32162 V(3,I3)=D2
32170 I3=I3+1
32175 PRINT
32180 PRINT "*GN";
32190 INPUT F
32192 IF F<>20 THEN 32200 \F=20.25\GO TO 21022
32194 IF F<>50 THEN 32200 \F=50.6\GO TO 21022
```

```
32200 IF F=0 THEN 20008
32202 IF F<>3 THEN 32204 \F4=3\PRINT "WITH SMOOTH FUN."\GO TO 32180
32204 IF F<>4 THEN 32210 \F4=4\PRINT "WITHOUT SMOOTH FUN"\GO TO 32180
32210 IF F=7 THEN 20050
32211 IF F=8 THEN 20
32212 IF F=9 THEN 32218
32213 IF F=6 THEN 21021
32214 GO TO 21022
32218 PRINT "ARE YOU SURE? '9' IF YES, '0' OTHERWISE";
32219 INPUT F\IF F<>9 THEN 32180 \PRINT \GOSUB 10
32220 PRINT \PRINT "*** PLEASE MAKE AN ENTRY ON THE ** LOG BOOK **"
32222 O=O+1.00000E-04\U3=INT(O)\U4=INT((O-U3)*100)
32226 GOSUB 30
32228 PRINT " ";"DATE: ";V$
32230 PRINT "MEASUREMENT STARTED AT";U1;":";U2;
32235 PRINT " COMPLETED AT";U3;":";U4
32240 PRINT \PRINT
33002 PRINT
33010 L=1
33015 N=1
33020 K=1
33030 IF W(0,L)>0 THEN 33070
33040 IF L>=W9 THEN 33480
33050 L=L+1
33060 GO TO 33030
33070 REM
33080 F1=W(0,L)
33100 FOR I=L TO W9
33110 IF ABS(W(0,I)-F1)/F1>.01 THEN 33160
33120 Z(K)=W(0,I)\W(0,I)=0
33130 Z(K+20)=W(1,I)
33140 Q(K)=W(3,I)
33141 IF Q(K)<>Q(K-1) THEN 33145 \W(0,I)=0\PRINT Q(K);Z(K)\GO TO 33160
33145 Z(K+40)=W(2,I)
33147 IF K>1 THEN 33150 \PRINT "(";Z(1);"K-HZ)"
33150 PRINT Q(K);Z(K+20),Z(K+40),
33151 IF K>1 THEN 33153
33152 PRINT \GO TO 33158
33153 O=(Z(K+19)-Z(K+20))/(Q(K)-Q(K-1))
33154 O1=(Z(K+40)-Z(K+39))/(Q(K)-Q(K-1))
33155 PRINT O/2;O1/2
33158 K=K+1
33160 NEXT I
33170 IF K=2GO TO 33460
33180 M=K-1
33190 GOSUB 27500
33192 Y(N+100)=Z3/2
33195 PRINT "*(DB/M):";Z3/2;
33197 B1=Z(21)-Z3*Q(1)
33200 FOR J=1 TO M
33210 Z(J+20)=Z(J+40)
33220 NEXT J
33230 GOSUB 27500
33235 Y(N+200)=Z3/2
33238 Y(N)=Z(1)
33240 PRINT Z3/2
33250 B3=Z(21)-Z3*Q(1)
33270 PRINT
33400 N=N+1
33440 L=L+1
33450 GO TO 33020
33460 PRINT " THIS FREQ. HAS ONE DISTANCE ONLY"
33470 GO TO 33020
33480 PRINT \PRINT
33482 PRINT "*  DATE : ";V$\PRINT
33485 PRINT "* TEMP. :";H0;"DEG. F"
33490 PRINT "* P.H.  : ";H1;"%"
33495 PRINT \PRINT
33500 PRINT "TYPE 0,PUSH ON,THEN RETURN"
33502 PRINT \PRINT
33505 PRINT "FREQ   1ST PKh.   SLOPE"
33510 INPUT O
33515 PRINT "TEMP:";H0;"  P.H. :";H1
33520 FOR I=1 TO N
33530 PRINT Y(I);Y(I+100);Y(I+200)
33540 NEXT I
35000 END
35001 REM THE END.
```

B.2 Program Used to Correct Data for Tube Losses

```
C       THIS PROGRAM CORRECTS MEASURED ABSORPTION FOR TUBE LOSSES AND
C       PRINTS OUT RESULTS ALONG WITH RESULTS PREDECTED BY PROPOSED
C       S1-57 STANDARD.
C     ABDBM = AMPLITUDE ABSORPTION COEFFICIENT IN DB/ METER
C     OM = ACOUSTIC FREQUENCY
C     P = AMBIENT PRESSURE IN ATMOSPHERES
C     PS = SATURATED VAPOR PRESSURE FOR WATER IN ATMOSPHERES
C     T = TEMPERATURE IN DEGREES KELVIN
C     TF = TEMPERATURE IN DEGREES FAHRENHEIT
C     WAVEL = WAVELENGTH OF SOUND WAVE
C       RH=RELATIVE HUMIDITY IN PERCENT
C       AB1=MEASURED ABSORPTION USING FIRST PEAK HEIGHT
C       AB2=MEASURED ABSORPTION USING SLOPE OF THE DECAY PATTERN.
        DOUBLE PRECISION DT,DV,DCF,DALFA,ALFAP
        DIMENSION F(200),AB1(200),AB2(200),FF(200)
      REAL MUO2,MUN2
C       READ TEMPERATURE IN DEGREES F, RELATIVE HUMIDITY IN %
1       READ(5,10)TF,RH
10      FORMAT(3F)
        T=(TF-32.)/1.8+273.16
        WRITE(6,5)T,RH
5       FORMAT(1H1,15X,'ABSORPTION OF SOUND IN AIR',/,5X,
     2  'TEMPERATURE =',F5.1,' K    ','RELATIVE HUMIDITY =',F5.1,' %',/,
     3  5X,'FREQUENCY',8X,'MEASURED ABS',10X,'PREDICTED')
        WRITE(6,6)
6       FORMAT(7X,'(KHZ)',13X,'(DB/M)',14X,'(DB/M)')
C       READ DATA IN THE FORM FREQUENCY(KHZ),ABS FROM FIRST PEAK,
C       ABS FROM ECHO.
        K=0
        T1=T/293.
        V=7.318E-2*T1**1.5/(T+110.4)
        P=1.
        P1=P*760.
        DO 110 I=1,200
100     READ(5,10)F(I),AB1(I),AB2(I)
        IF(F(I).EQ.0.0)GO TO 120
        K=K+1
        DT=DBLE(T)
        DV=DBLE(V)
        DCF=DBLE(F(I))
C       COMPUTE TUBE ABSORPTION
        CALL TUBEC(DT,DV,DCF,ALFAP,DALFA)
        SALFAP=ALFAP
        VEL=34340.*SQRT(T1)
        WAVEL=VEL/(F(I)*1.0E3)
C       COMPUTE EMPIRICAL CORRECTION
        SDALFA=(DALFA)*(1.-.014/(WAVEL**3.1))
C       SELECT FIRST PEAK HEIGHT OR SLOPE
        IF(F(I).GE.4.E01)AB2(I)=AB1(I)-SDALFA*100.
        IF(F(I).LT.4.E01)AB2(I)=AB2(I)-SDALFA*100.
110     FF(I)=F(I)*1.0E3
120     CONTINUE
C       PUT DATA IN ORDER OF DECREASING FREQUENCY
        DO 122 J=1,200
        DUM=1.0
        DO 121 I=1,K
        IF(FF(I).GT.DUM)L=I
        IF(FF(I).GT.DUM)AB1(J)=AB2(I)
        IF(FF(I).GT.DUM)F(J)=FF(I)
121     IF(FF(I).GT.DUM)DUM=FF(I)
        IF(DUM.EQ.1.)GO TO 123
122     FF(L)=0.0
123     PI=3.14159
      VEL=343.4*SQRT(T1)
        PS=(10.0)**(20.5315-2939./T-4.922*ALOG10(T))
      CVO2=(2239./T)**2*EXP(-2239./T)/(1-EXP(-2239/T))**2
      CVN2=(3352./T)**2*EXP(-3352./T)/(1-EXP(-3352/T))**2
        MUO2=CVO2*2.*PI*.20948/35.
        MUN2=CVN2*2.*PI*.78084/35.
      H=PS/P*RH
        DEV=0.0
        A=24
        B=18.4
        DO 150 I=1,K
        OM=F(I)
        CF=F(I)/1000.
      FRO2=P*(A+4.41E04*H*(0.05+H)/(0.391+H))
      FRN2=P/(T1)**2*(9.+350.*H*EXP(-6.142*((1./T1)**.333-1.)))
      TERM1=2.*OM*OM/VEL*(FRO2*MUO2)/(OM*OM+FRO2*FRO2)
      TERM2=2.*OM*OM/VEL*(FRN2*MUN2)/(OM*OM+FRN2*FRN2)
        V=7.318E-2*T1**1.5/(T+110.4)
      TERM3=OM*OM*(B*(T/295.)**.5)*1.E-12/P
      ALPHA=(TERM1+TERM2+TERM3)
        ABDBM=ALPHA*8.686
C       AB1(I)=(AB1(I)-8.686*(TERM2+TERM3))*VEL/F(I)
C       ABDBM=(ABDBM-8.686*(TERM2+TERM3))*VEL/F(I)
        WRITE(6,20)CF,AB1(I),ABDBM
30      FORMAT(1X,/,2X,'STANDARD DEVIATION =',F10.6,2X,
     2  /,2X,'PARAMETER A =',F6.2,' HZ',5X,'B =',F6.2)
20      FORMAT(2X,F10.1,10X,F10.5,10X,F10.5,10X,F10.5)
150     DEV=DEV+((AB1(I)-ABDBM)/ABDBM)**2
200     SDEV=SQRT(DEV/FLOAT(K-1))
        WRITE(6,30)SDEV,A,B
        WRITE(6,31)H
31      FORMAT(1X,'ABSOLUTE HUMIDITY = ',E15.6)
        GO TO 1
        END
```

```
         SUBROUTINE TUBEC(T,V,F,ALFAP,DALFA)
C        THIS PROGRAM COMPUTES TUBE ABSORPTION
       IMPLICIT REAL*8 (A-H,O-Z)
         DIMENSION ARX(3),AIX(3),BF0R(3),BF0I(3)
         DIMENSION RBR(3),RBI(3),BF1R(3),BF1I(3)
       SQRTF(X)=DSQRT(X)
       COSF(X)=DCOS(X)
       SINF(X)=DSIN(X)
       EXPF(X)=DEXP(X)
1       FORMAT(2D)
2       FORMAT(1D)
       AF=2.D0*3.1416D0*1000.D0*F
        CV=2.5D0
        W=28.966D0
        ACS=0.8D0
        ACT=0.6D0
        P=760D0
        R=12.7D0
       RTM=8.3144D7*T/W
        GAMA=1.D0+1.D0/CV
       SRTMG=SQRTF(RTM*GAMA)
       PDN=1.3332D3*P
       VOD=V*RTM/PDN
       URN=VOD*(9.D0*GAMA-5.D0)/4.D0
       AR=1.3333D0*VOD*URN
        AI=-RTM*URN/AF
        BR=-RTM*GAMA
        BI=-AF*(URN+1.33333D0*VOD)
       AB=2.D0*(AR*AR+AI*AI)
       ABR=-(BR*AR+BI*AI)/AB
       ABI=-(BI*AR-BR*AI)/AB
       ARAR=AR*AR+AI*AI
       FR=ABR*ABR-ABI*ABI+AF*AF*AR/ARAR
       FI=2.D0*ABR*ABI-AF*AF*AI/ARAR
       FRI=SQRTF(FR*FR+FI*FI)
       IF(FI) 11,12,12
11     GR=-SQRTF((FRI+FR)/2.D0)
       GO TO 13
12     GR=SQRTF((FRI+FR)/2.D0)
13     GI=SQRTF((FRI-FR)/2.0D0)
       RL2=ABR+GR
       FI2=ABI+GI
       RL1=ABR-GR
       FI1=ABI-GI
       ATM=P/760.D0
       RF=SRTMG/AF
       RFS=RF*RF
       G1SR=RL1*RFS
       G1SI=FI1*RFS
       G2SR=RL2*RFS
       G2SI=FI2*RFS
       PP=R/RF
       RW=SRTMG*SRTMG/(VOD*AF)
        SQIGI=0.0D0
       SQIGR=URN/VOD
       G1SAV=G1SR*G1SR+G1SI*G1SI
       BET1R=G1SI/G1SAV-SQIGR/RW
       BET1I=G1SR/G1SAV-SQIGI/RW
       G2SAV=G2SR*G2SR+G2SI*G2SI
       BET2R=G2SI/G2SAV-SQIGR/RW
       BET2I=G2SR/G2SAV-SQIGI/RW
       FKPA=F/ATM
        CG=GAMA
       TC=(CG-1.D0)/CG
       TB=(9.D0*CG-5.D0)/4.D0
       TK=13.3339D0*(1.D0/SQRTF(CG)+TC*SQRTF(TB))*SQRTF(V)/R
       TA=TK*SQRTF(F/P)
       FSV=SQRTF(8.3144D3*CG*T/W)
       DELV=TK*FSV*FSV*.0018323D0/SQRTF(F*P)
       CA=(1.333333D0+TC*TB)*V*SQRTF(W/T)
       CA=14.106D0*CA*F*F/(P*SQRTF(CG*CG*CG))
       VEL=(FSV-DELV)*100.D0
       TV=VEL
       ALPHA=(TA+CA)/8.686D0
       TCA=TA+CA
       ALFA=ALPHA
       PCR=+ALPHA
       PCI=AF/VEL
       PC2R=PCR*PCR-PCI*PCI
       PC2I=2.D0*PCR*PCI
7      Z1I=PC2I-AF/VOD
       ARAR=SQRTF(PC2R*PC2R+Z1I*Z1I)
       AR1R=-R*SQRTF((PC2R+ARAR)*.5D0)
       AR1I=R*SQRTF((-PC2R+ARAR)*.5D0)
       Z3R=PC2R-RL2
       Z3I=PC2I-FI2
       ARAR=SQRTF(Z3R*Z3R+Z3I*Z3I)
       AR3R=-R*SQRTF(.5D0*(ARAR+Z3R))
       AR3I=R*SQRTF(.5D0*(ARAR-Z3R))
       Z2R=PC2R-RL1
       Z2I=PC2I-FI1
       ARAR=SQRTF(Z2R*Z2R+Z2I*Z2I)
       AR2R=R*SQRTF(.5D0*(ARAR+Z2R))
       AR2I=R*SQRTF(.5D0*(ARAR-Z2R))
       ARX(1)= AR1R
       ARX(2)= AR2R
       ARX(3)=AR3R
       AIX(1)= AR1I
       AIX(2)= AR2I
       AIX(3)=AR3I
       DO 30 J=1,3
       AR= ARX(J)
       AI= AIX(J)
       AA=SQRTF(AR*AR+AI*AI)
       IF(AA-4.)19,19,25
19     COSX=AR/AA
```

```
      SINX=AI/AA
      COS2X=1.D0-2.D0*SINX*SINX
      SIN2X=2.D0*COSX*SINX
      B1I=AA*SINX/2.D0
      B1R=AA*COSX/2.D0
      F1H=AA/2.D0
      DO 20 I=1,30
      X=I
      COSPX=COSX
      COSX=COSX*COS2X-SINX*SIN2X
      SINX=SINX*COS2X+COSPX*SIN2X
      F1H=-F1H*AA*AA/(4.D0*X*(X+1.D0))
      B11R=COSX*F1H
      B1R=B1R+B11R
      B11I=SINX*F1H
      B1I=B1I+B11I
      IF(F1H*F1H-.00000001)21,21,20
20    CONTINUE
21    COSX=AR/AA
      SINX=AI/AA
      COS2X=1.D0-2.D0*SINX*SINX
      SIN2X=2.D0*COSX*SINX
      COSX=COS2X
      SINX=SIN2X
      F0H=-AA*AA/4.D0
      B0R=1.D0-AA*AA*COSX/4.D0
      B0I=-AA*AA*SINX/4.D0
      DO 22 I=2,30
      X=I
      F0H=-F0H*AA*AA/(4.D0*X*X)
      COSXP=COSX
      COSX=COSX*COS2X-SINX*SIN2X
      SINX=SINX*COS2X+COSXP*SIN2X
      B01R=F0H*COSX
      B01I=F0H*SINX
      B0R=B0R+B01R
      B0I=B0I+B01I
      IF(F0H*F0H-.00000001)23,22,22
22    CONTINUE
23    GO TO 26
25    AR=-AR
      AI=-AI
      SRZR=SQRTF(.5D0*(AA+AR))
      SRZI=-SQRTF(.5D0*(AA-AR))
 18     AA2=AA*AA
        AA3=AA2*AA
        AA4=AA2*AA2
        AA5=AA4*AA
        AA6=AA4*AA2
      C1R=.7978846D0*SRZR/AA
      C1I=-.7978846D0*SRZI/AA
      ARSR=AR*AR-AI*AI
        ARSR=ARSR/AA2
      ARSI=2.D0*AR*AI
        ARSI=ARSI/AA2
      ARCR=AR*ARSR-AI*ARSI
        ARCR=ARCR/AA
      ARCI=AI*ARSR+AR*ARSI
        ARCI=ARCI/AA
      ARFR=ARSR*ARSR-ARSI*ARSI
        ARFR=ARFR/AA
      ARFI=2.D0*ARSR*ARSI
        ARFI=ARFI/AA
      ARPR=ARFR*AR-ARFI*AI
        ARPR=ARPR/AA
      ARPI=ARFR*AI+ARFI*AR
        ARPI=ARPI/AA
      ARHR=ARCR*ARCR-ARCI*ARCI
        ARHR=ARHR/AA
      ARHI=2.D0*ARCR*ARCI
        ARHI=ARHI/AA
      CBR1=1.D0+.117188D0*ARSR/AA2-.14420D0*ARFR/AA4
      CBR1=CBR1+.67659279D0*ARHR/AA6
      CBI1=-.117188D0*ARSI/AA2+.14420D0*ARFI/AA4
      CBI1=CBI1-.67659279D0*ARHI/AA6
      SBR1=.375D0*AR/AA2-.10254D0*ARCR/AA3+.27758D0*ARPR/AA5
      SBI1=-.375D0*AI/AA2+.10254D0*ARCI/AA3-.27758D0*ARPI/AA5
      A1=COSF(AR-2.356195D0)
      A2=SINF(AR-2.356195D0)
        IF(AI.LT.40.) GO TO 201
        EP=1.0D0
        EN=0.0D0
201     IF(AI.GT.-40.) GO TO 202
        EP=0.0D0
        EN=1.0D0
        GO TO 203
202     EP=EXPF(AI)
        EN=EXPF(-AI)
203     CONTINUE
      CFR1=A1*(EP+EN)/2.D0
      CFI1=-A2*(EP-EN)/2.D0
      SFR1=A2*(EP+EN)/2.D0
      SFI1=A1*(EP-EN)/2.D0
      B=C1R*CBR1*CFR1-C1R*CBI1*CFI1-C1I*CBR1*CFI1-C1I*CBI1*CFR1
      B1R=B-C1R*SBR1*SFR1+C1R*SBI1*SFI1+C1I*SBR1*SFI1+C1I*SBI1*SFR1
      B1=C1I*CBR1*CFR1+C1R*CBI1*CFR1+C1R*CBR1*CFI1-C1I*CBI1*CFI1
      B1I=B1-C1I*SBR1*SFR1-C1R*SBI1*SFR1-C1R*SBR1*SFI1+C1I*SBI1*SFI1
      CBR0=1.D0-.0703125D0*ARSR/AA2+.112152D0*ARFR/AA4
      CBR0=CBR0-.572501D0*ARHR/AA6
      CBI0=+.0703125D0*ARSI/AA2-.112152D0*ARFI/AA4
      CBI0=CBI0+.572501D0*ARHI/AA6
      SBR0=-.125D0*AR/AA2+.073242D0*ARCR/AA3-.227108D0*ARPR/AA5
      SBI0=.125D0*AI/AA2-.073242D0*ARCI/AA3+.227108D0*ARPI/AA5
      A5=COSF(AR-.7853982D0)
      A6=SINF(AR-.7853982D0)
```

```
      CFR0=A5*(EP+EN)/2.D0
      CFI0=-A6*(EP-EN)/2.D0
      SFR0=A6*(EP+EN)/2.D0
      SFI0=A5*(EP-EN)/2.D0
      B0R=C1R*CBR0*CFR0-C1R*CBI0*CFI0-C1I*CBR0*CFI0-C1I*CBI0*CFR0
      B0R=B0R-C1R*SBR0*SFR0+C1R*SBI0*SFI0+C1I*SBR0*SFI0+C1I*SBI0*SFR0
      B0I=-C1I*CBI0*CFI0+C1R*CBR0*CFI0+C1R*CBI0*CFR0+C1I*CBR0*CFR0
      B0I=B0I+C1I*SBI0*SFI0-C1R*SBR0*SFI0-C1R*SBI0*SFR0-C1I*SBR0*SFR0
      B1R=-B1R
      B1I=-B1I
26    BF1R(J)=B1R
      BF1I(J)=B1I
      BF0R(J)=B0R
      BF0I(J)=B0I
      D1=BF0R(J)*BF0R(J)+BF0I(J)*BF0I(J)
      RBR(J)=(BF1R(J)*BF0R(J)+BF1I(J)*BF0I(J))/D1
30    RBI(J)=(BF1I(J)*BF0R(J)-BF1R(J)*BF0I(J))/D1
      DEL=SQRTF(3.1416D0*GAMA*.5D0)/(RP*RW)
      DELS=DEL*(2.D0-ACS)/ACS
      DELT=DEL*4.5D0*(2.D0-ACT)/ACT
      DELTD=(SQIGR+3.5D0)*(SQIGR+3.5D0)+SQIGI*SQIGI
      DELTR=DELT*(SQIGR*(SQIGR+3.5D0)+SQIGI*SQIGI)/DELTD
      DELTI=DELT*(SQIGI*(SQIGR+3.5D0)-SQIGR*SQIGI)/DELTD
      D11R=1.D0-DELS*(AR1R*RBR(1)-AR1I*RBI(1))
      D11I=-DELS*(AR1I*RBR(1)+AR1R*RBI(1))
      SD12R=AR3R*RBR(3)-AR3I*RBI(3)
      SD12I=AR3R*RBI(3)+AR3I*RBR(3)
      D12R=1.D0-(DELTR*SD12R-DELTI*SD12I)
      D12I=-DELTR*SD12I-DELTI*SD12R
      AR2AV=AR2R*AR2R+AR2I*AR2I
      SD13R=(BET1R*RBR(2)-BET1I*RBI(2))*RP/AR2AV
      SD13I=(BET1R*RBI(2)+BET1I*RBR(2))*RP/AR2AV
      D13R=SD13R*AR2R+SD13I*AR2I
      D13I=-SD13R*AR2I+SD13I*AR2R
      SD1R=D11R*D12R-D11I*D12I
      SD1I=D11R*D12I+D11I*D12R
      D1R=SD1R*D13R-SD1I*D13I
      D1I=SD1R*D13I+SD1I*D13R
      D21R=1.D0-DELS*(AR3R*RBR(3)-AR3I*RBI(3))
      D21I=-DELS*(AR3R*RBI(3)+AR3I*RBR(3))
      SD22R=AR2R*RBR(2)-AR2I*RBI(2)
      SD22I=AR2R*RBI(2)+AR2I*RBR(2)
      D22R=1.D0-(DELTR*SD22R-DELTI*SD22I)
      D22I=-DELTR*SD22I-DELTI*SD22R
      AR1AV=AR1R*AR1R+AR1I*AR1I
      SD23R=(BET2R*RBR(1)-BET2I*RBI(1))*RP/AR1AV
      SD23I=(BET2R*RBI(1)-BET2I*RBR(1))*RP/AR1AV
      D23R=SD23R*AR1R+SD23I*AR1I
      D23I=-SD23R*AR1I+SD23I*AR1R
      SD2R=D22R*D23R-D22I*D23I
      SD2I=D22R*D23I+D22I*D23R
      D2R=SD2R*D21R-SD2I*D21I
      D2I=SD2I*D21R+SD2R*D21I
      D31R=1.D0-DELS*(AR2R*RBR(2)-AR2I*RBI(2))
      D31I=-DELS*(AR2R*RBI(2)+AR2I*RBR(2))
      SD32R=AR3R*RBR(3)-AR3I*RBI(3)
      SD32I=AR3I*RBR(3)+AR3R*RBI(3)
      D32R=1.D0-(DELTR*SD32R-DELTI*SD32I)
      D32I=-DELTI*SD32R-DELTR*SD32I
      SD33R=(BET1R*RBR(1)-BET1I*RBI(1))*RP/AR1AV
      SD33I=(BET1R*RBI(1)+BET1I*RBR(1))*RP/AR1AV
      D33R=AR1R*SD33R+AR1I*SD33I
      D33I=AR1R*SD33I-AR1I*SD33R
      SD3R=D33R*D32R-D33I*D32I
      SD3I=D33R*D32I+D33I*D32R
      D3R=SD3R*D31R-SD3I*D31I
      D3I=SD3R*D31I+SD3I*D31R
      DR=D1R+D2R-D3R
      DI=D1I+D2I-D3I
      E1R=D1R
      E1I=D1I
      E21R=D11R
      E21I=D11I
      E22R=D22R
      E22I=D22I
      SE23R=(AR3R*RBR(3)-AR3I*RBI(3))/RP
      SE23I=(AR3I*RBR(3)+AR3R*RBI(3))/RP
      E23R=SE23R*BET2R-SE23I*BET2I
      E23I=SE23R*BET2I+SE23I*BET2R
      SE2R=E23R*E22R-E23I*E22I
      SE2I=E23R*E22I+E23I*E22R
      E2R=E21R*SE2R-E21I*SE2I
      E2I=E21R*SE2I+E21I*SE2R
      ER=E1R*G1SR-E1I*G1SI+E2R
      EI=E1R*G1SI+E1I*G1SR+E2I
      GSR=(ER*DR+EI*DI)/(DR*DR+DI*DI)
      GSI=(EI*DR-ER*DI)/(DR*DR+DI*DI)
      PC2PR=GSR/RFS
      PC2PI=GSI/RFS
      ARAR=SQRTF(PC2PR*PC2PR+PC2PI*PC2PI)
      PCPR=SQRTF(.5D0*(PC2PR+ARAR))
      PCPI=SQRTF(.5D0*(-PC2PR+ARAR))
      VELP=AF/PCPI
      ALFAP=PCPR
       EIV=(VELP-VEL)/VEL
       EIA=(ALFAP-ALPHA)/ALPHA
      VEL=VELP
      ALPHA=ALFAP
      PC2R=PC2PR
      PC2I=PC2PI
      IF(EIV*EIV-.00000001)41,40,40
40    GO TO 7
41    IF(EIA*EIA-.000004)43,42,42
42    GO TO 7
43     DALFA=(ALFAP-FI1*RF/2.D0)*8.686D0
1010    FORMAT(1X,5D15.6)
        RETURN
99    CONTINUE
      END
```

B.3 Subroutine AIRAB Used to Compute Pure Tone Absorption Coefficients

```
      SUBROUTINE AIRAB (P,T,RH,CF,ABDBM)
C     THIS PROGRAM CALCULATES THE ABSORPTION OF SOUND IN AIR AS A
C     FUNCTION OF TEMPERATURE, HUMIDITY, PRESSURE, AND FREQUENCY.
C     THE PROGRAM SHOULD NOT BE USED OUTSIDE THE TEMPERATURE RANGE
C     OF 0 DEGREES F (-20 DEGREES C) THROUGH 104 DEGREES F
C     (40 DEGREES C)
C     ABDBM = AMPLITUDE ABSORPTION COEFFICIENT IN DB/ METER
C     ABDBSC = AMPLITUDE ABSORPTION COEFFICIENT IN DB/SECONDS
C     ABDBTF = AMPLITUDE ABSORPTION COEFFICIENT IN DB/1000FEET
C     AFLAM = AMPLITUDE ABSORPTION COEFFICIENT PER WAVELENGTH IN NEPERS
C     ALPHA = AMPLITUDE ABSORPTION COEFFICIENT IN NEPERS PER METER
C     CF = ACOUSTIC FREQUENCY
C     P = AMBIENT PRESSURE IN ATMOSPHERES
C     PS = SATURATED VAPOR PRESSURE FOR WATER IN ATMOSPHERES
C     T = TEMPERATURE IN DEGREES KELVIN
C     TC = TEMPERATURE IN DEGREES CENTIGRADE
C     TF = TEMPERATURE IN DEGREES FAHRENHEIT
C     WAVEL = WAVELENGTH OF SOUND WAVE
      REAL MUO2,MUN2
        PI=3.14159
      T1=T/293.
      TC=T-273.
      TF = TC*1.8+32.
      VEL=343.4*SQRT(T1)
      VELFPS = VEL*3.28
        T01=273.16
        PS=10.79586*(1.-T01/T)-5.02808*ALOG10(T/T01)+1.50474E-4*(1.-
     2  10.**-(8.29692*((T/T01)-1.)))+0.42873E-3*(10.**(4.76955*
     3  (1.-(T01/T)))-1.)-2.2195983
        PS=10.**PS
      H=PS/P*RH
      FRO2=P*(24.+4.41E04*H*(0.05+H)/(0.391+H))
      FRN2=P/SQRT(T1)*(9.+350.*H*EXP(-6.142*((1./T1)**.333-1.)))
        ALPHA=1.84E-11+2.1913E-4/T1*P*(2239.1/T)**2*EXP(-2239.1/T)
     2  /(FRO2+(CF**2/FRO2))
        ALPHA=ALPHA+8.1619E-4/T1*P*(3352./T)**2*EXP(-3352./T)
     2  /(FRN2+(CF**2/FRN2))
        ALPHA=ALPHA*SQRT(T1)*CF**2/P
      WAVEL=VEL/CF
      AFLAM=ALPHA*WAVEL
      ABDBTF =ALPHA*2647.
      ABDBM =ALPHA*8.6860
      ABDBSC =ALPHA*VEL*8.686
        CONTINUE
      RETURN
        END
```

B.4 Programs Used to Compute Band Loss Coefficients

The following programs perform the integration required in equation 6.5 or 6.33 depending on whether the slope of the input spectrum (SB) or received spectrum (SBP) is known. A brief description of the terms used follows.

Subroutine SPCTRM (SB, RF, M)

where

SB = slope of input spectrum/bandwidth (db/bandwidth) = change in spectrum level over the band of interest

RF = r = ratio of center frequencies for successive band $r = 2^{1/3}$ for 1/3 octave bands

M = slope parameter returned by the subroutine (equation 5.13)

For the purposes of this report, we will assume SB, hence M, is a constant over the band. However, for other applications, one might want to allow M to be a function of F. Subroutine SPCTRM requires as input WI, FI, SB, and F and returns M.

```
SUBROUTINE SPCTRM(SB,RF,FI,F,M,WJO)
REAL M
M=SB/(10.*ALOG10(RF))
WJO=(F/FI)**(M-1.)
RETURN
END
```

Subroutine ABSORP (FJ, T, RH, R, RF, B, N, AJ)

where

FJ = lower frequency of the band segment under consideration, Hz

F = any frequency in the band, Hz

T = temperature, °K

RH = relative humidity in percent

R = propagation distance, m

RF = r = ratio of center frequencies for successive bands, $r = 2^{1/3}$ for 1/2 octave bands

B = number of segments into which the band is divided

N = slope parameter for the absorption curve

AJ = atmospheric transmission at $f_j = 10^{-a(f_j)R/10}$

Subroutine ABSORP is based on the theory and measurements described earlier in this report and calls subroutine AIRAB which computes pure tone absorption coefficients. The subroutine requires as input FJ, T, RH, R, RF, and B and returns N and AJ using equations 6.14 and 6.18.

```
      SUBROUTINE ABSORP(FJ,T,RH,R,RF,B,N,AJ)
C     THIS SUBROUTINE USES SUBROUTINE AIRAB
C     FJ1=F(J+1)
      REAL N
      FJ1=FJ*RF**(1./B)
      CALL AIRAB(1.,T,RH,FJ,ALFJ)
      CALL AIRAB(1.,T,RH,FJ1,ALFJ1)
      N=(ALFJ1-ALFJ)*R/((10./B)*ALOG10(RF))
      AJ=10.**(-ALFJ*R/10.)
      RETURN
      END
```

Subroutine FILTR (FI,RF, B, FJ, K, TJ)

where

FI = center frequency of the band under consideration, Hz

K = slope parameter for the filter under consideration (equation 6.23)

TJ = transmission of filter at frequency f_j

Subroutine FILTR will depend upon the type of filter employed. For a perfect filter, we can set K = 0 and TJ = 1 for $f_i\sqrt{3} > f > f_i/\sqrt{3}$ and TJ = 0 outside these limits. For a more realistic filter, a description such as that given in equation 6.21 is required. In this report, we will be concerned primarily with an ANSI Class III 1/3 Octave Band Filter described by equation 6.21 or a perfect 1/3 octave band filter described by equation 6.20. For other types of filters, subroutine FILTR can be written accordingly.

```
      SUBROUTINE FILTR(FI,FJ,RF,B,K,TJ)
C     THIS SUBROUTINE USES SUBROUTINE FILTER
C     FJ1=F(J+1)
      REAL K
      FJ1=FJ*RF**(1./B)
      CALL FILTER(FI,FJ,TJ)
      CALL FILTER(FI,FJ1,TJ1)
      K=ALOG10(TJ1/TJ)/(10.*ALOG10(RF)/B)
      RETURN
      END
```

```
      SUBROUTINE FILTER(FI,F,T)
      T=1.
C     COMMENT NEXT SIX STATEMENTS FOR PERFECT FILTER
C     IF(F.LT..9*FI.AND.F.GE..2*FI)T=(8./13.+
C    2  2500.*(F/FI-FI/F)**6)
C     IF(F.LE.5.*FI.AND.F.GT.FI/.9)T=(8./13.+
C    2  2500.*(F/FI-FI/F)**6)
C     IF(F.LT.FI/5..OR.F.GT.5.*FI)T=10.**-7.5
      T=1./T
C     COMMENT NEXT STATEMENT FOR REAL FILTER
      IF(F.GE.FI*1.1225.OR.F.LT.FI/1.1225)T=1.0E-10
      RETURN
      END
```

Subprogram BANDL (FI, R, RH, T, RF, SB, BL, DELTA, CODE)

Where

BL = band loss in db = ΔL_i

DELTA = difference between band loss and absorption of a pure tone at band center = $\Delta L_i - a(f_i)R$

CODE = a flag to indicate if the integral converged

The terms FI, R, RH, T, RF, and SB must be read in or supplied by a driver program. The subroutine calculates the band loss BL and DELTA when the source spectrum slope is known by evaluating equations 6.27, 6.28 and 6.29. First, the sums are evaluated setting $f_i = f_i/\sqrt{r}$ and working up to $f_{b+1} = f_i\sqrt{r}$. For convenience let us call the sum

$$\sum_{j=1}^{b} B_j(R), \text{ BI and } \sum_{j=1}^{b} B_j(0), \text{ BOI.}$$

Next, the sums are extended one segment at a time to include the filter wings until the contribution from any one segment gives BJ < 10^{-4}BOI. If the filter is down to the noise floor (75 db) before this condition occurs, CODE is set equal to 1 which indicates measurements under these conditions can not be considered valid since filter noise contributes significantly to the measured result.

```
      SUBROUTINE BANDL(FI,R,RH,T,RF,SB,BL,DELTA,CODE)
C     THIS ROUTINE NUMERICALLY INTEGRATES TO FIND THE BAND LOSS IN DB
C     THE ROUTINE REQUIRES SUBROUTINES ABSORP,SPCTRM,FILTR,AND
C     AIRAB
      REAL M,N,K
      CODE=0.0
      B=20.
      BJ=0.
      BOJ=0.
      IB=B
      DO 10 J=1,IB
      FJ=FI*RF**((J-1)/B)/RF**.5
      CALL FILTR(FI,FJ,RF,B,K,TJ)
      CALL SPCTRM(SB,RF,FI,FJ,M,WJO)
100   FORMAT(1X,3E15.6)
      CALL ABSORP(FJ,T,RH,R,RF,B,N,AJ)
      IF(M-N+K.EQ.0.)GO TO 3
      BJ=BJ+AJ*WJO*FJ*TJ/(M-N+K)*(RF**((M-N+K)/B)-1.)
      GO TO 5
3     BJ=BJ+AJ*WJO*TJ*FJ*ALOG(RF)/B
5     IF(M+K.EQ.0.)GO TO 8
      BOJ=BOJ+TJ*WJO*FJ/(M+K)*(RF**((M+K)/B)-1.)
      GO TO 10
8     BOJ=BOJ+TJ*WJO*FJ*ALOG(RF)/B
10    CONTINUE
C     COMMENT THE NEXT CARD FOR A REAL FILTER.
      GO TO 70
C     THE VARIABLES SUMOJ,SUMJ,DUM1,AND DUM2 ARE WORKING
C     VARIABLES AND HAVE NO COUNTERPART IN THE THEORY SECTION.
      SUMOJ=0.
      SUMJ=0.
C     NOW SUM OVER THE LOWER FILTER SKIRT
      DO 20 J=1,300
      FJ=(FI/SQRT(RF))/RF**(J/B)
      CALL FILTR(FI,FJ,RF,B,K,TJ)
C     TEST TO SEE IF THE NOISE FLOOR OF THE FILTER HAS BEEN REACHED.
      IF(TJ.LE.10.**(-7.5))GO TO 30
      CALL SPCTRM(SB,RF,FI,FJ,M,WJO)
      CALL ABSORP(FJ,T,RH,R,RF,B,N,AJ)
      IF(M-N+K.NE.0.)DUM1=WJO*AJ*FJ*TJ/(M-N+K)*(RF**((M-N+K)/B)-1.)
      IF(M-N+K.EQ.0.)DUM1=AJ*WJO*TJ*FJ*ALOG(RF)/B
      IF(M+K.NE.0.)DUM2=TJ*WJO*FJ/(M+K)*(RF**((M+K)/B)-1.)
      IF(M+K.EQ.0.)DUM2=TJ*WJO*FJ*ALOG(RF)/B
C     TEST CONVERGENCE
      IF(DUM1.GT.1.0E-3*BJ)GO TO 15
      IF(DUM2.GT.1.0E-3*BOJ)GO TO 15
      GO TO 40
15    SUMJ=SUMJ+DUM1
20    SUMOJ=SUMOJ+DUM2
C     SET CODE=1 IF NOISE FLOOR REACHED BEFORE CONVERGENCE
30    CODE=1.
C     NOW SUM OVER UPPER FILTER SKIRT
40    DO 50 J=1,300
      FJ=(FI*SQRT(RF))*RF**(J/B)
      CALL FILTR(FI,FJ,RF,B,K,TJ)
C     TEST TO SEE IF THE NOISE FLOOR OF THE FILTER HAS BEEN REACHED
      IF(TJ.LE.10.**(-7.5))GO TO 60
      CALL SPCTRM(SB,RF,FI,FJ,M,WJO)
      CALL ABSORP(FJ,T,RH,R,RF,B,N,AJ)
      IF(M-N+K.NE.0.)DUM1=AJ*WFO*FJ*TJ/(M-N+K)*(RF**((M-N+K)/B)-1.)
      IF(M-N+K.EQ.0.)DUM1=AJ*WFO*TJ*FJ*ALOG(RF)/B
      IF(M+K.NE.0.)DUM2=TJ*WFO*FJ/(M+K)*(RF**((M+K)/B)-1.)
      IF(M+K.EQ.0.)DUM2=TJ*WFO*FJ*ALOG(RF)/B
C     TEST CONVERGENCE
      IF(DUM1.GT.1.0E-03*BJ)GO TO 45
      IF(DUM2.GT.1.0E-3*BOJ)GO TO 45
      GO TO 70
45    SUMJ=SUMJ+DUM1
50    SUMOJ=SUMOJ+DUM2
C     SET CODE=1 IF NOISE FLOOR REACHED BEFORE CONVERGENCE
60    CODE=1.
70    BJ=BJ+SUMJ
      BOJ=BOJ+SUMOJ
      BL=-10.*ALOG10(BJ/BOJ)
      CALL AIRAB(1.,T,RH,FI,ALF)
      DELTA=BL-ALF*R
      RETURN
      END
```

Subprogram BANDLP (FI, R, RH, T, RF, SB, BL, DELTA, CODE)

where

SB = slope of received spectrum level in db/ 1/3 octave

and the other terms are defined above. The subroutine calculates the band loss BL and DELTA when the received spectrum slope is known.

```
      SUBROUTINE BANDLP(FI,R,RH,T,RF,SB,BL,DELTA,CODE)
C     THIS ROUTINE NUMERICALLY INTEGRATES TO FIND THE BAND LOSS IN DB
C     THE ROUTINE REQUIRES SUBROUTINES ABSORP,SPCTRM,FILTR,AND
C     AIRAB
      REAL M,N,K
      CODE=0.0
      B=10.
      BJ=0.
      BJO=0.
      IB=B
      DO 10 J=1,IB
      FJ=FI*RF**((J-1)/B)/RF**.5
      CALL FILTR(FI,FJ,RF,R,K,TJ)
      CALL SPCTRM(SB,RF,FI,FJ,Q,WJO)
100   FORMAT(1X,4E15.6)
      CALL ABSORP(FJ,T,RH,R,RF,B,N,AJ)
      IF(Q+N+K.EQ.0.)GO TO 3
      BJO=BJO+WJO/AJ*FJ*TJ/(Q+N+K)*(RF**((Q+N+K)/B)-1.)
      GO TO 5
3     BJO=BJ+WJO/AJ*TJ*FJ*ALOG(RF)/B
5     IF(M+K.EQ.0.)GO TO 8
      BJ=BJ+TJ*WJO*FJ/(Q+K)*(RF**((Q+K)/B)-1.)
      GO TO 9
8     BJ=BJ+TJ*WJO*FJ*ALOG(RF)/B
9     AL=-10.*ALOG10(BJ/BJO)
10    CONTINUE
C     COMMENT THE FOLLOWING CARD FOR A REAL FILTER
      GO TO 75
C     THE VARIABLES SUMOJ,SUMJ,DUM1,AND DUM2 ARE WORKING
C     VARIABLES AND HAVE NO COUNTERPART IN THE THEORY SECTION.
      SUMOJ=0.
      SUMJ=0.
C     NOW SUM OVER THE LOWER FILTER SKIRT
      DO 20 J=1,300
      FJ=(FI/SQRT(RF))/RF**(J/B)
      CALL FILTR(FI,FJ,RF,R,K,TJ)
C     TEST TO SEE IF THE NOISE FLOOR OF THE FILTER HAS BEEN REACHED.
C     IF(TJ.LE.10.**(-7.5))GO TO 40
      IF(TJ.LE.10.**(-7.5))GO TO 30
      CALL SPCTRM(SB,RF,FI,FJ,Q,WJO)
      CALL ABSORP(FJ,T,RH,R,RF,B,N,AJ)
      IF(Q+N+K.NE.0.)DUM1=WJO/AJ*FJ*TJ/(Q+N+K)*(RF**((Q+N+K)/B)-1.)
      IF(Q+N+K.EQ.0.)DUM1=WJO/AJ*TJ*FJ*ALOG(RF)/B
      IF(Q+K.NE.0.)DUM2=TJ*WJO*FJ/(Q+K)*(RF**((Q+K)/B)-1.)
      IF(Q+K.EQ.0.)DUM2=TJ*WJO*FJ*ALOG(RF)/B
C     TEST CONVERGENCE
      IF(DUM1.GT.1.0E-3*BJO)GO TO 15
      IF(DUM2.GT.1.0E-3*BJ)GO TO 15
      GO TO 40
15    SUMJ=SUMJ+DUM2
20    SUMOJ=SUMOJ+DUM1
C     SET CODE=1 IF NOISE FLOOR REACHED BEFORE CONVERGENCE
30    CODE=1.
C     NOW SUM OVER UPPER FILTER SKIRT
40    DO 50 J=1,300
      FJ=(FI*SQRT(RF))*RF**(J/B)
      CALL FILTR(FI,FJ,RF,R,K,TJ)
C     TEST TO SEE IF THE NOISE FLOOR OF THE FILTER HAS BEEN REACHED
C     IF(TJ.LE.10.**(-7.5))GO TO 70
      IF(TJ.LE.10.**(-7.5))GO TO 60
      CALL SPCTRM(SB,RF,FI,FJ,Q,WJO)
      CALL ABSORP(FJ,T,RH,R,RF,B,N,AJ)
      IF(Q+N+K.NE.0.)DUM1=WJO/AJ*FJ*TJ/(Q+N+K)*(RF**((Q+N+K)/B)-1.)
      IF(Q+N+K.EQ.0.)DUM1=WJO/AJ*TJ*FJ*ALOG(RF)/B
      IF(Q+K.NE.0.)DUM2=TJ*WJO*FJ/(Q+K)*(RF**((Q+K)/B)-1.)
      IF(Q+K.EQ.0.)DUM2=TJ*WJO*FJ*ALOG(RF)/B
C     TEST CONVERGENCE
      IF(DUM1.GT.1.0E-03*BJO)GO TO 45
      IF(DUM2.GT.1.0E-3*BJ)GO TO 45
      GO TO 70
45    SUMJ=SUMJ+DUM2
50    SUMOJ=SUMOJ+DUM1
C     SET CODE=1 IF NOISE FLOOR REACHED BEFORE CONVERGENCE
60    CODE=1.
70    BJ=BJ+SUMJ
      BJO=BJO+SUMOJ
75    BL=-10.*ALOG10(BJ/BJO)
      CALL AIRAB(1.,T,RH,FI,ALF)
      DELTA=BL-ALF*R
      RETURN
      END
```

Driver Programs:

Various driver programs using the subroutines above were developed for special purposes in this study. There were three driver programs most frequently used. The first of these generates tables of band loss coefficients in terms of the source spectrum slope. This program, as does all those which follow, requires no input. The program internally increments temperature, relative humidity, and propagation distance and produces tables such as those shown in Appendix C.

```
C         PROGRAM TO CALCULATE ABSORPTION OF A BAND OF NOISE.
C         INPUT REQUIRED INCLUDES RELATIVE HUMIDITY,TEMPERATURE,
C         SOURCE ROLLOFF,AND PROPAGATION DISTANCE.
C         STEP FUNCTION TO GENERATE CENTER FREQUENCIES OF 1/3 OCTAVE BANDS
          INTEGER STEP(10),DECADE
          DIMENSION ALOSS(9),DIST(8)
          DIST(1)=5.
          DIST(2)=10.
          DIST(3)=20.
          DIST(4)=50.
          DIST(5)=100.
          DIST(6)=200.
          DIST(7)=400.
          DIST(8)=720.
          STEP(6)=1250000
          STEP(7)=1600000
          STEP(8)=2000000
          STEP(9)=2500000
          STEP(10)=3150000
          STEP(1)=400000
          STEP(2)=500000
          STEP(3)=630000
          STEP(4)=800000
          STEP(5)=1000000
          ICOUNT=0
          T=277.59
C         DO 25 IIII=1,3
C         T=T+25.
          RH=10.
C         DO 25 I=1,3
C         RH=RH+50.
          SB=-6.
          DO 25 II=1,5
          SB=SB+2.
          DECADE=1000
          ICOUNT=ICOUNT+1
          IF(ICOUNT.EQ.4)WRITE(6,10)
          IF(ICOUNT.EQ.4)ICOUNT=1
10        FORMAT(1H1)
          TF=9./5.*(T-273.16)+32.
          WRITE(6,1)SB,T,TF,RH
1         FORMAT(1X,'***************************************************',
      1   '********************************',
      2   /,11X,'SB =',F4.1,' DB/THIRD OCTAVE   T = ',F5.1,'K (',F5.1,
      3   'F)   RH =',F5.1,' %',/)
          WRITE(6,2)
2         FORMAT(4X,'FREQ     A(F)',25X,'DISTANCE, M',/,5X,
      2   'HZ      DB/M          5        10        20        50       100       200',
      3   '      400      720')
          RF=2.**(.33333)
          DO 20 J=1,2
          DECADE=DECADE/10
          DO 20 L=1,10
          FI=FLOAT(STEP(L)/DECADE)
          IF(FI.GT.100000.)GO TO 25
          CALL AIRAB(1.,T,RH,FI,ALOSS(1))
          DO 19 III=1,8
          R=DIST(III)
          CALL BANDL(FI,R,RH,T,RF,SB,BL,ALOSS(III+1),CODE)
19        IF(CODE.EQ.1.)ALOSS(III+1)=99.99
          IF(ALOSS(III+1).LT.-99.99)ALOSS(III+1)=99.99
20        WRITE(6,15)FI,(ALOSS(K),K=1,9)
15        FORMAT(1X,F8.0,2X,F6.4,8(2X,F6.2))
25        CONTINUE
          STOP
          END
```

The following program generates tables of band loss correction factors in terms of the received spectrum slope (S_B').

```
C         PROGRAM TC CALCULATE ABSORPTION OF A BANC OF NOISE.
C         INPUT REGUIRED INCLUDES RELATIVE HUMIDITY,TEMPERATURE,
C         SOURCE ROLLOFF,AND PROPAGATION DISTANCE.
C         STEP FUNCTION TO GENERATE CENTER FRECUENCIES OF 1/3 OCTAVE BANDS
          INTEGER STEP(10),DECADE
          DIMENSION ALOSS(9),DIST(8)
          DIST(1)=5.
          DIST(2)=10.
          DIST(3)=20.
          DIST(4)=50.
          DIST(5)=100.
          DIST(6)=200.
          DIST(7)=400.
          DIST(8)=720.
          STEP(6)=1250000
          STEP(7)=1600000
          STEP(8)=2000000
          STEP(9)=2500000
          STEP(10)=3150000
          STEP(1)=400000
          STEP(2)=500000
          STEP(3)=630000
          STEP(4)=800000
          STEP(5)=1000000
          ICOUNT=0
          T=305.37
C         DO 25 IIII=1,3
C         T=T+25.
          RH=90.
C         DO 25 I=1,3
C         RH=RH+50.
          SBP=-10.
          DO 25 II=1,6
          SBP=SBP+2.
          DECADE=1000
          ICOUNT=ICOUNT+1
          IF(ICOUNT.EQ.4)WRITE(6,10)
          IF(ICOUNT.EQ.4)ICOUNT=1
10        FORMAT(1H1)
          TF=9./5.*(T-273.16)+32.
          WRITE(6,1)SBP,T,TF,RH
1         FORMAT(1X,'***********************************************',
        1 '*******************************',
        2 /,11X,'SBP=',F4.0,' DB/THIRD CCTAVF   T = ',F5.1,'K (',F5.1,
        3 'F)   RH =',F5.1,' %',/)
          WRITE(6,2)
2         FORMAT(4X,'FREG    A(F)',25X,'DISTANCE, M',/,5X,
        2 'HZ      DB/M        5       10       20       50      100      200',
        3 '      400      720')
          RF=2.**(.33333)
          DO 20 J=1,2
          DECADE=DECADE/10
          DO 20 L=1,10
          FI=FLCAT(STEP(L)/DECADE)
          IF(FI.GT.10000.)GO TO 25
          CALL ATFAB(1.,T,RH,FI,ALOSS(1))
          DO 19 III=1,8
          R=DIST(III)
          CALL BANDLP(FI,R,RH,T,RF,SBP,BLP,ALOSS(III+1),CODEP)
19        IF(CODEP.EQ.1.)ALOSS(III+1)=99.99
          IF(ALOSS(III+1).LT.-99.99)ALOSS(III+1)=99.99
20        WRITE(6,15)FI,(ALOSS(K),K=1,9)
15        FORMAT(1X,F6.0,2X,F6.4,8(2X,F6.2))
25        CONTINUE
          STOP
          END
```

The third driver program computes differences between attenuation at some temperature and relative humidity and the attenuation over the same propagation path under standard conditions of temperature (T_{ref}) and relative humidity (RH_{ref}). For sample output see Appendix C.

```
C       PROGRAM TC CALCULATE ABSORPTION OF A BAND CF NOISE.
C       INPUT REQUIRED INCLUDES RELATIVE HUMIDITY,TEMPERATURE,
C       SOURCE ROLLCFF,AND PROPAGATION DISTANCE.
C       STEP FUNCTICN TO GENERATE CENTER FREQUENCIES OF 1/3 OCTAVE BANDS
        INTEGER STEF(10),DECADE
        DIMENSICN DIFF(9),DIST(8)
        DIST(1)=5.
        DIST(2)=10.
        DIST(3)=20.
        DIST(4)=5C.
        DIST(5)=100.
        DIST(6)=200.
        DIST(7)=400.
        DIST(8)=720.
        STEP(6)=1250000
        STEP(7)=160C000
        STEP(8)=2000000
        STEP(9)=2500000
        STEP(10)=3150000
        STEP(1)=400000
        STEP(2)=500C00
        STEP(3)=630000
        STEP(4)=800C00
        STEP(5)=100C000
        ICOUNT=0
        RHREF=70.
        TREF=(59.-32.)*5./9.+273.16
        T=277.6
C       CO 25 IIII=1,4
C       T=T+20.
        RH=10.
C       CO 25 I=1,3
C       RH=RH+50.
        SBP=-10.
        CO 25 II=1,6
        SBP=SBP+2.
        DECADE=1000
        ICOUNT=ICCUNT+1
        IF(ICCUNT.EC.4)WRITE(6,10)
        IF(ICCUNT.EC.4)ICOUNT=1
10      FORMAT(1H1)
        TF=9./5.*(T-273.16)+32.
        WRITE(6,1)SBP,T,TF,RH
1       FORMAT(1X,'**************************************************',
     1  '********************************',
     2  /,11X,'SBP=',F4.0,' DB/THIRD CCTAVE   T = ',F5.1,'K (',F5.1,
     3  'F)   RH =',F5.1,' %',/)
        WRITE(6,2)
2       FORMAT(4X,'FREQ   DA(F)',25X,'DISTANCE, M',/,5X,
     2  'HZ      DB/M       5       10       20       5C      100      200',
     3  '      400      720')
        RF=2.**(.33333)
        CO 20 J=1,2
        DECADE=DECACE/10
        CO 20 L=1,1C
        FI=FLCAT(STEP(L)/DECADE)
        IF(FI.GT.10C000.)GO TO 25
        CALL AIRAB(1.,T,RH,FI,ALR)
        CALL AIRAB(1.,TREF,RHREF,FI,ALS)
        DIFF(1)=ALR-ALS
        FIM1=FI/RF
        FIP1=FI*RF
        CALL AIRAB(1.,T,RH,FIP1,ALP1)
        CALL AIRAB(1.,T,RH,FIM1,ALM1)
        CO 19 III=1,8
        R=DIST(III)
        CALL BANDLP(FI,R,RH,T,RF,SBP,BLP,ALOSSP,CCCEP)
        CSLOPE=(ALM1-ALP1)*R/2.
        SB=SBP+CSLOPE
        CALL BANDL(FI,R,RHREF,TREF,RF,SB,BL,ALOSS,CCDE)
        DIFF(III+1)=BLP-BL
        IF(CODEP.EQ.1.)DIFF(III+1)=1000.0
19      IF(CODE.EC.1.)DIFF(III+1)=1000.
        IF(ABS(DIFF(III+1)).GE.+100.)DIFF(III+1)=1000.0
20      WRITE(6,15)FI,(DIFF(K),K=1,9)
15      FORMAT(1X,F8.0,2X,F6.3,8(2X,F6.2))
25      CONTINUE
        STOP
        END
```

APPENDIX C - TABULATED LOSS COEFFICIENTS FOR BANDS OF NOISE

C.1 Tables of Band Loss Corrections (Δ)

In the following tables the following nomenclature is used to the exclusion of symbols used elsewhere in this report.

SB = Source Spectrum Level Rolloff, db/ 1/3 octave
SBP = Received Spectrum Level Rolloff, db/ 1/3 octave
T = Temperature of Atmosphere
RH = Relative Humidity
F = Center Frequency of Band, Hz
A(F) = Pure Tone Absorption Coefficient at F, db/m
Δ = Band Loss Coefficient - A(F) x Propagation Distance, db
= Correction Factor, db = value given in table

Example Calculation

Find Band Loss Coefficient for and ANSI Class III 1/3 Octave Band Filter (see equation 5.21 with a center frequency of 50 kHz, a propagation distance of 20 meters, at a temperature of 298°K and at 70% relative humidity. Assume the source spectrum level rolls off at 2 db per 1/3 octave. From table C.1, A(50 kHz) = 1.6946 db/m x 20 meters -3.56 db = 30.33 db.

Table C.1 ANSI Class III, 1/3 Octave Band Filter for Known Source Spectrum

SB =-4.0 DB/THIRD OCTAVE T = 305.4K (90.0F) RH = 90.0 %

FREQ HZ	A(F) DB/M	DISTANCE, M 5	10	20	50	100	200	400	720
4000.	.0284	-0.00	-0.01	-0.02	-0.05	-0.09	-0.20	-0.43	-0.86
5000.	.0342	-0.01	-0.01	-0.02	-0.06	-0.13	-0.26	-0.58	-1.21
6300.	.0429	-0.01	-0.02	-0.03	-0.09	-0.18	-0.40	-0.91	-1.98
8000.	.0564	-0.01	-0.03	-0.05	-0.14	-0.29	-0.66	-1.59	-3.78
10000.	.0760	-0.02	-0.04	-0.08	-0.22	-0.48	-1.12	-2.89	99.99
12500.	.1063	-0.03	-0.06	-0.13	-0.36	-0.81	-2.00	99.99	99.99
16000.	.1597	-0.05	-0.10	-0.22	-0.63	-1.51	-4.10	99.99	99.99
20000.	.2361	-0.08	-0.17	-0.36	-1.08	-2.78	99.99	99.99	99.99
25000.	.3545	-0.13	-0.27	-0.60	-1.93	-5.60	99.99	99.99	99.99
31500.	.5452	-0.21	-0.45	-1.04	-3.72	99.99	99.99	99.99	99.99
40000.	.8541	-0.34	-0.77	-1.90	99.99	99.99	99.99	99.99	99.99
50000.	1.2974	-0.55	-1.30	-3.47	99.99	99.99	99.99	99.99	******
63000.	1.9878	-0.91	-2.29	99.99	99.99	99.99	99.99	******	******
80000.	3.0515	-1.53	-4.29	99.99	99.99	99.99	99.99	******	******
100000.	4.4799	-2.50	99.99	99.99	99.99	99.99	******	******	******

SB =-2.0 DB/THIRD OCTAVE T = 305.4K (90.0F) RH = 90.0 %

FREQ HZ	A(F) DB/M	DISTANCE, M 5	10	20	50	100	200	400	720
4000.	.0284	-0.00	-0.01	-0.01	-0.03	-0.06	-0.14	-0.30	-0.64
5000.	.0342	-0.00	-0.01	-0.02	-0.04	-0.09	-0.18	-0.42	-0.92
6300.	.0429	-0.01	-0.01	-0.02	-0.06	-0.13	-0.28	-0.68	-1.54
8000.	.0564	-0.01	-0.02	-0.04	-0.09	-0.20	-0.48	-1.22	-2.96
10000.	.0760	-0.01	-0.03	-0.05	-0.15	-0.34	-0.84	-2.30	-6.04
12500.	.1063	-0.02	-0.04	-0.09	-0.25	-0.59	-1.56	-4.60	99.99
16000.	.1597	-0.03	-0.07	-0.15	-0.45	-1.16	-3.28	99.99	99.99
20000.	.2361	-0.05	-0.11	-0.25	-0.81	-2.21	-6.90	99.99	99.99
25000.	.3545	-0.09	-0.19	-0.43	-1.51	-4.42	99.99	99.99	99.99
31500.	.5452	-0.14	-0.32	-0.78	-2.98	99.99	99.99	99.99	99.99
40000.	.8541	-0.24	-0.57	-1.48	-6.39	99.99	99.99	99.99	99.99
50000.	1.2974	-0.40	-1.00	-2.77	99.99	99.99	99.99	99.99	******
63000.	1.9878	-0.68	-1.80	-5.49	99.99	99.99	99.99	******	******
80000.	3.0515	-1.18	-3.37	99.99	99.99	99.99	99.99	******	******
100000.	4.4799	-1.96	-6.25	99.99	99.99	99.99	******	******	******

SB = 0.0 DB/THIRD OCTAVE T = 305.4K (90.0F) RH = 90.0 %

FREQ HZ	A(F) DB/M	DISTANCE, M 5	10	20	50	100	200	400	720
4000.	.0284	-0.00	-0.00	-0.01	-0.02	-0.04	-0.08	-0.19	-0.42
5000.	.0342	-0.00	-0.00	-0.01	-0.02	-0.05	-0.11	-0.26	-0.63
6300.	.0429	-0.00	-0.01	-0.01	-0.03	-0.07	-0.17	-0.45	-1.13
8000.	.0564	-0.00	-0.01	-0.02	-0.05	-0.12	-0.30	-0.87	-2.32
10000.	.0760	-0.01	-0.01	-0.03	-0.08	-0.20	-0.57	-1.76	-4.86
12500.	.1063	-0.01	-0.02	-0.05	-0.14	-0.38	-1.15	-3.71	-11.29
16000.	.1597	-0.02	-0.04	-0.08	-0.28	-0.82	-2.59	-9.06	99.99
20000.	.2361	-0.03	-0.06	-0.15	-0.55	-1.69	-5.60	99.99	99.99
25000.	.3545	-0.04	-0.10	-0.27	-1.10	-3.56	99.99	99.99	99.99
31500.	.5452	-0.08	-0.19	-0.52	-2.33	-8.04	99.99	99.99	99.99
40000.	.8541	-0.14	-0.37	-1.08	-5.17	99.99	99.99	99.99	99.99
50000.	1.2974	-0.24	-0.69	-2.16	-11.76	99.99	99.99	99.99	******
63000.	1.9878	-0.45	-1.35	-4.41	99.99	99.99	99.99	******	******
80000.	3.0515	-0.84	-2.65	-9.74	99.99	99.99	99.99	******	******
100000.	4.4799	-1.48	-4.93	99.99	99.99	99.99	******	******	******

SB = 2.0 DB/THIRD OCTAVE T = 305.4K (90.0F) RH = 90.0 %

FREQ HZ	A(F) DB/M	DISTANCE, M 5	10	20	50	100	200	400	720
4000.	.0284	-0.00	-0.00	-0.00	-0.00	-0.01	-0.02	-0.07	-0.21
5000.	.0342	-0.00	-0.00	-0.00	-0.00	-0.01	-0.03	-0.11	-0.35
6300.	.0429	0.00	0.00	-0.00	-0.00	-0.01	-0.05	-0.22	-0.72
8000.	.0564	0.00	0.00	-0.00	-0.01	-0.03	-0.13	-0.52	-1.70
10000.	.0760	0.00	0.00	-0.00	-0.02	-0.07	-0.30	-1.23	-3.88
12500.	.1063	0.00	-0.00	-0.00	-0.04	-0.18	-0.74	-2.89	-9.15
16000.	.1597	0.00	-0.00	-0.02	-0.11	-0.48	-1.93	-7.43	99.99
20000.	.2361	-0.00	-0.01	-0.04	-0.29	-1.17	-4.53	99.99	99.99
25000.	.3545	-0.00	-0.02	-0.11	-0.70	-2.76	-10.84	99.99	99.99
31500.	.5452	-0.01	-0.06	-0.27	-1.71	-6.58	99.99	99.99	99.99
40000.	.8541	-0.04	-0.17	-0.69	-4.15	99.99	99.99	99.99	******
50000.	1.2974	-0.10	-0.39	-1.56	-9.48	99.99	99.99	99.99	******
63000.	1.9878	-0.22	-0.90	-3.49	99.99	99.99	99.99	******	******
80000.	3.0515	-0.51	-1.98	-7.80	99.99	99.99	******	******	******
100000.	4.4799	-1.01	-3.91	99.99	99.99	99.99	******	******	******

****

SB =-4.0 DB/THIRD OCTAVE . T = 298.2K (77.0F) RH = 70.0 %

FREQ HZ	A(F) DB/M	DISTANCE, M 5	10	20	50	100	200	400	720
4000.	.0226	-0.01	-0.01	-0.02	-0.05	-0.11	-0.23	-0.50	-1.03
5000.	.0304	-0.01	-0.02	-0.03	-0.08	-0.17	-0.37	-0.84	-1.80
6300.	.0430	-0.01	-0.03	-0.05	-0.13	-0.28	-0.62	-1.49	-3.44
8000.	.0636	-0.02	-0.04	-0.08	-0.22	-0.48	-1.11	-2.87	99.99
10000.	.0939	-0.03	-0.06	-0.13	-0.36	-0.81	-2.00	99.99	99.99
12500.	.1407	-0.05	-0.10	-0.21	-0.59	-1.41	-3.78	99.99	99.99
16000.	.2223	-0.08	-0.16	-0.35	-1.06	-2.71	99.99	99.99	99.99
20000.	.3370	-0.12	-0.26	-0.57	-1.84	-5.32	99.99	99.99	99.99
25000.	.5092	-0.19	-0.41	-0.94	-3.32	99.99	99.99	99.99	99.99
31500.	.7739	-0.29	-0.66	-1.58	99.99	99.99	99.99	99.99	99.99
40000.	1.1735	-0.45	-1.05	-2.71	99.99	99.99	99.99	99.99	******
50000.	1.6946	-0.66	-1.60	-4.69	99.99	99.99	99.99	******	******
63000.	2.4128	-0.94	-2.40	99.99	99.99	99.99	99.99	******	******
80000.	3.3699	-1.30	-3.79	99.99	99.99	99.99	******	******	******
100000.	4.4908	-1.75	99.99	99.99	99.99	99.99	******	******	******

****

SB =-2.0 DB/THIRD OCTAVE T = 298.2K (77.0F) RH = 70.0 %

FREQ HZ	A(F) DB/M	DISTANCE, M 5	10	20	50	100	200	400	720
4000.	.0226	-0.00	-0.01	-0.01	-0.03	-0.07	-0.16	-0.36	-0.77
5000.	.0304	-0.01	-0.01	-0.02	-0.05	-0.12	-0.26	-0.62	-1.40
6300.	.0430	-0.01	-0.02	-0.03	-0.09	-0.19	-0.45	-1.15	-2.75
8000.	.0636	-0.01	-0.03	-0.05	-0.15	-0.34	-0.84	-2.29	-5.95
10000.	.0939	-0.02	-0.04	-0.09	-0.25	-0.59	-1.56	-4.60	99.99
12500.	.1407	-0.03	-0.07	-0.14	-0.43	-1.08	-3.03	99.99	99.99
16000.	.2223	-0.05	-0.11	-0.25	-0.79	-2.16	-6.73	99.99	99.99
20000.	.3370	-0.08	-0.18	-0.41	-1.44	-4.19	99.99	99.99	99.99
25000.	.5092	-0.13	-0.29	-0.70	-2.64	99.99	99.99	99.99	99.99
31500.	.7739	-0.21	-0.48	-1.22	-5.10	99.99	99.99	99.99	99.99
40000.	1.1735	-0.32	-0.79	-2.14	99.99	99.99	99.99	99.99	******
50000.	1.6946	-0.48	-1.23	-3.56	99.99	99.99	99.99	******	******
63000.	2.4128	-0.70	-1.87	-6.21	99.99	99.99	99.99	******	******
80000.	3.3699	-0.99	-2.79	99.99	99.99	99.99	******	******	******
100000.	4.4908	-1.35	-4.19	99.99	99.99	99.99	******	******	******

****

SB = 0.0 DB/THIRD OCTAVE T = 298.2K (77.0F) RH = 70.0 %

FREQ HZ	A(F) DB/M	DISTANCE, M 5	10	20	50	100	200	400	720
4000.	.0226	-0.00	-0.00	-0.01	-0.02	-0.04	-0.09	-0.22	-0.51
5000.	.0304	-0.00	-0.01	-0.01	-0.03	-0.06	-0.15	-0.40	-1.01
6300.	.0430	-0.00	-0.01	-0.02	-0.05	-0.11	-0.28	-0.81	-2.14
8000.	.0636	-0.01	-0.01	-0.03	-0.08	-0.20	-0.57	-1.75	-4.83
10000.	.0939	-0.01	-0.02	-0.05	-0.14	-0.38	-1.15	-3.71	-11.19
12500.	.1407	-0.02	-0.03	-0.08	-0.26	-0.75	-2.38	-8.20	99.99
16000.	.2223	-0.03	-0.06	-0.14	-0.54	-1.64	-5.44	99.99	99.99
20000.	.3370	-0.04	-0.10	-0.26	-1.04	-3.35	-12.64	99.99	99.99
25000.	.5092	-0.07	-0.17	-0.47	-2.05	-7.00	99.99	99.99	99.99
31500.	.7739	-0.12	-0.30	-0.87	-4.08	99.99	99.99	99.99	99.99
40000.	1.1735	-0.20	-0.54	-1.63	-8.58	99.99	99.99	99.99	******
50000.	1.6946	-0.31	-0.88	-2.79	99.99	99.99	99.99	******	******
63000.	2.4128	-0.47	-1.40	-4.73	99.99	99.99	99.99	******	******
80000.	3.3699	-0.69	-2.14	99.99	99.99	99.99	******	******	******
100000.	4.4908	-0.97	-3.15	99.99	99.99	99.99	******	******	******

****

SB = 2.0 DB/THIRD OCTAVE T = 298.2K (77.0F) RH = 70.0 %

FREQ HZ	A(F) DB/M	DISTANCE, M 5	10	20	50	100	200	400	720
4000.	.0226	0.00	0.00	0.00	-0.00	-0.00	-0.02	-0.08	-0.27
5000.	.0304	0.00	0.00	0.00	-0.00	-0.01	-0.04	-0.19	-0.63
6300.	.0430	0.00	0.00	0.00	-0.01	-0.03	-0.11	-0.48	-1.55
8000.	.0636	0.00	0.00	-0.00	-0.02	-0.07	-0.30	-1.23	-3.86
10000.	.0939	0.00	-0.00	-0.01	-0.04	-0.18	-0.74	-2.89	-9.12
12500.	.1407	-0.00	-0.00	-0.01	-0.10	-0.44	-1.75	-6.71	99.99
16000.	.2223	-0.00	-0.01	-0.04	-0.28	-1.13	-4.39	99.99	99.99
20000.	.3370	-0.01	-0.02	-0.10	-0.66	-2.58	-10.18	99.99	99.99
25000.	.5092	-0.01	-0.06	-0.24	-1.47	-5.68	99.99	99.99	99.99
31500.	.7739	-0.03	-0.13	-0.53	-3.20	-13.53	99.99	99.99	99.99
40000.	1.1735	-0.08	-0.29	-1.13	-6.85	99.99	99.99	99.99	******
50000.	1.6946	-0.14	-0.54	-2.09	99.99	99.99	99.99	******	******
63000.	2.4128	-0.25	-0.95	-3.68	99.99	99.99	99.99	******	******
80000.	3.3699	-0.41	-1.55	-6.44	99.99	99.99	******	******	******
100000.	4.4908	-0.62	-2.37	99.99	99.99	99.99	******	******	******

****

SB =-4.0 DB/THIRD OCTAVE   T = 288.2K (59.0F)   RH = 70.0 %

FREQ HZ	A(F) DB/M	DISTANCE, M 5	10	20	50	100	200	400	720
4000.	.0251	-0.01	-0.02	-0.03	-0.08	-0.17	-0.36	-0.83	-1.78
5000.	.0371	-0.01	-0.02	-0.05	-0.13	-0.27	-0.61	-1.46	-3.33
6300.	.0564	-0.02	-0.04	-0.08	-0.21	-0.46	-1.06	-2.71	99.99
8000.	.0877	-0.03	-0.06	-0.13	-0.35	-0.79	-1.94	-5.65	99.99
10000.	.1327	-0.05	-0.10	-0.20	-0.56	-1.33	-3.55	99.99	99.99
12500.	.1999	-0.07	-0.15	-0.31	-0.91	-2.30	99.99	99.99	99.99
16000.	.3106	-0.11	-0.23	-0.50	-1.56	-4.39	99.99	99.99	99.99
20000.	.4542	-0.16	-0.33	-0.75	-2.51	99.99	99.99	99.99	99.99
25000.	.6480	-0.21	-0.47	-1.08	-4.14	99.99	99.99	99.99	99.99
31500.	.9066	-0.28	-0.63	-1.50	99.99	99.99	99.99	99.99	******
40000.	1.2352	-0.35	-0.80	-2.00	99.99	99.99	99.99	99.99	******
50000.	1.5970	-0.42	-0.97	-2.66	99.99	99.99	99.99	******	******
63000.	2.0369	-0.51	-1.20	99.99	99.99	99.99	99.99	******	******
80000.	2.5989	-0.67	-1.62	99.99	99.99	99.99	99.99	******	******
100000.	3.2958	-0.95	-2.43	99.99	99.99	99.99	******	******	******

SB =-2.0 DB/THIRD OCTAVE   T = 288.2K (59.0F)   RH = 70.0 %

FREQ HZ	A(F) DB/M	DISTANCE, M 5	10	20	50	100	200	400	720
4000.	.0251	-0.01	-0.01	-0.02	-0.05	-0.12	-0.26	-0.61	-1.39
5000.	.0371	-0.01	-0.02	-0.03	-0.09	-0.19	-0.44	-1.11	-2.67
6300.	.0564	-0.01	-0.03	-0.05	-0.14	-0.32	-0.79	-2.16	-5.55
8000.	.0877	-0.02	-0.04	-0.09	-0.24	-0.58	-1.51	-4.44	99.99
10000.	.1327	-0.03	-0.06	-0.14	-0.40	-1.02	-2.83	99.99	99.99
12500.	.1999	-0.05	-0.10	-0.22	-0.68	-1.81	-5.50	99.99	99.99
16000.	.3106	-0.07	-0.16	-0.36	-1.20	-3.44	99.99	99.99	99.99
20000.	.4542	-0.11	-0.23	-0.55	-1.98	-6.33	99.99	99.99	99.99
25000.	.6480	-0.15	-0.33	-0.81	-3.15	99.99	99.99	99.99	99.99
31500.	.9066	-0.20	-0.46	-1.15	-5.08	99.99	99.99	99.99	******
40000.	1.2352	-0.25	-0.59	-1.55	99.99	99.99	99.99	99.99	******
50000.	1.5970	-0.30	-0.73	-1.96	99.99	99.99	99.99	******	******
63000.	2.0369	-0.37	-0.91	-2.56	99.99	99.99	99.99	******	******
80000.	2.5989	-0.49	-1.24	99.99	99.99	99.99	99.99	******	******
100000.	3.2958	-0.70	-1.89	99.99	99.99	99.99	******	******	******

SB = 0.0 DB/THIRD OCTAVE   T = 288.2K (59.0F)   RH = 70.0 %

FREQ HZ	A(F) DB/M	DISTANCE, M 5	10	20	50	100	200	400	720
4000.	.0251	-0.00	-0.00	-0.01	-0.03	-0.06	-0.15	-0.40	-1.00
5000.	.0371	-0.00	-0.01	-0.02	-0.05	-0.11	-0.27	-0.78	-2.07
6300.	.0564	-0.01	-0.01	-0.03	-0.08	-0.19	-0.53	-1.64	-4.50
8000.	.0877	-0.01	-0.02	-0.04	-0.14	-0.37	-1.11	-3.57	-10.77
10000.	.1327	-0.02	-0.03	-0.07	-0.25	-0.71	-2.21	-7.62	99.99
12500.	.1999	-0.02	-0.05	-0.12	-0.45	-1.35	-4.42	99.99	99.99
16000.	.3106	-0.04	-0.09	-0.22	-0.86	-2.71	-10.04	99.99	99.99
20000.	.4542	-0.06	-0.14	-0.36	-1.49	-4.98	99.99	99.99	99.99
25000.	.6480	-0.09	-0.21	-0.56	-2.45	-9.56	99.99	99.99	99.99
31500.	.9066	-0.12	-0.30	-0.82	-3.86	99.99	99.99	99.99	******
40000.	1.2352	-0.16	-0.40	-1.14	-6.19	99.99	99.99	99.99	******
50000.	1.5970	-0.19	-0.50	-1.46	99.99	99.99	99.99	******	******
63000.	2.0369	-0.23	-0.63	-1.93	99.99	99.99	99.99	******	******
80000.	2.5989	-0.31	-0.89	-2.85	99.99	99.99	******	******	******
100000.	3.2958	-0.47	-1.41	-4.92	99.99	99.99	******	******	******

SB = 2.0 DB/THIRD OCTAVE   T = 288.2K (59.0F)   RH = 70.0 %

FREQ HZ	A(F) DB/M	DISTANCE, M 5	10	20	50	100	200	400	720
4000.	.0251	0.00	0.00	0.00	-0.00	-0.01	-0.04	-0.19	-0.62
5000.	.0371	0.00	0.00	-0.00	-0.00	-0.02	-0.11	-0.46	-1.49
6300.	.0564	0.00	0.00	-0.00	-0.01	-0.07	-0.28	-1.13	-3.57
8000.	.0877	0.00	-0.00	-0.01	-0.04	-0.17	-0.71	-2.77	-8.76
10000.	.1327	-0.00	-0.00	-0.01	-0.10	-0.40	-1.61	-6.20	99.99
12500.	.1999	-0.00	-0.01	-0.04	-0.23	-0.90	-3.50	-14.86	99.99
16000.	.3106	-0.01	-0.02	-0.09	-0.52	-2.03	-8.02	99.99	99.99
20000.	.4542	-0.01	-0.05	-0.17	-1.02	-3.94	99.99	99.99	99.99
25000.	.6480	-0.02	-0.08	-0.31	-1.81	-7.36	99.99	99.99	99.99
31500.	.9066	-0.04	-0.14	-0.50	-2.96	99.99	99.99	99.99	******
40000.	1.2352	-0.06	-0.20	-0.74	-4.58	99.99	99.99	99.99	******
50000.	1.5970	-0.08	-0.27	-1.00	-7.19	99.99	99.99	******	******
63000.	2.0369	-0.10	-0.36	-1.37	99.99	99.99	99.99	******	******
80000.	2.5989	-0.14	-0.55	-2.12	99.99	99.99	******	******	******
100000.	3.2958	-0.24	-0.95	-3.73	99.99	99.99	******	******	******

SB =-4.0 DB/THIRD OCTAVE T = 277.6K (40.0F) RH = 10.0 %

FREQ	A(F)	DISTANCE, M							
HZ	DB/M	5	10	20	50	100	200	400	720
4000.	.0418	-0.00	-0.00	-0.01	-0.02	-0.05	-0.09	-0.19	-0.37
5000.	.0441	-0.00	-0.00	-0.01	-0.02	-0.05	-0.10	-0.20	-0.38
6300.	.0471	-0.00	-0.01	-0.01	-0.03	-0.06	-0.12	-0.25	-0.49
8000.	.0513	-0.00	-0.01	-0.02	-0.04	-0.08	-0.17	-0.37	-0.74
10000.	.0571	-0.01	-0.01	-0.02	-0.06	-0.13	-0.27	-0.59	-1.22
12500.	.0660	-0.01	-0.02	-0.04	-0.09	-0.20	-0.43	-0.99	-2.16
16000.	.0817	-0.01	-0.03	-0.06	-0.16	-0.34	-0.76	-1.87	-4.50
20000.	.1041	-0.02	-0.05	-0.10	-0.25	-0.56	-1.34	-3.54	99.99
25000.	.1392	-0.04	-0.07	-0.15	-0.42	-0.97	-2.45	99.99	99.99
31500.	.1963	-0.06	-0.12	-0.25	-0.73	-1.78	-5.01	99.99	99.99
40000.	.2909	-0.09	-0.20	-0.43	-1.33	-3.53	99.99	99.99	99.99
50000.	.4309	-0.15	-0.33	-0.73	-2.45	99.99	99.99	99.99	99.99
63000.	.6594	-0.25	-0.56	-1.32	-5.00	99.99	99.99	99.99	99.99
80000.	1.0376	-0.43	-1.00	-2.53	99.99	99.99	99.99	99.99	******
100000.	1.5976	-0.73	-1.79	-5.07	99.99	99.99	99.99	99.99	******

SB =-2.0 DB/THIRD OCTAVE T = 277.6K (40.0F) RH = 10.0 %

FREQ	A(F)	DISTANCE, M							
HZ	DB/M	5	10	20	50	100	200	400	720
4000.	.0418	-0.00	-0.00	-0.01	-0.02	-0.03	-0.06	-0.14	-0.26
5000.	.0441	-0.00	-0.00	-0.01	-0.02	-0.03	-0.07	-0.14	-0.27
6300.	.0471	-0.00	-0.00	-0.01	-0.02	-0.04	-0.08	-0.17	-0.35
8000.	.0513	-0.00	-0.01	-0.01	-0.03	-0.06	-0.12	-0.26	-0.55
10000.	.0571	-0.00	-0.01	-0.02	-0.04	-0.08	-0.18	-0.42	-0.92
12500.	.0660	-0.01	-0.01	-0.02	-0.06	-0.13	-0.30	-0.74	-1.70
16000.	.0817	-0.01	-0.02	-0.04	-0.11	-0.23	-0.56	-1.46	-3.58
20000.	.1041	-0.02	-0.03	-0.06	-0.17	-0.40	-1.02	-2.84	-7.68
25000.	.1392	-0.02	-0.05	-0.10	-0.30	-0.72	-1.94	-5.90	99.99
31500.	.1963	-0.04	-0.08	-0.17	-0.53	-1.38	-3.99	99.99	99.99
40000.	.2909	-0.06	-0.14	-0.30	-1.01	-2.83	-9.35	99.99	99.99
50000.	.4309	-0.10	-0.23	-0.54	-1.94	-5.89	99.99	99.99	99.99
63000.	.6594	-0.17	-0.40	-1.00	-3.99	99.99	99.99	99.99	99.99
80000.	1.0376	-0.30	-0.74	-2.01	-9.34	99.99	99.99	99.99	******
100000.	1.5976	-0.54	-1.39	-4.04	99.99	99.99	99.99	99.99	******

SB = 0.0 DB/THIRD OCTAVE T = 277.6K (40.0F) RH = 10.0 %

FREQ	A(F)	DISTANCE, M							
HZ	DB/M	5	10	20	50	100	200	400	720
4000.	.0418	-0.00	-0.00	-0.00	-0.01	-0.02	-0.04	-0.08	-0.17
5000.	.0441	-0.00	-0.00	-0.00	-0.01	-0.02	-0.04	-0.08	-0.17
6300.	.0471	-0.00	-0.00	-0.00	-0.01	-0.02	-0.04	-0.10	-0.22
8000.	.0513	-0.00	-0.00	-0.01	-0.01	-0.03	-0.06	-0.15	-0.35
10000.	.0571	-0.00	-0.00	-0.01	-0.02	-0.04	-0.10	-0.26	-0.64
12500.	.0660	-0.00	-0.01	-0.01	-0.03	-0.07	-0.18	-0.49	-1.26
16000.	.0817	-0.00	-0.01	-0.02	-0.06	-0.13	-0.36	-1.06	-2.84
20000.	.1041	-0.01	-0.02	-0.03	-0.10	-0.25	-0.71	-2.22	-6.21
25000.	.1392	-0.01	-0.02	-0.05	-0.18	-0.48	-1.46	-4.79	99.99
31500.	.1963	-0.02	-0.04	-0.10	-0.34	-1.00	-3.20	-11.60	99.99
40000.	.2909	-0.03	-0.07	-0.18	-0.70	-2.21	-7.52	99.99	99.99
50000.	.4309	-0.05	-0.13	-0.34	-1.46	-4.78	99.99	99.99	99.99
63000.	.6594	-0.10	-0.24	-0.70	-3.19	-11.58	99.99	99.99	99.99
80000.	1.0376	-0.18	-0.50	-1.52	-7.51	99.99	99.99	99.99	******
100000.	1.5976	-0.34	-1.01	-3.24	99.99	99.99	99.99	99.99	******

SB = 2.0 DB/THIRD OCTAVE T = 277.6K (40.0F) RH = 10.0 %

FREQ	A(F)	DISTANCE, M							
HZ	DB/M	5	10	20	50	100	200	400	720
4000.	.0418	-0.00	-0.00	-0.00	-0.00	-0.01	-0.01	-0.03	-0.07
5000.	.0441	-0.00	-0.00	-0.00	-0.00	-0.00	-0.01	-0.03	-0.07
6300.	.0471	-0.00	-0.00	-0.00	-0.00	-0.00	-0.01	-0.03	-0.09
8000.	.0513	0.00	0.00	-0.00	-0.00	-0.00	-0.01	-0.05	-0.16
10000.	.0571	0.00	0.00	0.00	-0.00	-0.01	-0.02	-0.10	-0.35
12500.	.0660	0.00	0.00	0.00	-0.00	-0.01	-0.06	-0.25	-0.83
16000.	.0817	0.00	0.00	-0.00	-0.01	-0.04	-0.16	-0.67	-2.15
20000.	.1041	0.00	0.00	-0.00	-0.02	-0.09	-0.40	-1.62	-5.05
25000.	.1392	0.00	-0.00	-0.01	-0.06	-0.24	-0.99	-3.84	-12.42
31500.	.1963	-0.00	-0.00	-0.02	-0.15	-0.62	-2.45	-9.47	99.99
40000.	.2909	-0.00	-0.01	-0.06	-0.40	-1.61	-6.16	99.99	99.99
50000.	.4309	-0.01	-0.03	-0.15	-0.99	-3.83	-15.71	99.99	99.99
63000.	.6594	-0.02	-0.09	-0.39	-2.45	-9.46	99.99	99.99	99.99
80000.	1.0376	-0.06	-0.25	-1.03	-6.16	99.99	99.99	99.99	******
100000.	1.5976	-0.15	-0.63	-2.49	-15.71	99.99	99.99	******	******

Table C.2 Perfect 1/3 Octave Band Filter for Known Source Spectrum

SB = -4.0 DB/THIRD OCTAVE T = 305.4K (90.0F) RH = 90.0 %

FREQ HZ	A(F) DB/M	DISTANCE, M 5	10	20	50	100	200	400	720
4000.	.0284	-0.00	-0.00	-0.01	-0.02	-0.04	-0.08	-0.17	-0.37
5000.	.0342	-0.00	-0.00	-0.01	-0.02	-0.05	-0.10	-0.24	-0.54
6300.	.0429	-0.00	-0.01	-0.01	-0.03	-0.07	-0.16	-0.40	-0.91
8000.	.0564	-0.00	-0.01	-0.02	-0.05	-0.12	-0.28	-0.73	-1.73
10000.	.0760	-0.01	-0.01	-0.03	-0.08	-0.20	-0.50	-1.36	-3.30
12500.	.1063	-0.01	-0.02	-0.05	-0.14	-0.35	-0.93	-2.63	-6.26
16000.	.1597	-0.02	-0.04	-0.09	-0.26	-0.69	-1.93	-5.40	-12.30
20000.	.2361	-0.03	-0.06	-0.14	-0.48	-1.31	-3.72	-10.05	-21.79
25000.	.3545	-0.05	-0.11	-0.25	-0.90	-2.54	-7.03	-17.97	-37.28
31500.	.5452	-0.08	-0.18	-0.46	-1.75	-4.93	-13.01	-31.47	-62.93
40000.	.8541	-0.14	-0.33	-0.88	-3.46	-9.40	-23.42	-53.95	******
50000.	1.2974	-0.23	-0.59	-1.63	-6.33	-16.36	-38.79	******	******
63000.	1.9876	-0.40	-1.07	-3.01	-11.22	-27.51	-62.65	******	******
80000.	3.0515	-0.70	-1.93	-5.41	-18.99	-44.51	******	******	******
100000.	4.4799	-1.15	-3.23	-8.82	-29.23	-66.31	******	******	******

SB = -2.0 DB/THIRD OCTAVE T = 305.4K (90.0F) RH = 90.0 %

FREQ HZ	A(F) DB/M	DISTANCE, M 5	10	20	50	100	200	400	720
4000.	.0284	-0.00	-0.00	-0.00	-0.01	-0.02	-0.04	-0.10	-0.23
5000.	.0342	-0.00	-0.00	-0.00	-0.01	-0.02	-0.05	-0.14	-0.36
6300.	.0429	-0.00	-0.00	-0.00	-0.01	-0.03	-0.08	-0.25	-0.66
8000.	.0564	-0.00	-0.00	-0.01	-0.02	-0.06	-0.16	-0.51	-1.38
10000.	.0760	-0.00	-0.01	-0.01	-0.04	-0.11	-0.32	-1.05	-2.83
12500.	.1063	-0.00	-0.01	-0.02	-0.07	-0.21	-0.68	-2.20	-5.67
16000.	.1597	-0.01	-0.02	-0.04	-0.15	-0.48	-1.55	-4.85	-11.62
20000.	.2361	-0.01	-0.03	-0.07	-0.31	-1.01	-3.23	-9.40	-21.04
25000.	.3545	-0.02	-0.05	-0.14	-0.65	-2.11	-6.42	-17.24	-36.49
31500.	.5452	-0.04	-0.10	-0.30	-1.40	-4.39	-12.32	-30.69	-67.11
40000.	.8541	-0.07	-0.20	-0.64	-2.98	-8.76	-22.66	-53.14	******
50000.	1.2974	-0.13	-0.40	-1.28	-5.75	-15.64	-37.99	******	******
63000.	1.9876	-0.25	-0.80	-2.56	-10.55	-26.74	-61.83	******	******
80000.	3.0515	-0.49	-1.56	-4.86	-18.25	-43.70	******	******	******
100000.	4.4799	-0.87	-2.77	-8.18	-28.45	-65.48	******	******	******

SB = 0.0 DB/THIRD OCTAVE T = 305.4K (90.0F) RH = 90.0 %

FREQ HZ	A(F) DB/M	DISTANCE, M 5	10	20	50	100	200	400	720
4000.	.0284	0.00	0.00	0.00	0.00	0.00	0.00	-0.02	-0.09
5000.	.0342	0.00	0.00	0.00	0.00	0.01	0.00	-0.04	-0.17
6300.	.0429	0.00	0.00	0.00	0.01	0.01	-0.01	-0.09	-0.40
8000.	.0564	0.00	0.00	0.00	0.01	0.00	-0.04	-0.28	-1.00
10000.	.0760	0.00	0.00	0.01	0.01	-0.01	-0.14	-0.72	-2.32
12500.	.1063	0.00	0.01	0.01	0.00	-0.07	-0.41	-1.74	-5.04
16000.	.1597	0.01	0.01	0.01	-0.03	-0.25	-1.15	-4.24	-10.87
20000.	.2361	0.01	0.01	0.00	-0.13	-0.68	-2.69	-8.68	-20.22
25000.	.3545	0.01	0.01	-0.03	-0.39	-1.66	-5.77	-16.44	-35.62
31500.	.5452	0.01	-0.01	-0.12	-1.01	-3.80	-11.57	-29.83	-61.21
40000.	.8541	0.00	-0.06	-0.38	-2.46	-8.05	-21.84	-52.24	******
50000.	1.2974	-0.03	-0.20	-0.92	-5.11	-14.85	-37.12	******	******
63000.	1.9876	-0.10	-0.51	-2.07	-9.81	-25.90	-60.93	******	******
80000.	3.0515	-0.27	-1.17	-4.25	-17.45	-42.82	******	******	******
100000.	4.4799	-0.57	-2.27	-7.48	-27.60	-64.57	******	******	******

SB = 2.0 DB/THIRD OCTAVE T = 305.4K (90.0F) RH = 90.0 %

FREQ HZ	A(F) DB/M	DISTANCE, M 5	10	20	50	100	200	400	720
4000.	.0284	0.00	0.00	0.01	0.01	0.02	0.04	0.06	0.05
5000.	.0342	0.00	0.00	0.01	0.02	0.03	0.06	0.07	0.02
6300.	.0429	0.00	0.01	0.01	0.03	0.05	0.07	0.06	-0.12
8000.	.0564	0.00	0.01	0.02	0.04	0.07	0.08	-0.03	-0.60
10000.	.0760	0.01	0.01	0.03	0.06	0.08	0.05	-0.36	-1.77
12500.	.1063	0.01	0.02	0.04	0.08	0.08	-0.12	-1.24	-4.34
16000.	.1597	0.02	0.03	0.06	0.09	-0.02	-0.73	-3.58	-10.05
20000.	.2361	0.03	0.05	0.08	0.05	-0.33	-2.12	-7.90	-19.33
25000.	.3545	0.04	0.06	0.08	-0.11	-1.17	-5.05	-15.58	-34.68
31500.	.5452	0.05	0.08	0.05	-0.61	-3.16	-10.74	-28.91	-60.23
40000.	.8541	0.08	0.08	-0.10	-1.91	-7.28	-20.94	-51.28	******
50000.	1.2974	0.08	0.01	-0.53	-4.41	-13.99	-36.18	******	******
63000.	1.9878	0.06	-0.20	-1.54	-9.01	-24.98	-59.95	******	******
80000.	3.0515	-0.03	-0.74	-3.59	-16.57	-41.86	******	******	******
100000.	4.4799	-0.26	-1.73	-6.72	-26.68	-63.59	******	******	******

SB = -4.0 DB/THIRD OCTAVE   T = 298.2K (77.0F)   RH = 70.0 %

FREQ HZ	A(F) DB/M	DISTANCE, M 5	10	20	50	100	200	400	720
4000.	.0226	-0.00	-0.00	-0.01	-0.02	-0.04	-0.09	-0.21	-0.45
5000.	.0304	-0.00	-0.01	-0.01	-0.03	-0.07	-0.15	-0.36	-0.83
6300.	.0430	-0.00	-0.01	-0.02	-0.05	-0.11	-0.26	-0.68	-1.62
8000.	.0636	-0.01	-0.01	-0.03	-0.08	-0.20	-0.50	-1.36	-3.29
10000.	.0939	-0.01	-0.02	-0.05	-0.14	-0.35	-0.93	-2.63	-6.25
12500.	.1407	-0.02	-0.04	-0.08	-0.25	-0.64	-1.78	-5.01	-11.46
16000.	.2223	-0.03	-0.06	-0.14	-0.47	-1.28	-3.62	-9.80	-21.30
20000.	.3370	-0.05	-0.10	-0.24	-0.85	-2.40	-6.66	-17.12	-35.66
25000.	.5092	-0.07	-0.17	-0.41	-1.55	-4.37	-11.66	-28.49	-57.34
31500.	.7739	-0.12	-0.28	-0.72	-2.81	-7.72	-19.61	-45.83	******
40000.	1.1735	-0.19	-0.47	-1.25	-4.89	-12.94	-31.35	******	******
50000.	1.6946	-0.28	-0.72	-1.99	-7.65	-19.47	-45.59	******	******
63000.	2.4128	-0.41	-1.08	-3.02	-11.27	-27.69	******	******	******
80000.	3.3699	-0.58	-1.56	-4.36	-15.70	-37.48	******	******	******
100000.	4.4908	-0.78	-2.15	-5.98	-20.78	******	******	******	******

SB = -2.0 DB/THIRD OCTAVE   T = 298.2K (77.0F)   RH = 70.0 %

FREQ HZ	A(F) DB/M	DISTANCE, M 5	10	20	50	100	200	400	720
4000.	.0226	-0.00	-0.00	-0.00	-0.01	-0.02	-0.04	-0.11	-0.29
5000.	.0304	-0.00	-0.00	-0.00	-0.01	-0.03	-0.08	-0.22	-0.59
6300.	.0430	-0.00	-0.00	-0.01	-0.02	-0.05	-0.15	-0.47	-1.28
8000.	.0636	-0.00	-0.01	-0.01	-0.04	-0.11	-0.32	-1.05	-2.82
10000.	.0939	-0.00	-0.01	-0.02	-0.07	-0.21	-0.68	-2.20	-5.67
12500.	.1407	-0.01	-0.02	-0.04	-0.14	-0.44	-1.42	-4.46	-10.79
16000.	.2223	-0.01	-0.03	-0.07	-0.30	-0.98	-3.13	-9.15	-20.55
20000.	.3370	-0.02	-0.05	-0.14	-0.61	-1.99	-6.07	-16.40	-34.87
25000.	.5092	-0.03	-0.09	-0.26	-1.22	-3.85	-10.98	-27.72	-56.52
31500.	.7739	-0.06	-0.17	-0.51	-2.37	-7.11	-18.87	-45.03	******
40000.	1.1735	-0.10	-0.30	-0.96	-4.35	-12.25	-30.56	******	******
50000.	1.6946	-0.17	-0.51	-1.62	-7.04	-18.73	-44.78	******	******
63000.	2.4128	-0.27	-0.81	-2.57	-10.59	-26.91	******	******	******
80000.	3.3699	-0.40	-1.23	-3.84	-14.99	-36.69	******	******	******
100000.	4.4908	-0.56	-1.76	-5.40	-20.04	******	******	******	******

SB = 0.0 DB/THIRD OCTAVE   T = 298.2K (77.0F)   RH = 70.0 %

FREQ HZ	A(F) DB/M	DISTANCE, M 5	10	20	50	100	200	400	720
4000.	.0226	0.00	0.00	0.00	0.00	0.01	0.01	-0.02	-0.12
5000.	.0304	0.00	0.00	0.00	0.01	0.01	-0.00	-0.08	-0.34
6300.	.0430	0.00	0.00	0.01	0.01	0.01	-0.03	-0.25	-0.91
8000.	.0636	0.00	0.00	0.01	0.01	-0.01	-0.14	-0.71	-2.31
10000.	.0939	0.00	0.01	0.01	0.00	-0.07	-0.41	-1.74	-5.03
12500.	.1407	0.00	0.01	0.01	-0.03	-0.22	-1.04	-3.87	-10.05
16000.	.2223	0.01	0.01	-0.00	-0.13	-0.66	-2.61	-8.44	-19.73
20000.	.3370	0.01	0.01	-0.03	-0.36	-1.54	-5.42	-15.61	-34.01
25000.	.5092	0.01	-0.01	-0.10	-0.86	-3.28	-10.24	-26.87	-55.62
31500.	.7739	0.00	-0.05	-0.28	-1.89	-6.43	-18.06	-44.14	******
40000.	1.1735	-0.02	-0.14	-0.64	-3.76	-11.49	-29.71	******	******
50000.	1.6946	-0.05	-0.29	-1.22	-6.36	-17.92	-43.90	******	******
63000.	2.4128	-0.12	-0.53	-2.09	-9.86	-26.07	******	******	******
80000.	3.3699	-0.21	-0.88	-3.28	-14.20	-35.82	******	******	******
100000.	4.4908	-0.33	-1.35	-4.77	-19.22	******	******	******	******

SB = 2.0 DB/THIRD OCTAVE   T = 298.2K (77.0F)   RH = 70.0 %

FREQ HZ	A(F) DB/M	DISTANCE, M 5	10	20	50	100	200	400	720
4000.	.0226	0.00	0.00	0.01	0.02	0.03	0.06	0.08	0.06
5000.	.0304	0.00	0.01	0.01	0.03	0.05	0.08	0.08	-0.08
6300.	.0430	0.00	0.01	0.02	0.04	0.07	0.09	-0.01	-0.53
8000.	.0636	0.01	0.01	0.03	0.06	0.08	0.05	-0.36	-1.76
10000.	.0939	0.01	0.02	0.04	0.07	0.08	-0.13	-1.24	-4.34
12500.	.1407	0.02	0.03	0.05	0.08	-0.00	-0.63	-3.22	-9.24
16000.	.2223	0.02	0.05	0.07	0.05	-0.32	-2.04	-7.66	-18.85
20000.	.3370	0.04	0.06	0.08	-0.09	-1.07	-4.71	-14.75	-33.07
25000.	.5092	0.05	0.07	0.06	-0.48	-2.67	-9.44	-25.95	-54.65
31500.	.7739	0.06	0.07	-0.04	-1.39	-5.70	-17.18	-43.19	******
40000.	1.1735	0.07	0.04	-0.31	-3.13	-10.66	-28.78	******	******
50000.	1.6946	0.06	-0.05	-0.79	-5.63	-17.04	-42.94	******	******
63000.	2.4128	0.04	-0.23	-1.56	-9.05	-25.15	******	******	******
80000.	3.3699	-0.01	-0.51	-2.67	-13.35	-34.87	******	******	******
100000.	4.4908	-0.09	-0.91	-4.09	-18.33	******	******	******	******

SB =-4.0 DB/THIRD OCTAVE   T = 288.2K (59.0F)   RH = 70.0 %

FREQ HZ	A(F) DB/M	DISTANCE, M 5	10	20	50	100	200	400	720
4000.	.0251	-0.00	-0.01	-0.01	-0.03	-0.06	-0.15	-0.36	-0.83
5000.	.0371	-0.00	-0.01	-0.02	-0.05	-0.11	-0.26	-0.66	-1.58
6300.	.0564	-0.01	-0.01	-0.03	-0.08	-0.19	-0.47	-1.28	-3.09
8000.	.0877	-0.01	-0.02	-0.05	-0.14	-0.34	-0.90	-2.53	-6.04
10000.	.1327	-0.02	-0.04	-0.08	-0.24	-0.60	-1.66	-4.68	-10.77
12500.	.1999	-0.03	-0.06	-0.12	-0.40	-1.07	-3.01	-8.26	-18.21
16000.	.3106	-0.04	-0.09	-0.21	-0.71	-1.97	-5.51	-14.42	-30.44
20000.	.4542	-0.06	-0.13	-0.32	-1.15	-3.24	-8.84	-22.19	-45.43
25000.	.6480	-0.09	-0.19	-0.48	-1.77	-4.95	-13.09	-31.73	******
31500.	.9066	-0.12	-0.27	-0.67	-2.54	-7.02	-18.03	-42.55	******
40000.	1.2352	-0.15	-0.34	-0.89	-3.40	-9.24	-23.17	******	******
50000.	1.5970	-0.18	-0.42	-1.10	-4.26	-11.41	-28.05	******	******
63000.	2.0369	-0.21	-0.53	-1.41	-5.45	-14.32	-34.47	******	******
80000.	2.5989	-0.28	-0.72	-1.99	-7.63	-19.44	******	******	******
100000.	3.2958	-0.41	-1.10	-3.09	-11.50	-28.16	******	******	******

SB =-2.0 DB/THIRD OCTAVE   T = 288.2K (59.0F)   RH = 70.0 %

FREQ HZ	A(F) DB/M	DISTANCE, M 5	10	20	50	100	200	400	720
4000.	.0251	-0.00	-0.00	-0.00	-0.01	-0.03	-0.07	-0.22	-0.59
5000.	.0371	-0.00	-0.00	-0.01	-0.02	-0.05	-0.15	-0.46	-1.24
6300.	.0564	-0.00	-0.01	-0.01	-0.04	-0.10	-0.30	-0.98	-2.64
8000.	.0877	-0.00	-0.01	-0.02	-0.07	-0.21	-0.65	-2.11	-5.46
10000.	.1327	-0.01	-0.01	-0.04	-0.13	-0.41	-1.32	-4.15	-10.11
12500.	.1999	-0.01	-0.02	-0.06	-0.25	-0.80	-2.56	-7.64	-17.48
16000.	.3106	-0.02	-0.04	-0.12	-0.50	-1.60	-4.95	-13.72	-29.66
20000.	.4542	-0.03	-0.07	-0.20	-0.87	-2.78	-8.20	-21.43	-44.62
25000.	.6480	-0.04	-0.11	-0.32	-1.42	-4.41	-12.40	-30.95	******
31500.	.9066	-0.06	-0.16	-0.47	-2.13	-6.42	-17.30	-41.75	******
40000.	1.2352	-0.08	-0.22	-0.65	-2.93	-8.60	-22.41	******	******
50000.	1.5970	-0.10	-0.28	-0.83	-3.74	-10.73	-27.27	******	******
63000.	2.0369	-0.13	-0.36	-1.10	-4.89	-13.61	-33.68	******	******
80000.	2.5989	-0.17	-0.51	-1.61	-7.02	-18.70	******	******	******
100000.	3.2958	-0.26	-0.82	-2.63	-10.82	-27.38	******	******	******

SB = 0.0 DB/THIRD OCTAVE   T = 288.2K (59.0F)   RH = 70.0 %

FREQ HZ	A(F) DB/M	DISTANCE, M 5	10	20	50	100	200	400	720
4000.	.0251	0.00	0.00	0.00	0.01	0.01	-0.00	-0.07	-0.34
5000.	.0371	0.00	0.00	0.00	0.01	0.01	-0.03	-0.24	-0.88
6300.	.0564	0.00	0.00	0.01	0.01	-0.01	-0.13	-0.65	-2.14
8000.	.0877	0.00	0.01	0.01	-0.00	-0.07	-0.39	-1.66	-4.83
10000.	.1327	0.00	0.01	0.01	-0.03	-0.20	-0.95	-3.57	-9.38
12500.	.1999	0.01	0.01	0.00	-0.10	-0.51	-2.07	-6.95	-16.68
16000.	.3106	0.01	0.00	-0.02	-0.27	-1.19	-4.34	-12.94	-28.81
20000.	.4542	0.00	-0.01	-0.07	-0.57	-2.27	-7.50	-20.61	-43.74
25000.	.6480	-0.00	-0.03	-0.15	-1.04	-3.82	-11.64	-30.09	******
31500.	.9066	-0.01	-0.05	-0.26	-1.68	-5.76	-16.50	-40.87	******
40000.	1.2352	-0.02	-0.09	-0.40	-2.42	-7.89	-21.58	******	******
50000.	1.5970	-0.03	-0.13	-0.55	-3.19	-9.99	-26.42	******	******
63000.	2.0369	-0.04	-0.18	-0.77	-4.28	-12.84	-32.81	******	******
80000.	2.5989	-0.05	-0.29	-1.21	-6.34	-17.89	******	******	******
100000.	3.2956	-0.11	-0.53	-2.14	-10.08	-26.54	******	******	******

SB = 2.0 DB/THIRD OCTAVE   T = 288.2K (59.0F)   RH = 70.0 %

FREQ HZ	A(F) DB/M	DISTANCE, M 5	10	20	50	100	200	400	720
4000.	.0251	0.00	0.01	0.01	0.03	0.05	0.08	0.08	-0.08
5000.	.0371	0.00	0.01	0.02	0.04	0.07	0.08	-0.01	-0.50
6300.	.0564	0.01	0.01	0.03	0.05	0.08	0.05	-0.31	-1.61
8000.	.0877	0.01	0.02	0.04	0.07	0.08	-0.11	-1.17	-4.15
10000.	.1327	0.02	0.03	0.05	0.08	0.01	-0.56	-2.94	-8.58
12500.	.1999	0.02	0.04	0.06	0.06	-0.20	-1.55	-6.20	-15.81
16000.	.3106	0.03	0.05	0.07	-0.04	-0.77	-3.67	-12.10	-27.88
20000.	.4542	0.04	0.05	0.06	-0.26	-1.73	-6.74	-19.72	-42.78
25000.	.6480	0.04	0.06	0.02	-0.65	-3.18	-10.81	-29.16	******
31500.	.9066	0.05	0.06	-0.05	-1.20	-5.05	-15.63	-39.91	******
40000.	1.2352	0.05	0.04	-0.14	-1.87	-7.12	-20.67	******	******
50000.	1.5970	0.05	0.03	-0.25	-2.58	-9.18	-25.50	******	******
63000.	2.0369	0.06	0.00	-0.42	-3.62	-12.00	-31.87	******	******
80000.	2.5989	0.06	-0.06	-0.79	-5.61	-17.01	******	******	******
100000.	3.2956	0.05	-0.22	-1.61	-9.27	-25.62	******	******	******

SB = -4.0 DB/THIRD OCTAVE T = 277.6K (40.0F) RH = 10.0 %

FREQ HZ	A(F) DB/M	DISTANCE, M 5	10	20	50	100	200	400	720
4000.	.0418	-0.00	-0.00	-0.00	-0.01	-0.02	-0.04	-0.08	-0.15
5000.	.0441	-0.00	-0.00	-0.00	-0.01	-0.02	-0.04	-0.08	-0.16
6300.	.0471	-0.00	-0.00	-0.00	-0.01	-0.02	-0.05	-0.10	-0.20
8000.	.0513	-0.00	-0.00	-0.01	-0.01	-0.03	-0.07	-0.15	-0.32
10000.	.0571	-0.00	-0.00	-0.01	-0.02	-0.05	-0.10	-0.25	-0.55
12500.	.0660	-0.00	-0.01	-0.01	-0.04	-0.08	-0.17	-0.44	-1.01
16000.	.0817	-0.01	-0.01	-0.02	-0.06	-0.13	-0.33	-0.87	-2.09
20000.	.1041	-0.01	-0.02	-0.04	-0.10	-0.23	-0.60	-1.68	-4.05
25000.	.1392	-0.01	-0.03	-0.06	-0.17	-0.43	-1.16	-3.28	-7.71
31500.	.1963	-0.02	-0.04	-0.10	-0.31	-0.82	-2.32	-6.45	-14.48
40000.	.2909	-0.04	-0.08	-0.18	-0.60	-1.67	-4.72	-12.50	-26.65
50000.	.4309	-0.06	-0.13	-0.31	-1.16	-3.27	-8.93	-22.33	-45.63
63000.	.6594	-0.10	-0.23	-0.60	-2.31	-6.45	-16.61	-39.32	******
80000.	1.0376	-0.18	-0.44	-1.20	-4.72	-12.50	-30.33	-68.55	******
100000.	1.5976	-0.31	-0.83	-2.34	-8.93	-22.33	-51.61	******	******

SB = -2.0 DB/THIRD OCTAVE T = 277.6K (40.0F) RH = 10.0 %

FREQ HZ	A(F) DB/M	DISTANCE, M 5	10	20	50	100	200	400	720
4000.	.0418	-0.00	-0.00	-0.00	-0.00	-0.01	-0.02	-0.04	-0.09
5000.	.0441	-0.00	-0.00	-0.00	-0.00	-0.01	-0.02	-0.04	-0.09
6300.	.0471	-0.00	-0.00	-0.00	-0.00	-0.01	-0.02	-0.05	-0.11
8000.	.0513	-0.00	-0.00	-0.00	-0.01	-0.01	-0.03	-0.08	-0.19
10000.	.0571	-0.00	-0.00	-0.00	-0.01	-0.02	-0.05	-0.14	-0.36
12500.	.0660	-0.00	-0.00	-0.00	-0.01	-0.03	-0.09	-0.28	-0.74
16000.	.0817	-0.00	-0.00	-0.01	-0.03	-0.07	-0.20	-0.62	-1.70
20000.	.1041	-0.00	-0.01	-0.01	-0.05	-0.13	-0.41	-1.33	-3.55
25000.	.1392	-0.00	-0.01	-0.02	-0.09	-0.27	-0.87	-2.81	-7.10
31500.	.1963	-0.01	-0.02	-0.05	-0.18	-0.59	-1.91	-5.86	-13.78
40000.	.2909	-0.01	-0.03	-0.09	-0.41	-1.33	-4.19	-11.82	-25.88
50000.	.4309	-0.02	-0.06	-0.19	-0.87	-2.81	-8.29	-21.58	-44.82
63000.	.6594	-0.05	-0.13	-0.40	-1.91	-5.86	-15.90	-38.53	******
80000.	1.0376	-0.09	-0.28	-0.91	-4.18	-11.82	-29.55	-67.72	******
100000.	1.5976	-0.19	-0.59	-1.93	-8.29	-21.58	-50.79	******	******

SB = 0.0 DB/THIRD OCTAVE T = 277.6K (40.0F) RH = 10.0 %

FREQ HZ	A(F) DB/M	DISTANCE, M 5	10	20	50	100	200	400	720
4000.	.0418	-0.00	-0.00	0.00	-0.00	-0.00	-0.00	-0.01	-0.02
5000.	.0441	0.00	0.00	0.00	0.00	0.00	0.00	-0.00	-0.02
6300.	.0471	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.02
8000.	.0513	0.00	0.00	0.00	0.00	0.01	0.01	-0.00	-0.06
10000.	.0571	0.00	0.00	0.00	0.01	0.01	0.01	-0.03	-0.17
12500.	.0660	0.00	0.00	0.00	0.01	0.01	-0.01	-0.11	-0.46
16000.	.0817	0.00	0.00	0.01	0.01	0.00	-0.06	-0.36	-1.28
20000.	.1041	0.00	0.00	0.01	0.01	-0.02	-0.20	-0.96	-2.99
25000.	.1392	0.00	0.01	0.01	-0.01	-0.10	-0.56	-2.30	-6.42
31500.	.1963	0.01	0.01	0.01	-0.05	-0.33	-1.47	-5.22	-13.01
40000.	.2909	0.01	0.01	-0.01	-0.20	-0.95	-3.60	-11.07	-25.04
50000.	.4309	0.01	0.00	-0.05	-0.56	-2.30	-7.59	-20.76	-43.94
63000.	.6594	0.01	-0.02	-0.20	-1.47	-5.22	-15.11	-37.66	******
80000.	1.0376	-0.01	-0.11	-0.59	-3.60	-11.07	-28.70	-66.82	******
100000.	1.5976	-0.05	-0.34	-1.49	-7.59	-20.76	-49.90	******	******

SB = 2.0 DB/THIRD OCTAVE T = 277.6K (40.0F) RH = 10.0 %

FREQ HZ	A(F) DB/M	DISTANCE, M 5	10	20	50	100	200	400	720
4000.	.0418	0.00	0.00	0.00	0.00	0.01	0.02	0.03	0.04
5000.	.0441	0.00	0.00	0.00	0.01	0.01	0.02	0.04	0.05
6300.	.0471	0.00	0.00	0.00	0.01	0.02	0.03	0.05	0.07
8000.	.0513	0.00	0.00	0.01	0.01	0.02	0.05	0.07	0.07
10000.	.0571	0.00	0.00	0.01	0.02	0.04	0.06	0.08	0.03
12500.	.0660	0.00	0.01	0.01	0.03	0.05	0.08	0.06	-0.16
16000.	.0817	0.01	0.01	0.02	0.05	0.07	0.08	-0.09	-0.84
20000.	.1041	0.01	0.02	0.03	0.06	0.09	0.01	-0.56	-2.40
25000.	.1392	0.01	0.02	0.04	0.08	0.06	-0.24	-1.75	-5.69
31500.	.1963	0.02	0.04	0.06	0.08	-0.07	-1.01	-4.52	-12.17
40000.	.2909	0.03	0.05	0.08	0.02	-0.56	-2.97	-10.25	-24.13
50000.	.4309	0.04	0.07	0.08	-0.24	-1.75	-6.83	-19.86	-42.98
63000.	.6594	0.06	0.09	0.02	-1.00	-4.52	-14.25	-36.71	******
80000.	1.0376	0.08	0.06	-0.26	-2.97	-10.25	-27.78	-65.84	******
100000.	1.5976	0.08	-0.08	-1.02	-6.83	-19.86	-48.94	******	******

Table C.3 ANSI Class III, 1/3 Octave Band Filter for Known Received Spectrum

SBP= -6. DB/THIRD OCTAVE T = 305.4K (90.0F) RH = 90.0 %

FREQ HZ	A(F) DB/M	5	10	20	50	100	200	400	720
		DISTANCE, M							
4000.	.0284	-0.19	-0.19	-0.21	-0.24	-0.29	-0.40	-0.59	-0.82
5000.	.0342	-0.19	-0.20	-0.21	-0.26	-0.33	-0.46	-0.68	-0.93
6300.	.0429	-0.19	-0.20	-0.23	-0.29	-0.39	-0.56	-0.83	-1.01
8000.	.0564	-0.20	-0.22	-0.25	-0.34	-0.48	-0.72	-0.97	-0.81
10000.	.0760	-0.21	-0.23	-0.28	-0.42	-0.61	-0.89	-0.93	0.24
12500.	.1063	-0.22	-0.26	-0.33	-0.53	-0.78	-0.99	-0.27	3.21
16000.	.1597	-0.25	-0.31	-0.42	-0.70	-0.96	-0.71	2.29	10.41
20000.	.2361	-0.28	-0.37	-0.53	-0.88	-0.94	0.62	7.64	22.27
25000.	.3545	-0.33	-0.46	-0.68	-0.99	-0.34	4.05	17.40	41.75
31500.	.5452	-0.41	-0.60	-0.87	-0.80	1.75	11.17	34.25	99.99
40000.	.8541	-0.52	-0.77	-1.00	0.34	6.72	23.95	99.99	99.99
50000.	1.2974	-0.66	-0.94	-0.88	3.13	15.00	42.74	99.99	99.99
63000.	1.9878	-0.83	-1.02	-0.09	8.60	28.34	99.99	99.99	99.99
80000.	3.0515	-0.99	-0.79	1.99	17.55	28.88	99.99	99.99	99.99
100000.	4.4799	-1.04	-0.03	5.46	29.24	99.99	99.99	99.99	99.99

SBP= -4. DB/THIRD OCTAVE T = 305.4K (90.0F) RH = 90.0 %

FREQ HZ	A(F) DB/M	5	10	20	50	100	200	400	720
		DISTANCE, M							
4000.	.0284	-0.13	-0.14	-0.15	-0.17	-0.21	-0.29	-0.41	-0.55
5000.	.0342	-0.14	-0.14	-0.15	-0.18	-0.23	-0.33	-0.47	-0.59
6300.	.0429	-0.14	-0.15	-0.16	-0.21	-0.27	-0.39	-0.54	-0.54
8000.	.0564	-0.14	-0.15	-0.18	-0.24	-0.34	-0.48	-0.56	-0.14
10000.	.0760	-0.15	-0.17	-0.20	-0.30	-0.42	-0.55	-0.34	1.16
12500.	.1063	-0.16	-0.19	-0.24	-0.37	-0.51	-0.51	0.56	4.36
16000.	.1597	-0.18	-0.22	-0.30	-0.47	-0.56	0.01	3.39	11.71
20000.	.2361	-0.20	-0.26	-0.37	-0.55	-0.36	1.58	8.91	23.64
25000.	.3545	-0.24	-0.33	-0.46	-0.52	0.47	5.23	18.76	43.16
31500.	.5452	-0.29	-0.41	-0.55	-0.12	2.82	12.48	35.65	99.99
40000.	.8541	-0.36	-0.51	-0.54	1.28	7.97	25.33	99.99	99.99
50000.	1.2974	-0.45	-0.57	-0.23	4.28	16.34	44.16	99.99	99.99
63000.	1.9878	-0.54	-0.50	0.79	9.88	29.73	99.99	99.99	99.99
80000.	3.0515	-0.59	-0.09	3.08	18.90	29.58	99.99	99.99	99.99
100000.	4.4799	-0.51	0.87	6.68	30.64	99.99	99.99	99.99	99.99

SBP= -2. DB/THIRD OCTAVE T = 305.4K (90.0F) RH = 90.0 %

FREQ HZ	A(F) DB/M	5	10	20	50	100	200	400	720
		DISTANCE, M							
4000.	.0284	-0.07	-0.07	-0.08	-0.10	-0.12	-0.17	-0.23	-0.28
5000.	.0342	-0.07	-0.08	-0.08	-0.10	-0.13	-0.19	-0.25	-0.25
6300.	.0429	-0.07	-0.08	-0.09	-0.12	-0.16	-0.22	-0.25	-0.08
8000.	.0564	-0.08	-0.08	-0.10	-0.14	-0.19	-0.24	-0.15	0.51
10000.	.0760	-0.08	-0.09	-0.11	-0.17	-0.22	-0.22	0.24	2.03
12500.	.1063	-0.09	-0.10	-0.13	-0.20	-0.24	-0.04	1.35	5.42
16000.	.1597	-0.10	-0.12	-0.17	-0.24	-0.16	0.70	4.41	12.91
20000.	.2361	-0.11	-0.15	-0.20	-0.23	0.20	2.49	10.07	24.91
25000.	.3545	-0.13	-0.18	-0.24	-0.06	1.25	6.32	20.00	44.47
31500.	.5452	-0.16	-0.22	-0.23	0.53	3.81	13.69	36.95	99.99
40000.	.8541	-0.20	-0.25	-0.08	2.16	9.12	26.60	99.99	99.99
50000.	1.2974	-0.24	-0.21	0.40	5.34	17.57	45.47	99.99	99.99
63000.	1.9878	-0.25	-0.00	1.61	11.06	31.01	99.99	99.99	99.99
80000.	3.0515	-0.20	0.59	4.08	20.15	30.17	99.99	99.99	99.99
100000.	4.4799	0.00	1.71	7.80	31.92	99.99	99.99	99.99	99.99

SBP= 0. DB/THIRD OCTAVE T = 305.4K (90.0F) RH = 90.0 %

FREQ HZ	A(F) DB/M	5	10	20	50	100	200	400	720
		DISTANCE, M							
4000.	.0284	-0.00	-0.00	-0.01	-0.01	-0.02	-0.04	-0.05	-0.02
5000.	.0342	-0.00	-0.00	-0.01	-0.01	-0.03	-0.04	-0.03	0.09
6300.	.0429	-0.00	-0.00	-0.01	-0.02	-0.03	-0.04	0.04	0.37
8000.	.0564	-0.00	-0.01	-0.01	-0.03	-0.03	-0.00	0.25	1.13
10000.	.0760	-0.00	-0.01	-0.02	-0.03	-0.02	0.10	0.79	2.83
12500.	.1063	-0.01	-0.01	-0.02	-0.03	0.03	0.41	2.09	6.40
16000.	.1597	-0.01	-0.02	-0.03	-0.01	0.23	1.34	5.35	14.00
20000.	.2361	-0.02	-0.03	-0.03	0.09	0.75	3.33	11.14	26.07
25000.	.3545	-0.02	-0.03	-0.01	0.38	1.98	7.32	21.14	45.67
31500.	.5452	-0.03	-0.03	0.08	1.15	4.73	14.79	38.14	99.99
40000.	.8541	-0.04	0.01	0.36	2.97	10.17	27.76	99.99	99.99
50000.	1.2974	-0.02	0.14	1.00	6.31	18.70	46.67	99.99	99.99
63000.	1.9878	0.03	0.48	2.38	12.13	32.18	99.99	99.99	99.99
80000.	3.0515	0.19	1.23	5.01	21.29	30.66	99.99	99.99	99.99
100000.	4.4799	0.50	2.49	8.83	33.09	99.99	99.99	99.99	99.99

SBP= 2. DB/THIRD OCTAVE T = 305.4K (90.0F) RH = 90.0 %

FREQ HZ	A(F) DB/M	5	10	20	50	100	200	400	720
		DISTANCE, M							
4000.	.0284	0.07	0.07	0.07	0.07	0.08	0.09	0.13	0.25
5000.	.0342	0.07	0.07	0.07	0.08	0.08	0.11	0.19	0.41
6300.	.0429	0.07	0.07	0.08	0.08	0.10	0.14	0.32	0.79
8000.	.0564	0.07	0.08	0.08	0.09	0.12	0.23	0.63	1.71
10000.	.0760	0.08	0.08	0.08	0.11	0.17	0.42	1.31	3.58
12500.	.1063	0.08	0.08	0.09	0.14	0.29	0.85	2.78	7.28
16000.	.1597	0.08	0.08	0.11	0.23	0.61	1.95	6.21	15.00
20000.	.2361	0.08	0.10	0.14	0.41	1.26	4.10	12.11	27.12
25000.	.3545	0.09	0.12	0.21	0.81	2.66	8.23	22.18	46.76
31500.	.5452	0.10	0.16	0.38	1.73	5.56	15.79	39.22	99.99
40000.	.8541	0.13	0.27	0.78	3.73	11.12	28.82	99.99	99.99
50000.	1.2974	0.19	0.49	1.56	7.19	19.72	47.76	99.99	99.99
63000.	1.9878	0.31	0.94	3.09	13.11	33.26	99.99	99.99	99.99
80000.	3.0515	0.56	1.82	5.86	22.33	31.05	99.99	99.99	99.99
100000.	4.4799	0.97	3.72	9.77	34.17	99.99	99.99	99.99	99.99

SBP= -6, CB/THIRD OCTAVE T = 298.2K (77.0F) RH = 70.0 %

FREQ	A(F)				DISTANCE, M				
HZ	DB/M	5	10	20	50	100	200	400	720
4000.	.0226	-0.19	-0.20	-0.21	-0.25	-0.31	-0.43	-0.63	-0.86
5000.	.0304	-0.19	-0.20	-0.22	-0.28	-0.37	-0.54	-0.79	-0.99
6300.	.0430	-0.20	-0.21	-0.24	-0.33	-0.47	-0.70	-0.96	-0.84
8000.	.0636	-0.21	-0.23	-0.28	-0.42	-0.61	-0.88	-0.93	0.24
10000.	.0939	-0.22	-0.26	-0.33	-0.53	-0.78	-0.99	-0.28	3.20
12500.	.1407	-0.24	-0.30	-0.41	-0.68	-0.95	-0.79	1.84	9.30
16000.	.2223	-0.28	-0.37	-0.53	-0.87	-0.96	0.49	7.22	21.38
20000.	.3370	-0.33	-0.45	-0.67	-1.00	-0.47	3.52	16.02	39.03
25000.	.5092	-0.39	-0.57	-0.84	-0.91	1.09	9.19	29.71	99.99
31500.	.7739	-0.48	-0.72	-0.99	-0.27	4.47	18.42	31.16	99.99
40000.	1.1735	-0.60	-0.89	-1.03	1.39	10.12	31.78	99.99	99.99
50000.	1.6946	-0.73	-1.02	-0.84	3.99	17.19	0.92	99.99	99.99
63000.	2.4128	-0.86	-1.09	-0.31	7.60	25.91	******	99.99	99.99
80000.	3.3699	-0.97	-1.04	0.64	12.21	-0.92	99.99	99.99	99.99
100000.	4.4908	-1.05	-0.83	2.09	17.92	******	99.99	99.99	99.99

SBP= -4, CB/THIRD OCTAVE T = 298.2K (77.0F) RH = 70.0 %

FREQ	A(F)				DISTANCE, M				
HZ	DB/M	5	10	20	50	100	200	400	720
4000.	.0226	-0.14	-0.14	-0.15	-0.18	-0.22	-0.30	-0.43	-0.55
5000.	.0304	-0.14	-0.15	-0.16	-0.20	-0.27	-0.38	-0.52	-0.54
6300.	.0430	-0.14	-0.15	-0.18	-0.24	-0.33	-0.47	-0.%6	-0.19
8000.	.0636	-0.15	-0.17	-0.20	-0.30	-0.42	-0.55	-0.34	1.16
10000.	.0939	-0.16	-0.19	-0.24	-0.37	-0.51	-0.51	0.56	4.34
12500.	.1407	-0.17	-0.21	-0.29	-0.46	-0.56	-0.10	2.92	10.59
16000.	.2223	-0.20	-0.26	-0.37	-0.55	-0.39	1.44	8.48	22.75
20000.	.3370	-0.23	-0.32	-0.46	-0.55	0.32	4.68	17.37	40.44
25000.	.5092	-0.28	-0.40	-0.55	-0.28	2.11	10.48	31.11	99.99
31500.	.7739	-0.34	-0.49	-0.58	0.58	5.66	19.78	31.85	99.99
40000.	1.1735	-0.42	-0.57	-0.47	2.44	11.42	33.18	99.99	99.99
50000.	1.6946	-0.50	-0.61	-0.13	5.17	18.54	1.55	99.99	99.99
63000.	2.4128	-0.57	-0.58	0.54	8.86	27.29	******	99.99	99.99
80000.	3.3699	-0.63	-0.43	1.63	13.53	-0.30	99.99	99.99	99.99
100000.	4.4908	-0.64	-0.10	3.19	19.27	******	99.99	99.99	99.99

SBP= -2, CB/THIRD OCTAVE T = 298.2K (77.0F) RH = 70.0 %

FREQ	A(F)				DISTANCE, M				
HZ	DB/M	5	10	20	50	100	200	400	720
4000.	.0226	-0.07	-0.07	-0.08	-0.10	-0.12	-0.17	-0.23	-0.24
5000.	.0304	-0.07	-0.08	-0.09	-0.11	-0.15	-0.21	-0.24	-0.10
6300.	.0430	-0.08	-0.08	-0.10	-0.13	-0.18	-0.24	-0.16	0.44
8000.	.0636	-0.08	-0.09	-0.11	-0.17	-0.22	-0.22	0.24	2.03
10000.	.0939	-0.09	-0.10	-0.13	-0.20	-0.24	-0.04	1.35	5.40
12500.	.1407	-0.10	-0.12	-0.16	-0.24	-0.18	0.56	3.91	11.77
16000.	.2223	-0.11	-0.15	-0.20	-0.23	0.17	2.34	9.64	24.01
20000.	.3370	-0.13	-0.18	-0.24	-0.10	1.08	5.75	18.61	41.75
25000.	.5092	-0.16	-0.22	-0.25	0.33	3.06	11.66	32.39	99.99
31500.	.7739	-0.19	-0.25	-0.18	1.38	6.76	21.03	32.43	99.99
40000.	1.1735	-0.23	-0.26	0.06	3.41	12.61	34.47	99.99	99.99
50000.	1.6946	-0.27	-0.22	0.55	6.26	19.78	2.02	99.99	99.99
63000.	2.4128	-0.29	-0.09	1.35	10.02	28.57	******	99.99	99.99
80000.	3.3699	-0.28	0.17	2.55	14.73	0.20	99.99	99.99	99.99
100000.	4.4908	-0.23	0.59	4.20	20.51	******	99.99	99.99	99.99

SBP= 0, CB/THIRD OCTAVE T = 298.2K (77.0F) RH = 70.0 %

FREQ	A(F)				DISTANCE, M				
HZ	DB/M	5	10	20	50	100	200	400	720
4000.	.0226	-0.00	-0.00	-0.01	-0.01	-0.02	-0.03	-0.02	0.07
5000.	.0304	-0.00	-0.00	-0.01	-0.02	-0.03	-0.03	0.03	0.33
6300.	.0430	-0.00	-0.01	-0.01	-0.02	-0.03	-0.01	0.22	1.04
8000.	.0636	-0.00	-0.01	-0.02	-0.03	-0.02	0.10	0.79	2.83
10000.	.0939	-0.01	-0.01	-0.02	-0.03	0.03	0.41	2.08	6.38
12500.	.1407	-0.01	-0.02	-0.03	-0.01	0.19	1.18	4.83	12.86
16000.	.2223	-0.02	-0.03	-0.03	0.08	0.70	3.17	10.70	25.17
20000.	.3370	-0.02	-0.04	-0.02	0.33	1.78	6.74	19.74	42.94
25000.	.5092	-0.03	-0.04	0.04	0.91	3.94	12.75	33.57	99.99
31500.	.7739	-0.04	-0.02	0.21	2.13	7.77	22.17	32.90	99.99
40000.	1.1735	-0.04	0.04	0.58	4.31	13.70	35.65	99.99	99.99
50000.	1.6946	-0.03	0.17	1.18	7.26	20.92	2.28	99.99	99.99
63000.	2.4128	-0.01	0.38	2.10	11.08	29.73	******	99.95	99.99
80000.	3.3699	0.06	0.73	3.40	15.84	0.59	99.99	99.99	99.99
100000.	4.4908	0.17	1.25	5.14	21.65	******	99.99	99.99	99.99

SBP= 2, CB/THIRD OCTAVE T = 298.2K (77.0F) RH = 70.0 %

FREQ	A(F)				DISTANCE, M				
HZ	DB/M	5	10	20	50	100	200	400	720
4000.	.0226	0.07	0.07	0.08	0.08	0.08	0.11	0.18	0.38
5000.	.0304	0.07	0.07	0.08	0.08	0.10	0.14	0.30	0.74
6300.	.0430	0.07	0.08	0.08	0.09	0.12	0.22	0.60	1.60
8000.	.0636	0.08	0.08	0.08	0.11	0.17	0.42	1.31	3.58
10000.	.0939	0.08	0.08	0.09	0.14	0.29	0.85	2.77	7.26
12500.	.1407	0.08	0.08	0.10	0.21	0.55	1.77	5.67	13.85
16000.	.2223	0.08	0.09	0.14	0.39	1.20	3.93	11.66	26.22
20000.	.3370	0.09	0.11	0.20	0.75	2.44	7.63	20.77	44.03
25000.	.5092	0.10	0.15	0.33	1.46	4.74	13.73	34.64	99.99
31500.	.7739	0.11	0.21	0.59	2.82	8.69	23.22	33.27	99.99
40000.	1.1735	0.15	0.34	1.07	5.13	14.69	36.73	99.99	99.99
50000.	1.6946	0.20	0.54	1.78	8.16	21.95	2.44	99.99	99.99
63000.	2.4128	0.27	0.83	2.80	12.05	30.79	******	99.99	99.99
80000.	3.3699	0.38	1.26	4.18	16.85	0.88	99.99	99.99	99.99
100000.	4.4908	0.55	1.86	5.99	22.69	******	99.99	99.99	99.99

SBP= -6. DB/THIRD OCTAVE T = 288.2K (59.0F) RH = 70.0 %

FREQ	A(F)	DISTANCE, M							
HZ	DB/M	5	10	20	50	100	200	400	720
4000.	.0251	-0.19	-0.20	-0.22	-0.28	-0.37	-0.54	-0.79	-0.98
5000.	.0371	-0.20	-0.21	-0.24	-0.33	-0.47	-0.69	-0.95	-0.87
6300.	.0564	-0.21	-0.23	-0.28	-0.41	-0.60	-0.87	-0.96	0.06
8000.	.0877	-0.22	-0.26	-0.33	-0.52	-0.78	-1.00	-0.37	2.88
10000.	.1327	-0.24	-0.30	-0.40	-0.67	-0.94	-0.86	1.43	8.24
12500.	.1999	-0.27	-0.35	-0.50	-0.83	-1.02	-0.09	5.17	16.98
16000.	.3106	-0.31	-0.43	-0.63	-0.99	-0.78	2.06	12.05	31.15
20000.	.4542	-0.36	-0.52	-0.77	-1.05	-0.06	5.37	20.61	16.19
25000.	.6480	-0.42	-0.61	-0.91	-0.95	1.23	9.66	30.68	******
31500.	.9066	-0.48	-0.71	-1.02	-0.66	2.98	14.53	-20.77	******
40000.	1.2352	-0.54	-0.81	-1.10	-0.20	4.96	19.55	******	99.99
50000.	1.5970	-0.59	-0.88	-1.13	0.41	7.12	13.68	******	99.99
63000.	2.0369	-0.65	-0.95	-1.09	1.52	10.53	-68.43	99.99	99.99
80000.	2.5989	-0.73	-1.02	-0.85	3.94	17.06	******	99.99	99.99
100000.	3.2958	-0.85	-1.04	-0.09	8.64	2.87	99.99	99.99	99.99

SBP= -4. DB/THIRD OCTAVE T = 288.2K (59.0F) RH = 70.0 %

FREQ	A(F)	DISTANCE, M							
HZ	DB/M	5	10	20	50	100	200	400	720
4000.	.0251	-0.14	-0.15	-0.16	-0.20	-0.26	-0.37	-0.52	-0.54
5000.	.0371	-0.14	-0.15	-0.17	-0.24	-0.33	-0.47	-0.56	-0.22
6300.	.0564	-0.15	-0.17	-0.20	-0.29	-0.41	-0.55	-0.39	0.96
8000.	.0877	-0.16	-0.18	-0.24	-0.37	-0.51	-0.53	0.45	4.01
10000.	.1327	-0.17	-0.21	-0.28	-0.45	-0.57	-0.20	2.47	9.51
12500.	.1999	-0.19	-0.25	-0.35	-0.54	-0.50	0.79	6.39	18.34
16000.	.3106	-0.22	-0.30	-0.44	-0.59	-0.07	3.15	13.36	32.55
20000.	.4542	-0.26	-0.36	-0.52	-0.52	0.84	6.58	21.98	16.85
25000.	.6480	-0.30	-0.43	-0.59	-0.29	2.27	10.96	32.08	******
31500.	.9066	-0.34	-0.50	-0.64	0.12	4.12	15.86	-20.16	******
40000.	1.2352	-0.38	-0.55	-0.66	0.69	6.17	20.91	******	99.99
50000.	1.5970	-0.42	-0.59	-0.63	1.38	8.38	14.42	******	99.99
63000.	2.0369	-0.45	-0.62	-0.51	2.58	11.83	-67.81	99.99	99.99
80000.	2.5989	-0.50	-0.62	-0.14	5.12	18.42	******	99.99	99.99
100000.	3.2958	-0.55	-0.52	0.79	9.92	3.48	99.99	99.99	99.99

SBP= -2. DB/THIRD OCTAVE T = 288.2K (59.0F) RH = 70.0 %

FREQ	A(F)	DISTANCE, M							
HZ	DB/M	5	10	20	50	100	200	400	720
4000.	.0251	-0.07	-0.08	-0.09	-0.11	-0.15	-0.20	-0.24	-0.10
5000.	.0371	-0.08	-0.08	-0.10	-0.13	-0.18	-0.24	-0.17	0.40
6300.	.0564	-0.08	-0.09	-0.11	-0.16	-0.22	-0.23	0.17	1.80
8000.	.0877	-0.09	-0.10	-0.13	-0.20	-0.25	-0.07	1.22	5.06
10000.	.1327	-0.10	-0.12	-0.16	-0.24	-0.21	0.43	3.45	10.69
12500.	.1999	-0.11	-0.14	-0.20	-0.25	-0.00	1.62	7.50	19.58
16000.	.3106	-0.13	-0.17	-0.24	-0.19	0.61	4.16	14.58	33.84
20000.	.4542	-0.15	-0.21	-0.27	-0.01	1.68	7.70	23.23	17.37
25000.	.6480	-0.17	-0.24	-0.28	0.34	3.24	12.14	33.36	******
31500.	.9066	-0.20	-0.27	-0.27	0.87	5.17	17.09	-19.69	******
40000.	1.2352	-0.22	-0.30	-0.22	1.52	7.28	22.16	******	99.99
50000.	1.5970	-0.24	-0.31	-0.14	2.29	9.53	15.03	******	99.99
63000.	2.0369	-0.26	-0.29	0.05	3.57	13.02	-67.44	99.99	99.99
80000.	2.5989	-0.27	-0.22	0.53	6.20	19.66	******	99.99	99.99
100000.	3.2958	-0.26	-0.01	1.62	11.10	3.98	99.99	99.99	99.99

SBP= 0. DB/THIRD OCTAVE T = 288.2K (59.0F) RH = 70.0 %

FREQ	A(F)	DISTANCE, M							
HZ	DB/M	5	10	20	50	100	200	400	720
4000.	.0251	-0.00	-0.00	-0.01	-0.02	-0.03	-0.03	0.03	0.33
5000.	.0371	-0.00	-0.01	-0.01	-0.02	-0.03	-0.01	0.21	0.99
6300.	.0564	-0.00	-0.01	-0.02	-0.03	-0.03	0.08	0.70	2.58
8000.	.0877	-0.01	-0.01	-0.02	-0.04	0.02	0.37	1.95	6.02
10000.	.1327	-0.01	-0.02	-0.03	-0.02	0.15	1.03	4.34	11.76
12500.	.1999	-0.02	-0.03	-0.04	0.03	0.48	2.39	8.53	20.72
16000.	.3106	-0.02	-0.04	-0.04	0.19	1.25	5.09	15.68	35.02
20000.	.4542	-0.03	-0.05	-0.02	0.48	2.46	8.73	24.38	17.78
25000.	.6480	-0.04	-0.05	0.02	0.94	4.13	13.23	34.54	******
31500.	.9066	-0.05	-0.05	0.09	1.56	6.14	18.21	-19.43	******
40000.	1.2352	-0.06	-0.05	0.20	2.29	8.29	23.30	******	99.99
50000.	1.5970	-0.06	-0.03	0.33	3.12	10.58	15.43	******	99.99
63000.	2.0369	-0.06	0.03	0.59	4.48	14.11	-67.18	99.99	99.99
80000.	2.5989	-0.04	0.16	1.17	7.20	20.79	******	99.99	99.99
100000.	3.2958	0.03	0.47	2.39	12.18	4.38	99.99	99.99	99.99

SBP= 2. DB/THIRD OCTAVE T = 288.2K (59.0F) RH = 70.0 %

FREQ	A(F)	DISTANCE, M							
HZ	DB/M	5	10	20	50	100	200	400	720
4000.	.0251	0.07	0.07	0.08	0.08	0.10	0.14	0.30	0.74
5000.	.0371	0.07	0.08	0.08	0.09	0.12	0.22	0.58	1.55
6300.	.0564	0.07	0.08	0.08	0.10	0.17	0.39	1.21	3.31
8000.	.0877	0.08	0.08	0.09	0.13	0.28	0.80	2.62	6.90
10000.	.1327	0.08	0.08	0.10	0.19	0.50	1.60	5.17	12.73
12500.	.1999	0.08	0.09	0.12	0.31	0.94	3.10	9.46	21.75
16000.	.3106	0.08	0.10	0.16	0.57	1.85	5.94	16.69	36.09
20000.	.4542	0.09	0.11	0.23	0.95	3.18	9.66	25.43	18.08
25000.	.6480	0.09	0.14	0.32	1.51	4.94	14.21	35.61	******
31500.	.9066	0.09	0.16	0.45	2.21	7.02	19.23	-19.27	******
40000.	1.2352	0.10	0.20	0.60	3.01	9.22	24.35	******	99.99
50000.	1.5970	0.11	0.25	0.78	3.89	11.54	15.73	******	99.99
63000.	2.0369	0.14	0.33	1.09	5.31	15.11	-67.02	99.99	99.99
80000.	2.5989	0.19	0.53	1.76	8.10	21.83	******	99.99	99.99
100000.	3.2958	0.31	0.94	3.11	13.16	4.66	99.99	99.99	99.99

SBP= -6. DB/THIRD OCTAVE   T = 277.6K (40.0F)   RH = 10.0 %

FREQ HZ	A(F) DB/M	5	10	20	50	100	200	400	720
		DISTANCE, M							
4000.	.0418	-0.19	-0.19	-0.19	-0.21	-0.24	-0.29	-0.39	-0.55
5000.	.0441	-0.19	-0.19	-0.19	-0.21	-0.24	-0.30	-0.40	-0.56
6300.	.0471	-0.19	-0.19	-0.20	-0.22	-0.25	-0.32	-0.45	-0.63
8000.	.0513	-0.19	-0.19	-0.20	-0.23	-0.28	-0.38	-0.54	-0.76
10000.	.0571	-0.19	-0.20	-0.21	-0.26	-0.33	-0.46	-0.68	-0.91
12500.	.0660	-0.19	-0.21	-0.23	-0.29	-0.40	-0.58	-0.85	-0.99
16000.	.0817	-0.20	-0.22	-0.26	-0.36	-0.52	-0.76	-0.99	-0.61
20000.	.1041	-0.21	-0.24	-0.30	-0.45	-0.66	-0.93	-0.82	0.94
25000.	.1392	-0.23	-0.27	-0.36	-0.58	-0.84	-0.97	0.25	4.91
31500.	.1963	-0.25	-0.32	-0.45	-0.75	-0.98	-0.47	3.46	13.18
40000.	.2909	-0.30	-0.40	-0.58	-0.93	-0.82	1.60	10.72	28.57
50000.	.4309	-0.35	-0.51	-0.75	-0.97	0.24	6.35	23.09	99.99
63000.	.6594	-0.45	-0.66	-0.93	-0.47	3.46	15.86	44.69	99.99
80000.	1.0376	-0.58	-0.85	-0.96	1.60	10.72	33.25	99.99	99.99
100000.	1.5976	-0.75	-0.98	-0.46	6.35	23.09	99.99	99.99	99.99

SBP= -4. DB/THIRD OCTAVE   T = 277.6K (40.0F)   RH = 10.0 %

FREQ HZ	A(F) DB/M	5	10	20	50	100	200	400	720
		DISTANCE, M							
4000.	.0418	-0.13	-0.13	-0.14	-0.15	-0.17	-0.21	-0.29	-0.39
5000.	.0441	-0.13	-0.13	-0.14	-0.15	-0.17	-0.21	-0.29	-0.40
6300.	.0471	-0.13	-0.14	-0.14	-0.16	-0.18	-0.23	-0.32	-0.44
8000.	.0513	-0.13	-0.14	-0.15	-0.17	-0.20	-0.27	-0.38	-0.51
10000.	.0571	-0.14	-0.14	-0.15	-0.18	-0.23	-0.32	-0.46	-0.56
12500.	.0660	-0.14	-0.15	-0.16	-0.21	-0.28	-0.40	-0.54	-0.49
16000.	.0817	-0.14	-0.16	-0.18	-0.26	-0.36	-0.50	-0.53	0.13
20000.	.1041	-0.15	-0.17	-0.21	-0.32	-0.45	-0.56	-0.15	1.94
25000.	.1392	-0.16	-0.19	-0.25	-0.40	-0.54	-0.43	1.17	6.12
31500.	.1963	-0.18	-0.23	-0.32	-0.50	-0.53	0.31	4.62	14.51
40000.	.2909	-0.21	-0.28	-0.40	-0.56	-0.15	2.66	12.03	29.96
50000.	.4309	-0.25	-0.35	-0.50	-0.43	1.17	7.59	24.47	99.99
63000.	.6594	-0.32	-0.45	-0.56	0.31	4.62	17.21	46.12	99.99
80000.	1.0376	-0.40	-0.54	-0.41	2.66	12.03	34.65	99.99	99.99
100000.	1.5976	-0.50	-0.53	0.34	7.59	24.47	99.99	99.99	99.99

SBP= -2. DB/THIRD OCTAVE   T = 277.6K (40.0F)   RH = 10.0 %

FREQ HZ	A(F) DB/M	5	10	20	50	100	200	400	720
		DISTANCE, M							
4000.	.0418	-0.07	-0.07	-0.07	-0.08	-0.10	-0.12	-0.17	-0.23
5000.	.0441	-0.07	-0.07	-0.07	-0.08	-0.10	-0.12	-0.17	-0.23
6300.	.0471	-0.07	-0.07	-0.08	-0.09	-0.10	-0.13	-0.18	-0.24
8000.	.0513	-0.07	-0.07	-0.08	-0.09	-0.11	-0.15	-0.21	-0.25
10000.	.0571	-0.07	-0.08	-0.08	-0.10	-0.13	-0.18	-0.24	-0.22
12500.	.0660	-0.07	-0.08	-0.09	-0.12	-0.16	-0.22	-0.23	0.00
16000.	.0817	-0.08	-0.09	-0.10	-0.14	-0.20	-0.24	-0.07	0.84
20000.	.1041	-0.08	-0.09	-0.12	-0.18	-0.23	-0.19	0.49	2.88
25000.	.1392	-0.09	-0.11	-0.14	-0.21	-0.23	0.10	2.03	7.23
31500.	.1963	-0.10	-0.13	-0.18	-0.24	-0.09	1.06	5.69	15.73
40000.	.2909	-0.12	-0.16	-0.22	-0.19	0.49	3.64	13.23	31.25
50000.	.4309	-0.14	-0.20	-0.24	0.10	2.03	8.74	25.74	99.99
63000.	.6594	-0.18	-0.23	-0.19	1.06	5.68	18.45	47.42	99.99
80000.	1.0376	-0.22	-0.23	0.13	3.64	13.23	35.95	99.99	99.99
100000.	1.5976	-0.24	-0.09	1.09	8.73	25.73	99.99	99.99	99.99

SBP= 0. DB/THIRD OCTAVE   T = 277.6K (40.0F)   RH = 10.0 %

FREQ HZ	A(F) DB/M	5	10	20	50	100	200	400	720
		DISTANCE, M							
4000.	.0418	-0.00	-0.00	-0.00	-0.01	-0.01	-0.03	-0.05	-0.07
5000.	.0441	-0.00	-0.00	-0.00	-0.01	-0.01	-0.03	-0.04	-0.06
6300.	.0471	-0.00	-0.00	-0.00	-0.01	-0.01	-0.03	-0.04	-0.04
8000.	.0513	-0.00	-0.00	-0.00	-0.01	-0.02	-0.03	-0.04	0.00
10000.	.0571	-0.00	-0.00	-0.01	-0.01	-0.02	-0.03	-0.02	0.13
12500.	.0660	-0.00	-0.00	-0.01	-0.02	-0.03	-0.03	0.07	0.48
16000.	.0817	-0.00	-0.01	-0.01	-0.03	-0.03	0.02	0.37	1.52
20000.	.1041	-0.01	-0.01	-0.02	-0.03	-0.01	0.17	1.10	3.74
25000.	.1392	-0.01	-0.02	-0.03	-0.03	0.07	0.61	2.84	8.25
31500.	.1963	-0.01	-0.02	-0.03	0.01	0.33	1.76	6.67	16.85
40000.	.2909	-0.02	-0.03	-0.03	0.17	1.10	4.54	14.33	32.42
50000.	.4309	-0.03	-0.03	0.01	0.61	2.83	9.78	26.90	99.99
63000.	.6594	-0.03	-0.01	0.17	1.76	6.67	19.58	48.62	99.99
80000.	1.0376	-0.03	0.08	0.65	4.54	14.33	37.13	99.99	99.99
100000.	1.5976	0.01	0.34	1.79	9.78	26.90	99.99	99.99	99.99

SBP= 2. DB/THIRD OCTAVE   T = 277.6K (40.0F)   RH = 10.0 %

FREQ HZ	A(F) DB/M	5	10	20	50	100	200	400	720
		DISTANCE, M							
4000.	.0418	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.09
5000.	.0441	0.07	0.07	0.07	0.07	0.07	0.07	0.08	0.11
6300.	.0471	0.07	0.07	0.07	0.07	0.08	0.08	0.10	0.15
8000.	.0513	0.07	0.07	0.07	0.08	0.08	0.09	0.14	0.25
10000.	.0571	0.07	0.07	0.08	0.08	0.09	0.11	0.21	0.46
12500.	.0660	0.07	0.07	0.08	0.08	0.10	0.16	0.37	0.93
16000.	.0817	0.07	0.08	0.08	0.09	0.13	0.28	0.79	2.14
20000.	.1041	0.08	0.08	0.08	0.11	0.20	0.53	1.67	4.54
25000.	.1392	0.08	0.08	0.09	0.16	0.36	1.10	3.58	9.17
31500.	.1963	0.08	0.09	0.11	0.26	0.74	2.42	7.56	17.87
40000.	.2909	0.08	0.10	0.16	0.53	1.67	5.37	15.33	33.49
50000.	.4309	0.09	0.13	0.27	1.09	3.58	10.73	27.96	99.99
63000.	.6594	0.11	0.20	0.52	2.42	7.56	20.61	49.72	99.99
80000.	1.0376	0.16	0.37	1.14	5.37	15.33	38.21	99.99	99.99
100000.	1.5976	0.27	0.75	2.45	10.73	27.96	99.99	99.99	99.99

Table C.4 Perfect 1/3 Octave Band Filter for Known Received Spectrum

SBP= -6. DB/THIRD OCTAVE T = 305.4K (90.0F) RH = 90.0 %

FREQ HZ	A(F) DB/M	DISTANCE, M 5	10	20	50	100	200	400	720
4000.	.0284	-0.30	-0.30	-0.31	-0.32	-0.35	-0.39	-0.47	-0.55
5000.	.0342	-0.30	-0.30	-0.31	-0.33	-0.36	-0.42	-0.50	-0.55
6300.	.0429	-0.30	-0.31	-0.32	-0.34	-0.39	-0.45	-0.53	-0.48
8000.	.0564	-0.30	-0.31	-0.33	-0.37	-0.42	-0.50	-0.51	-0.09
10000.	.0760	-0.31	-0.32	-0.34	-0.40	-0.47	-0.53	-0.28	1.12
12500.	.1063	-0.31	-0.33	-0.36	-0.44	-0.52	-0.45	0.56	4.17
16000.	.1597	-0.32	-0.35	-0.40	-0.50	-0.51	0.05	3.23	11.37
20000.	.2361	-0.34	-0.38	-0.44	-0.53	-0.30	1.52	8.61	23.23
25000.	.3545	-0.36	-0.42	-0.49	-0.47	0.48	5.01	18.37	42.71
31500.	.5452	-0.39	-0.47	-0.53	-0.07	2.69	12.13	35.21	-49.46
40000.	.8541	-0.44	-0.52	-0.48	1.23	7.68	24.91	0.38	******
50000.	1.2974	-0.49	-0.54	-0.17	4.09	15.96	43.71	******	******
63000.	1.9878	-0.53	-0.44	0.77	9.56	29.30	-57.51	******	******
80000.	3.0515	-0.54	-0.04	2.93	18.51	29.84	******	******	******
100000.	4.4799	-0.44	0.85	6.42	30.21	******	******	******	******

SBP= -4. DB/THIRD OCTAVE T = 305.4K (90.0F) RH = 90.0 %

FREQ HZ	A(F) DB/M	DISTANCE, M 5	10	20	50	100	200	400	720
4000.	.0284	-0.20	-0.20	-0.21	-0.21	-0.23	-0.26	-0.29	-0.31
5000.	.0342	-0.20	-0.20	-0.21	-0.22	-0.24	-0.27	-0.29	-0.26
6300.	.0429	-0.20	-0.20	-0.21	-0.23	-0.25	-0.28	-0.28	-0.09
8000.	.0564	-0.20	-0.21	-0.22	-0.24	-0.27	-0.28	-0.16	0.46
10000.	.0760	-0.21	-0.21	-0.22	-0.25	-0.28	-0.24	0.20	1.87
12500.	.1063	-0.21	-0.22	-0.24	-0.27	-0.28	-0.06	1.24	5.12
16000.	.1597	-0.22	-0.23	-0.25	-0.28	-0.17	0.63	4.14	12.47
20000.	.2361	-0.22	-0.24	-0.27	-0.25	0.17	2.30	9.67	24.41
25000.	.3545	-0.24	-0.26	-0.28	-0.08	1.14	5.99	19.52	43.93
31500.	.5452	-0.25	-0.28	-0.26	0.48	3.56	13.24	36.42	-49.17
40000.	.8541	-0.27	-0.28	-0.10	1.99	8.73	26.09	0.67	******
50000.	1.2974	-0.29	-0.23	0.36	5.03	17.10	44.93	******	******
63000.	1.9878	-0.28	-0.02	1.48	10.64	30.49	-57.23	******	******
80000.	3.0515	-0.21	0.53	3.82	19.67	30.34	******	******	******
100000.	4.4799	-0.01	1.57	7.44	31.40	******	******	******	******

SBP= -2. DB/THIRD OCTAVE T = 305.4K (90.0F) RH = 90.0 %

FREQ HZ	A(F) DB/M	DISTANCE, M 5	10	20	50	100	200	400	720
4000.	.0284	-0.10	-0.10	-0.10	-0.11	-0.11	-0.12	-0.11	-0.06
5000.	.0342	-0.10	-0.10	-0.10	-0.11	-0.11	-0.11	-0.09	0.04
6300.	.0429	-0.10	-0.10	-0.10	-0.11	-0.11	-0.10	-0.02	0.30
8000.	.0564	-0.10	-0.10	-0.10	-0.11	-0.11	-0.06	0.19	1.00
10000.	.0760	-0.10	-0.10	-0.11	-0.11	-0.09	0.05	0.68	2.59
12500.	.1063	-0.10	-0.11	-0.11	-0.10	-0.03	0.34	1.90	6.02
16000.	.1597	-0.10	-0.11	-0.11	-0.06	0.17	1.20	5.01	13.51
20000.	.2361	-0.11	-0.11	-0.10	0.04	0.65	3.06	10.68	25.51
25000.	.3545	-0.11	-0.11	-0.07	0.31	1.79	6.92	20.61	45.07
31500.	.5452	-0.11	-0.09	0.02	1.02	4.40	14.29	37.55	-48.96
40000.	.8541	-0.10	-0.04	0.29	2.73	9.72	27.20	0.88	******
50000.	1.2974	-0.08	0.09	0.88	5.93	18.17	46.07	******	******
63000.	1.9878	-0.02	0.40	2.17	11.66	31.61	-57.01	******	******
80000.	3.0515	0.13	1.09	4.68	20.75	30.78	******	******	******
100000.	4.4799	0.42	2.27	8.41	32.52	******	******	******	******

SBP= 0. DB/THIRD OCTAVE T = 305.4K (90.0F) RH = 90.0 %

FREQ HZ	A(F) DB/M	DISTANCE, M 5	10	20	50	100	200	400	720
4000.	.0284	0.00	0.00	0.00	0.00	0.01	0.02	0.07	0.18
5000.	.0342	0.00	0.00	0.00	0.01	0.02	0.04	0.12	0.33
6300.	.0429	0.00	0.00	0.00	0.01	0.03	0.08	0.24	0.68
8000.	.0564	0.00	0.00	0.01	0.02	0.06	0.16	0.53	1.53
10000.	.0760	0.00	0.01	0.01	0.04	0.11	0.34	1.16	3.29
12500.	.1063	0.00	0.01	0.02	0.07	0.22	0.73	2.53	6.87
16000.	.1597	0.01	0.02	0.04	0.16	0.51	1.75	5.82	14.48
20000.	.2361	0.01	0.03	0.08	0.33	1.11	3.79	11.62	26.54
25000.	.3545	0.02	0.05	0.15	0.70	2.41	7.80	21.62	46.14
31500.	.5452	0.04	0.10	0.31	1.55	5.20	15.27	38.61	-48.82
40000.	.8541	0.07	0.20	0.67	3.43	10.64	28.24	1.02	******
50000.	1.2974	0.13	0.40	1.39	6.78	19.17	47.14	******	******
63000.	1.9878	0.24	0.82	2.83	12.61	32.66	-56.88	******	******
80000.	3.0515	0.47	1.63	5.48	21.77	31.14	******	******	******
100000.	4.4799	0.84	2.94	9.31	33.57	******	******	******	******

SBP= 2. DB/THIRD OCTAVE T = 305.4K (90.0F) RH = 90.0 %

FREQ HZ	A(F) DB/M	DISTANCE, M 5	10	20	50	100	200	400	720
4000.	.0284	0.10	0.10	0.11	0.11	0.13	0.16	0.25	0.43
5000.	.0342	0.10	0.10	0.11	0.12	0.14	0.20	0.33	0.63
6300.	.0429	0.10	0.11	0.11	0.13	0.17	0.26	0.50	1.06
8000.	.0564	0.11	0.11	0.12	0.15	0.22	0.39	0.88	2.03
10000.	.0760	0.11	0.12	0.13	0.19	0.31	0.63	1.61	3.94
12500.	.1063	0.11	0.12	0.15	0.25	0.47	1.12	3.13	7.66
16000.	.1597	0.12	0.14	0.19	0.38	0.85	2.28	6.59	15.38
20000.	.2361	0.13	0.17	0.25	0.61	1.56	4.47	12.49	27.50
25000.	.3545	0.15	0.21	0.36	1.08	3.01	8.61	22.56	47.14
31500.	.5452	0.18	0.29	0.59	2.06	5.94	16.17	39.60	-48.76
40000.	.8541	0.24	0.44	1.04	4.09	11.51	29.21	1.08	******
50000.	1.2974	0.33	0.71	1.88	7.57	20.11	48.14	******	******
63000.	1.9876	0.50	1.22	3.45	13.49	33.64	-56.81	******	******
80000.	3.0515	0.80	2.16	6.23	22.71	31.43	******	******	******
100000.	4.4799	1.26	3.58	10.15	34.55	******	******	******	******

SBP= -6. DB/THIRD OCTAVE   T = 288.2K (59.0F)   RH = 70.0 %

FREQ HZ	A(F) DB/M	DISTANCE, M 5	10	20	50	100	200	400	720
4000.	.0251	-0.30	-0.31	-0.31	-0.34	-0.38	-0.44	-0.52	-0.48
5000.	.0371	-0.30	-0.31	-0.32	-0.36	-0.42	-0.50	-0.52	-0.17
6300.	.0564	-0.31	-0.32	-0.34	-0.39	-0.47	-0.53	-0.32	0.93
8000.	.0877	-0.31	-0.33	-0.36	-0.44	-0.52	-0.47	0.46	3.83
10000.	.1327	-0.32	-0.35	-0.39	-0.49	-0.53	-0.15	2.36	9.20
12500.	.1999	-0.33	-0.37	-0.43	-0.53	-0.44	0.78	6.13	17.95
16000.	.3106	-0.35	-0.40	-0.48	-0.54	-0.02	3.00	13.01	32.12
20000.	.4542	-0.37	-0.44	-0.53	-0.45	0.82	6.33	21.57	15.76
25000.	.6480	-0.40	-0.48	-0.57	-0.22	2.17	10.63	31.65	******
31500.	.9066	-0.43	-0.52	-0.59	0.16	3.93	15.49	-20.56	******
40000.	1.2352	-0.45	-0.55	-0.58	0.68	5.92	20.51	******	******
50000.	1.5970	-0.47	-0.57	-0.54	1.33	8.09	14.64	******	******
63000.	2.0369	-0.49	-0.58	-0.42	2.46	11.49	-68.38	******	******
80000.	2.5989	-0.52	-0.56	-0.08	4.90	18.03	******	******	******
100000.	3.2958	-0.54	-0.45	0.77	9.61	3.83	******	******	******

SBP= -4. DB/THIRD OCTAVE   T = 288.2K (59.0F)   RH = 70.0 %

FREQ HZ	A(F) DB/M	DISTANCE, M 5	10	20	50	100	200	400	720
4000.	.0251	-0.20	-0.20	-0.21	-0.22	-0.25	-0.27	-0.27	-0.11
5000.	.0371	-0.20	-0.21	-0.21	-0.24	-0.26	-0.28	-0.19	0.35
6300.	.0564	-0.21	-0.21	-0.22	-0.25	-0.28	-0.25	0.14	1.65
8000.	.0877	-0.21	-0.22	-0.24	-0.27	-0.28	-0.09	1.11	4.77
10000.	.1327	-0.21	-0.23	-0.25	-0.29	-0.22	0.38	3.21	10.28
12500.	.1999	-0.22	-0.24	-0.27	-0.28	-0.02	1.48	7.15	19.10
16000.	.3106	-0.23	-0.26	-0.29	-0.20	0.55	3.90	14.13	33.31
20000.	.4542	-0.25	-0.28	-0.30	-0.02	1.54	7.34	22.74	16.23
25000.	.6480	-0.26	-0.30	-0.30	0.31	3.02	11.72	32.84	******
31500.	.9066	-0.28	-0.31	-0.27	0.79	4.88	16.63	-20.15	******
40000.	1.2352	-0.29	-0.32	-0.22	1.39	6.93	21.67	******	******
50000.	1.5970	-0.30	-0.32	-0.14	2.11	9.14	15.18	******	******
63000.	2.0369	-0.31	-0.30	0.04	3.33	12.59	-67.96	******	******
80000.	2.5989	-0.31	-0.23	0.48	5.88	19.18	******	******	******
100000.	3.2958	-0.29	-0.03	1.49	10.69	4.25	******	******	******

SBP= -2. DB/THIRD OCTAVE   T = 288.2K (59.0F)   RH = 70.0 %

FREQ HZ	A(F) DB/M	DISTANCE, M 5	10	20	50	100	200	400	720
4000.	.0251	-0.10	-0.10	-0.10	-0.11	-0.11	-0.10	-0.02	0.26
5000.	.0371	-0.10	-0.10	-0.10	-0.11	-0.11	-0.07	0.15	0.87
6300.	.0564	-0.10	-0.10	-0.11	-0.11	-0.09	0.03	0.61	2.36
8000.	.0877	-0.10	-0.11	-0.11	-0.10	-0.04	0.30	1.76	5.66
10000.	.1327	-0.10	-0.11	-0.11	-0.08	0.10	0.91	4.03	11.29
12500.	.1999	-0.11	-0.11	-0.11	-0.02	0.40	2.17	8.10	20.18
16000.	.3106	-0.11	-0.11	-0.10	0.14	1.11	4.75	15.18	34.44
20000.	.4542	-0.11	-0.11	-0.07	0.41	2.24	8.31	23.84	16.59
25000.	.6480	-0.12	-0.11	-0.02	0.83	3.83	12.74	33.97	******
31500.	.9066	-0.12	-0.11	0.05	1.40	5.77	17.69	-19.81	******
40000.	1.2352	-0.13	-0.09	0.14	2.08	7.88	22.76	******	******
50000.	1.5970	-0.12	-0.07	0.27	2.87	10.13	15.63	******	******
63000.	2.0369	-0.12	-0.02	0.50	4.16	13.63	-67.61	******	******
80000.	2.5989	-0.09	0.11	1.04	6.80	20.26	******	******	******
100000.	3.2958	-0.02	0.40	2.18	11.70	4.59	******	******	******

SBP= 0. DB/THIRD OCTAVE   T = 288.2K (59.0F)   RH = 70.0 %

FREQ HZ	A(F) DB/M	DISTANCE, M 5	10	20	50	100	200	400	720
4000.	.0251	0.00	0.00	0.00	0.01	0.03	0.08	0.23	0.63
5000.	.0371	0.00	0.00	0.01	0.02	0.05	0.15	0.48	1.38
6300.	.0564	0.00	0.01	0.01	0.04	0.10	0.31	1.06	3.03
8000.	.0877	0.00	0.01	0.02	0.07	0.21	0.69	2.38	6.50
10000.	.1327	0.01	0.01	0.03	0.13	0.41	1.42	4.81	12.23
12500.	.1999	0.01	0.02	0.06	0.24	0.82	2.83	9.00	21.19
16000.	.3106	0.01	0.03	0.10	0.47	1.66	5.56	16.16	35.50
20000.	.4542	0.02	0.05	0.16	0.83	2.91	9.21	24.86	16.87
25000.	.6480	0.03	0.08	0.25	1.34	4.60	13.70	35.02	******
31500.	.9066	0.03	0.10	0.37	2.00	6.61	18.68	-19.55	******
40000.	1.2352	0.04	0.14	0.50	2.75	8.77	23.78	******	******
50000.	1.5970	0.05	0.18	0.67	3.59	11.06	15.91	******	******
63000.	2.0369	0.08	0.27	0.96	4.95	14.59	-67.34	******	******
80000.	2.5989	0.13	0.44	1.58	7.67	21.27	******	******	******
100000.	3.2958	0.24	0.82	2.84	12.65	4.85	******	******	******

SBP= 2. DB/THIRD OCTAVE   T = 288.2K (59.0F)   RH = 70.0 %

FREQ HZ	A(F) DB/M	DISTANCE, M 5	10	20	50	100	200	400	720
4000.	.0251	0.10	0.11	0.11	0.13	0.17	0.25	0.48	1.00
5000.	.0371	0.10	0.11	0.12	0.15	0.21	0.37	0.81	1.86
6300.	.0564	0.11	0.11	0.13	0.18	0.29	0.60	1.51	3.67
8000.	.0877	0.11	0.12	0.15	0.24	0.45	1.07	2.97	7.28
10000.	.1327	0.12	0.14	0.18	0.34	0.73	1.92	5.54	13.11
12500.	.1999	0.13	0.15	0.22	0.50	1.22	3.46	9.84	22.13
16000.	.3106	0.14	0.18	0.30	0.81	2.19	6.32	17.07	36.48
20000.	.4542	0.15	0.22	0.39	1.24	3.54	10.04	25.81	17.08
25000.	.6480	0.17	0.26	0.52	1.83	5.32	14.59	36.00	******
31500.	.9066	0.19	0.31	0.68	2.56	7.40	19.61	-19.35	******
40000.	1.2352	0.21	0.37	0.86	3.37	9.60	24.73	******	******
50000.	1.5970	0.23	0.44	1.06	4.26	11.92	16.11	******	******
63000.	2.0369	0.27	0.55	1.40	5.68	15.49	-67.14	******	******
80000.	2.5989	0.35	0.77	2.10	8.48	22.21	******	******	******
100000.	3.2958	0.50	1.22	3.47	13.54	5.05	******	******	******

C.2 CORRECTION TO STANDARD ATMOSPHERIC CONDITIONS

Reference conditions: T = 288.2°K (59°F), RH = 70%, Perfect Filter

All terms are as defined in Appendix C.1 with the following exceptions:

DA(F) = Difference Between Pure Tone Absorption in db/m at the Measured Atmospheric Condition and the Reference Atmospheric Condition = $a(T,RH) - a(T_{ref}, RH_{ref})$

δ = Difference in Band Loss Coefficients = $L_i(T, RH) - L_i(T_{ref}, RH_{ref})$ in db = value given in table.

Note: Entries of 99.99 or ***** indicate the integral does not converge. The user should check to insure that his filter is capable of recovering a signal with a roll off of the magnitude used.

Table C.5 ANSI Class III, 1/3 Octave Band Filter Used at Receiver

SBP= -6. DB/THIRD OCTAVE T = 298.2K (77.0F) RH = 70.0 %

FREQ	A(F)	DISTANCE, M							
HZ	DB/M	5	10	20	50	100	200	400	720
4000.	.0226	-0.30	-0.30	-0.31	-0.33	-0.35	-0.40	-0.48	-0.53
5000.	.0304	-0.30	-0.31	-0.31	-0.34	-0.38	-0.44	-0.52	-0.48
6300.	.0430	-0.30	-0.31	-0.32	-0.36	-0.42	-0.50	-0.51	-0.14
8000.	.0636	-0.31	-0.32	-0.34	-0.40	-0.47	-0.53	-0.28	1.12
10000.	.0939	-0.31	-0.33	-0.36	-0.44	-0.52	-0.45	0.56	4.15
12500.	.1407	-0.32	-0.35	-0.39	-0.49	-0.52	-0.05	2.78	10.26
16000.	.2223	-0.34	-0.38	-0.44	-0.53	-0.33	1.38	8.19	22.34
20000.	.3370	-0.36	-0.41	-0.49	-0.49	0.34	4.48	16.98	39.99
25000.	.5092	-0.39	-0.46	-0.54	-0.22	2.01	10.16	30.68	-22.56
31500.	.7739	-0.43	-0.51	-0.53	0.58	5.43	19.39	30.01	******
40000.	1.1735	-0.47	-0.55	-0.40	2.32	11.09	32.75	******	******
50000.	1.6946	-0.52	-0.56	-0.07	4.95	18.15	0.76	******	******
63000.	2.4128	-0.56	-0.50	0.55	8.56	26.87	******	******	******
80000.	3.3699	-0.58	-0.35	1.56	13.17	-0.95	******	******	******
100000.	4.4906	-0.57	-0.04	3.04	18.88	******	******	******	******

SBP= -4. DB/THIRD OCTAVE T = 298.2K (77.0F) RH = 70.0 %

FREQ	A(F)	DISTANCE, M							
HZ	DB/M	5	10	20	50	100	200	400	720
4000.	.0226	-0.20	-0.20	-0.21	-0.22	-0.23	-0.26	-0.28	-0.26
5000.	.0304	-0.20	-0.20	-0.21	-0.22	-0.25	-0.27	-0.27	-0.11
6300.	.0430	-0.20	-0.21	-0.22	-0.24	-0.26	-0.28	-0.18	0.39
8000.	.0636	-0.21	-0.21	-0.22	-0.25	-0.28	-0.24	0.20	1.87
10000.	.0939	-0.21	-0.22	-0.24	-0.27	-0.28	-0.06	1.23	5.10
12500.	.1407	-0.21	-0.23	-0.25	-0.28	-0.20	0.50	3.66	11.35
16000.	.2223	-0.22	-0.24	-0.27	-0.26	0.14	2.16	9.24	23.51
20000.	.3370	-0.24	-0.26	-0.29	-0.11	0.98	5.44	18.13	41.21
25000.	.5092	-0.25	-0.28	-0.28	0.29	2.84	11.24	31.87	-22.27
31500.	.7739	-0.27	-0.29	-0.19	1.26	6.42	20.54	30.52	******
40000.	1.1735	-0.29	-0.28	0.05	3.18	12.18	33.95	******	******
50000.	1.6946	-0.30	-0.22	0.49	5.93	19.30	1.18	******	******
63000.	2.4128	-0.31	-0.10	1.24	9.62	28.06	******	******	******
80000.	3.3699	-0.29	0.14	2.36	14.29	-0.54	******	******	******
100000.	4.4908	-0.23	0.54	3.94	20.03	******	******	******	******

SBP= -2. DB/THIRD OCTAVE T = 298.2K (77.0F) RH = 70.0 %

FREQ	A(F)	DISTANCE, M							
HZ	DB/M	5	10	20	50	100	200	400	720
4000.	.0226	-0.10	-0.10	-0.10	-0.10	-0.11	-0.11	-0.09	0.02
5000.	.0304	-0.10	-0.10	-0.10	-0.11	-0.11	-0.10	-0.02	0.26
6300.	.0430	-0.10	-0.10	-0.10	-0.11	-0.11	-0.06	0.16	0.92
8000.	.0636	-0.10	-0.10	-0.11	-0.11	-0.09	0.05	0.69	2.59
10000.	.0939	-0.10	-0.11	-0.11	-0.10	-0.03	0.34	1.89	6.00
12500.	.1407	-0.10	-0.11	-0.11	-0.07	0.13	1.05	4.51	12.38
16000.	.2223	-0.11	-0.11	-0.10	0.03	0.60	2.91	10.24	24.62
20000.	.3370	-0.11	-0.11	-0.08	0.26	1.61	6.35	19.21	42.35
25000.	.5092	-0.11	-0.10	-0.01	0.80	3.64	12.27	33.00	-22.06
31500.	.7739	-0.11	-0.07	0.15	1.93	7.36	21.63	30.97	******
40000.	1.1735	-0.10	-0.01	0.50	4.00	13.21	35.08	******	******
50000.	1.6946	-0.09	0.11	1.05	6.86	20.39	1.53	******	******
63000.	2.4128	-0.05	0.31	1.91	10.62	29.17	******	******	******
80000.	3.3699	0.01	0.63	3.13	15.34	-0.20	******	******	******
100000.	4.4908	0.12	1.11	4.80	21.12	******	******	******	******

SBP= 0. DB/THIRD OCTAVE T = 298.2K (77.0F) RH = 70.0 %

FREQ	A(F)	DISTANCE, M							
HZ	DB/M	5	10	20	50	100	200	400	720
4000.	.0226	0.00	0.00	0.00	0.01	0.02	0.04	0.11	0.30
5000.	.0304	0.00	0.00	0.00	0.01	0.03	0.08	0.23	0.64
6300.	.0430	0.00	0.00	0.01	0.02	0.05	0.16	0.50	1.43
8000.	.0636	0.00	0.01	0.01	0.04	0.11	0.34	1.16	3.29
10000.	.0939	0.00	0.01	0.02	0.07	0.22	0.73	2.52	6.85
12500.	.1407	0.01	0.01	0.04	0.14	0.46	1.58	5.30	13.34
16000.	.2223	0.01	0.03	0.07	0.31	1.06	3.63	11.18	25.65
20000.	.3370	0.02	0.05	0.13	0.64	2.21	7.21	20.22	43.42
25000.	.5092	0.03	0.08	0.26	1.29	4.40	13.22	34.05	-21.92
31500.	.7739	0.05	0.15	0.49	2.57	8.25	22.65	31.35	******
40000.	1.1735	0.08	0.27	0.94	4.78	14.18	36.13	******	******
50000.	1.6946	0.13	0.45	1.59	7.73	21.40	1.81	******	******
63000.	2.4128	0.20	0.72	2.55	11.56	30.21	******	******	******
80000.	3.3699	0.31	1.11	3.87	16.32	0.07	******	******	******
100000.	4.4906	0.46	1.66	5.61	22.13	******	******	******	******

SBP= 2. DB/THIRD OCTAVE T = 298.2K (77.0F) RH = 70.0 %

FREQ	A(F)	DISTANCE, M							
HZ	DB/M.	5	10	20	50	100	200	400	720
4000.	.0226	0.10	0.10	0.11	0.12	0.14	0.19	0.31	0.58
5000.	.0304	0.10	0.11	0.11	0.13	0.17	0.25	0.48	1.00
6300.	.0430	0.10	0.11	0.12	0.15	0.21	0.38	0.84	1.93
8000.	.0636	0.11	0.12	0.13	0.19	0.31	0.63	1.62	3.94
10000.	.0939	0.11	0.12	0.15	0.25	0.47	1.12	3.12	7.64
12500.	.1407	0.12	0.14	0.18	0.36	0.79	2.10	6.05	14.23
16000.	.2223	0.13	0.16	0.25	0.59	1.50	4.30	12.04	26.60
20000.	.3370	0.15	0.20	0.35	1.01	2.79	8.01	21.15	44.41
25000.	.5092	0.17	0.27	0.52	1.77	5.11	14.11	35.03	-21.86
31500.	.7739	0.21	0.37	0.83	3.17	9.07	23.60	31.66	******
40000.	1.1735	0.27	0.54	1.37	5.51	15.08	37.11	******	******
50000.	1.6946	0.35	0.78	2.12	8.54	22.33	2.01	******	******
63000.	2.4128	0.46	1.11	3.16	12.43	31.18	******	******	******
80000.	3.3699	0.60	1.57	4.56	17.23	0.26	******	******	******
100000.	4.4908	0.80	2.20	6.37	23.07	******	******	******	******

Table C.6 Perfect 1/3 Octave Band Filter Used at Receiver

SBP= -6. DB/THIRD OCTAVE T = 305.4K (90.0F) RH = 90.0 %

FREQ HZ	DA(F) DB/M	DISTANCE, M 5	10	20	50	100	200	400	720
4000.	0.003	-0.13	-0.11	-0.07	0.04	0.24	0.66	1.61	3.38
5000.	-0.003	-0.16	-0.17	-0.19	-0.24	-0.32	-0.41	-0.38	0.12
6300.	-0.014	-0.21	-0.27	-0.39	-0.74	-1.28	-2.23	-3.72	-5.32
8000.	-0.031	-0.30	-0.44	-0.73	-1.55	-2.85	-5.15	-8.95	-13.77
10000.	-0.057	-0.42	-0.68	-1.20	-2.70	-5.00	-9.06	-15.87	-24.89
12500.	-0.094	-0.59	-1.03	-1.88	-4.31	-7.97	-14.34	-25.08	-39.57
16000.	-0.151	-0.87	-1.57	-2.93	-6.70	-12.26	-21.78	-37.75	-59.78
20000.	-0.218	-1.18	-2.19	-4.11	-9.32	-16.77	-29.26	-50.05	-79.72
25000.	-0.294	-1.54	-2.87	-5.38	-11.93	-20.90	-35.36	-59.49	******
31500.	-0.361	-1.86	-3.46	-6.37	-13.49	-22.36	-35.59	-57.59	******
40000.	-0.381	-1.94	-3.52	-6.19	-11.51	-16.02	-20.39	******	******
50000.	-0.300	-1.50	-2.50	-3.65	-2.94	3.51	20.62	******	******
63000.	-0.049	-0.16	0.43	3.12	17.09	45.76	-24.91	******	******
80000.	0.453	2.53	6.42	16.59	54.29	98.59	******	******	******
100000.	1.184	6.65	15.53	36.68	107.52	44.47	******	******	******

SBP= -4. DB/THIRD OCTAVE T = 305.4K (90.0F) RH = 90.0 %

FREQ HZ	DA(F) DB/M	DISTANCE, M 5	10	20	50	100	200	400	720
4000.	0.003	-0.08	-0.06	-0.03	0.08	0.27	0.68	1.62	3.39
5000.	-0.003	-0.11	-0.12	-0.15	-0.21	-0.29	-0.40	-0.39	0.13
6300.	-0.014	-0.16	-0.23	-0.35	-0.71	-1.27	-2.25	-3.74	-5.25
8000.	-0.031	-0.25	-0.40	-0.69	-1.54	-2.85	-5.17	-8.91	-13.53
10000.	-0.057	-0.37	-0.64	-1.17	-2.69	-5.02	-9.06	-15.70	-24.41
12500.	-0.094	-0.55	-0.99	-1.86	-4.32	-7.98	-14.25	-24.68	-38.82
16000.	-0.151	-0.83	-1.54	-2.91	-6.71	-12.21	-21.49	-37.05	-58.82
20000.	-0.218	-1.15	-2.16	-4.10	-9.29	-16.58	-28.71	-49.14	-78.66
25000.	-0.294	-1.50	-2.84	-5.35	-11.80	-20.48	-34.55	-58.45	******
31500.	-0.361	-1.82	-3.41	-6.29	-13.18	-21.67	-34.61	-56.48	******
40000.	-0.381	-1.86	-3.43	-6.09	-10.94	-15.11	-19.30	******	******
50000.	-0.300	-1.41	-2.34	-3.30	-2.13	4.55	21.76	******	******
63000.	-0.049	-0.04	0.70	3.67	18.07	46.87	-24.65	******	******
80000.	0.453	2.74	6.84	17.36	55.36	98.91	******	******	******
100000.	1.184	6.95	16.12	37.59	108.64	44.76	******	******	******

SBP= -2. DB/THIRD OCTAVE T = 305.4K (90.0F) RH = 90.0 %

FREQ HZ	DA(F) DB/M	DISTANCE, 5	10	20	50	100	200	400	720
4000.	0.003	-0.03	-0.02	0.02	0.12	0.31	0.70	1.62	3.39
5000.	-0.003	-0.05	-0.08	-0.13	-0.17	-0.27	-0.40	-0.42	0.11
6300.	-0.014	-0.12	-0.16	-0.31	-0.69	-1.27	-2.27	-3.78	-5.21
8000.	-0.031	-0.20	-0.36	-0.66	-1.52	-2.87	-5.21	-8.91	-13.33
10000.	-0.057	-0.33	-0.60	-1.14	-2.69	-5.05	-9.09	-15.56	-23.97
12500.	-0.094	-0.51	-0.96	-1.84	-4.33	-8.01	-14.20	-24.32	-38.13
16000.	-0.151	-0.79	-1.51	-2.90	-6.73	-12.18	-21.24	-36.41	-57.94
20000.	-0.218	-1.11	-2.14	-4.09	-9.27	-16.42	-28.20	-48.30	-77.67
25000.	-0.294	-1.47	-2.82	-5.33	-11.69	-20.10	-33.81	-57.49	******
31500.	-0.361	-1.77	-3.37	-6.22	-12.90	-21.03	-33.70	-55.43	******
40000.	-0.381	-1.81	-3.35	-5.83	-10.41	-14.20	-18.29	******	******
50000.	-0.300	-1.32	-2.19	-2.98	-1.39	5.52	22.83	******	******
63000.	-0.049	0.09	0.95	4.19	18.97	47.91	-24.45	******	******
80000.	0.453	2.94	7.24	18.07	56.36	99.16	******	******	******
100000.	1.184	7.23	16.67	38.44	109.68	44.96	******	******	******

SBP= 0. DB/THIRD OCTAVE T = 305.4K (90.0F) RH = 90.0 %

FREQ HZ	DA(F) DB/M	DISTANCE, M 5	10	20	50	100	200	400	720
4000.	0.003	0.02	0.03	0.06	0.16	0.34	0.72	1.61	3.36
5000.	-0.003	-0.02	-0.03	-0.06	-0.14	-0.25	-0.41	-0.46	0.07
6300.	-0.014	-0.07	-0.14	-0.27	-0.66	-1.26	-2.31	-3.84	-5.21
8000.	-0.031	-0.16	-0.31	-0.62	-1.51	-2.89	-5.27	-8.94	-13.18
10000.	-0.057	-0.26	-0.57	-1.12	-2.70	-5.09	-9.14	-15.47	-23.59
12500.	-0.094	-0.47	-0.93	-1.83	-4.35	-8.07	-14.18	-24.02	-37.51
16000.	-0.151	-0.75	-1.48	-2.90	-6.76	-12.19	-21.03	-35.84	-57.13
20000.	-0.218	-1.07	-2.11	-4.09	-9.28	-16.30	-27.75	-47.54	-76.76
25000.	-0.294	-1.43	-2.79	-5.32	-11.62	-19.78	-33.13	-56.60	******
31500.	-0.361	-1.73	-3.33	-6.17	-12.66	-20.46	-32.86	-54.47	******
40000.	-0.381	-1.76	-3.28	-5.66	-9.93	-13.49	-17.35	******	******
50000.	-0.300	-1.24	-2.06	-2.69	-0.70	6.41	23.82	******	******
63000.	-0.049	0.22	1.19	4.67	19.80	48.88	-24.33	******	******
80000.	0.453	3.13	7.61	18.73	57.28	99.33	******	******	******
100000.	1.184	7.49	17.17	39.23	110.65	45.12	******	******	******

SBP= 2. DB/THIRD OCTAVE T = 305.4K (90.0F) RH = 90.0 %

FREQ HZ	DA(F) DB/M	DISTANCE, M 5	10	20	50	100	200	400	720
4000.	0.003	0.07	0.08	0.11	0.20	0.37	0.74	1.60	3.32
5000.	-0.003	0.03	0.02	-0.01	-0.10	-0.23	-0.42	-0.51	-0.01
6300.	-0.014	-0.02	-0.09	-0.23	-0.64	-1.26	-2.35	-3.93	-5.26
8000.	-0.031	-0.11	-0.27	-0.59	-1.50	-2.92	-5.35	-9.02	-13.09
10000.	-0.057	-0.24	-0.53	-1.09	-2.71	-5.15	-9.23	-15.44	-23.28
12500.	-0.094	-0.43	-0.89	-1.81	-4.38	-8.14	-14.22	-23.79	-36.97
16000.	-0.151	-0.71	-1.46	-2.89	-6.80	-12.24	-20.89	-35.34	-56.40
20000.	-0.218	-1.04	-2.09	-4.09	-9.32	-16.24	-27.38	-46.85	-75.92
25000.	-0.294	-1.40	-2.77	-5.31	-11.59	-19.52	-32.53	-55.79	******
31500.	-0.361	-1.69	-3.30	-6.13	-12.47	-19.95	-32.10	-53.58	******
40000.	-0.381	-1.70	-3.21	-5.56	-9.52	-12.79	-16.49	******	******
50000.	-0.300	-1.16	-1.93	-2.44	-0.09	7.23	24.74	******	******
63000.	-0.049	0.34	1.40	5.09	20.56	49.77	-24.28	******	******
80000.	0.453	3.31	7.94	19.33	58.13	99.43	******	******	******
100000.	1.184	7.73	17.63	39.94	111.55	45.18	******	******	******

SBP= -6. DB/THIRD OCTAVE   T = 305.4K (90.0F)   RH = 90.0 %

FREQ HZ	DA(F) DB/M	DISTANCE, M 5	10	20	50	100	200	400	720
4000.	0.003	-0.09	-0.07	-0.04	0.05	0.22	0.58	1.41	3.00
5000.	-0.003	-0.12	-0.13	-0.16	-0.24	-0.36	-0.53	-0.65	-0.37
6300.	-0.014	-0.17	-0.24	-0.37	-0.75	-1.36	-2.43	-4.12	-5.99
8000.	-0.031	-0.26	-0.41	-0.72	-1.60	-2.99	-5.46	-9.54	-14.66
10000.	-0.057	-0.38	-0.66	-1.21	-2.79	-5.23	-9.53	-16.68	-25.96
12500.	-0.094	-0.57	-1.03	-1.93	-4.48	-8.34	-15.02	-26.10	-40.72
16000.	-0.151	-0.85	-1.59	-3.02	-7.00	-12.83	-22.71	-38.89	-60.95
20000.	-0.218	-1.19	-2.26	-4.29	-9.78	-17.56	-30.36	-51.22	-80.89
25000.	-0.294	-1.58	-3.00	-5.67	-12.59	-21.91	-36.52	-60.66	******
31500.	-0.361	-1.95	-3.68	-6.82	-14.39	-23.49	-36.76	-58.76	******
40000.	-0.381	-2.10	-3.88	-6.84	-12.59	-17.19	-21.56	******	******
50000.	-0.300	-1.77	-3.02	-4.52	-4.10	2.34	19.45	******	******
63000.	-0.049	-0.58	-0.29	2.07	15.93	44.59	-25.27	******	******
80000.	0.453	1.96	5.49	15.45	53.12	97.42	******	******	******
100000.	1.184	5.91	14.47	35.51	106.35	44.36	******	******	******

SBP= -4. DB/THIRD OCTAVE   T = 305.4K (90.0F)   RH = 90.0 %

FREQ HZ	DA(F) DB/M	DISTANCE, M 5	10	20	50	100	200	400	720
4000.	0.003	-0.06	-0.04	-0.01	0.08	0.24	0.60	1.44	3.07
5000.	-0.003	-0.09	-0.10	-0.13	-0.22	-0.34	-0.52	-0.63	-0.28
6300.	-0.014	-0.14	-0.21	-0.34	-0.74	-1.35	-2.42	-4.08	-5.80
8000.	-0.031	-0.23	-0.39	-0.70	-1.59	-2.98	-5.44	-9.40	-14.25
10000.	-0.057	-0.36	-0.64	-1.19	-2.79	-5.22	-9.46	-16.36	-25.26
12500.	-0.094	-0.54	-1.00	-1.91	-4.47	-8.30	-14.81	-25.49	-39.73
16000.	-0.151	-0.83	-1.57	-3.01	-6.97	-12.69	-22.24	-37.95	-59.74
20000.	-0.218	-1.17	-2.23	-4.26	-9.68	-17.23	-29.58	-50.06	-79.58
25000.	-0.294	-1.55	-2.96	-5.60	-12.35	-21.29	-35.46	-59.37	******
31500.	-0.361	-1.90	-3.60	-6.67	-13.90	-22.56	-35.53	-57.39	******
40000.	-0.381	-2.03	-3.74	-6.54	-11.80	-16.03	-20.22	******	******
50000.	-0.300	-1.64	-2.78	-4.01	-3.04	3.63	20.84	******	******
63000.	-0.049	-0.39	0.11	2.83	17.15	45.96	-24.75	******	******
80000.	0.453	2.26	6.09	16.46	54.44	97.99	******	******	******
100000.	1.184	6.33	15.27	36.68	107.72	44.89	******	******	******

SBP= -2. DB/THIRD OCTAVE   T = 305.4K (90.0F)   RH = 90.0 %

FREQ HZ	DA(F) DB/M	DISTANCE, M 5	10	20	50	100	200	400	720
4000.	0.003	-0.02	-0.01	0.02	0.11	0.27	0.63	1.46	3.11
5000.	-0.003	-0.05	-0.07	-0.10	-0.19	-0.32	-0.51	-0.62	-0.23
6300.	-0.014	-0.11	-0.18	-0.32	-0.72	-1.34	-2.43	-4.06	-5.66
8000.	-0.031	-0.20	-0.36	-0.67	-1.58	-2.98	-5.44	-9.31	-13.91
10000.	-0.057	-0.33	-0.61	-1.17	-2.78	-5.23	-9.42	-16.09	-24.64
12500.	-0.094	-0.51	-0.98	-1.89	-4.47	-8.28	-14.66	-24.97	-38.84
16000.	-0.151	-0.80	-1.55	-2.99	-6.95	-12.58	-21.83	-37.12	-58.66
20000.	-0.218	-1.14	-2.20	-4.23	-9.60	-16.95	-28.88	-49.02	-78.39
25000.	-0.294	-1.52	-2.92	-5.54	-12.14	-20.74	-34.52	-58.21	******
31500.	-0.361	-1.86	-3.54	-6.54	-13.48	-21.73	-34.42	-56.15	******
40000.	-0.381	-1.95	-3.61	-6.28	-11.09	-14.98	-19.01	******	******
50000.	-0.300	-1.52	-2.56	-3.55	-2.10	4.80	22.11	******	******
63000.	-0.049	-0.20	0.47	3.53	18.26	47.20	-24.35	******	******
80000.	0.453	2.55	6.64	17.37	55.64	98.44	******	******	******
100000.	1.184	6.73	16.00	37.73	108.97	45.31	******	******	******

SBP= 0. DB/THIRD OCTAVE   T = 305.4K (90.0F)   RH = 90.0 %

FREQ HZ	DA(F) DB/M	DISTANCE, M 5	10	20	50	100	200	400	720
4000.	0.003	0.01	0.03	0.06	0.15	0.30	0.65	1.48	3.14
5000.	-0.003	-0.02	-0.03	-0.07	-0.16	-0.30	-0.50	-0.63	-0.21
6300.	-0.014	-0.07	-0.14	-0.29	-0.70	-1.33	-2.44	-4.08	-5.57
8000.	-0.031	-0.16	-0.33	-0.64	-1.57	-2.99	-5.46	-9.27	-13.63
10000.	-0.057	-0.29	-0.58	-1.15	-2.78	-5.25	-9.42	-15.90	-24.11
12500.	-0.094	-0.48	-0.95	-1.88	-4.47	-8.29	-14.55	-24.52	-38.06
16000.	-0.151	-0.77	-1.52	-2.98	-6.94	-12.51	-21.50	-36.38	-57.68
20000.	-0.218	-1.11	-2.18	-4.21	-9.55	-16.72	-28.28	-48.09	-77.31
25000.	-0.294	-1.48	-2.89	-5.50	-11.98	-20.28	-33.68	-57.15	******
31500.	-0.361	-1.81	-3.48	-6.43	-13.11	-21.00	-33.41	-55.02	******
40000.	-0.381	-1.88	-3.49	-6.04	-10.46	-14.04	-17.90	******	******
50000.	-0.300	-1.41	-2.35	-3.14	-1.25	5.86	23.27	******	******
63000.	-0.049	-0.02	0.80	4.16	19.25	48.33	-24.06	******	******
80000.	0.453	2.81	7.14	18.19	56.73	98.78	******	******	******
100000.	1.184	7.09	16.66	38.68	110.10	45.61	******	******	******

SBP= 2. DB/THIRD OCTAVE   T = 305.4K (90.0F)   RH = 90.0 %

FREQ HZ	DA(F) DB/M	DISTANCE, M 5	10	20	50	100	200	400	720
4000.	0.003	0.05	0.07	0.10	0.18	0.33	0.67	1.48	3.13
5000.	-0.003	0.02	0.00	-0.03	-0.13	-0.28	-0.50	-0.66	-0.23
6300.	-0.014	-0.03	-0.11	-0.25	-0.67	-1.33	-2.46	-4.12	-5.55
8000.	-0.031	-0.13	-0.29	-0.62	-1.56	-3.01	-5.51	-9.28	-13.44
10000.	-0.057	-0.26	-0.55	-1.13	-2.78	-5.28	-9.45	-15.77	-23.67
12500.	-0.094	-0.45	-0.92	-1.86	-4.49	-8.32	-14.51	-24.17	-37.38
16000.	-0.151	-0.74	-1.50	-2.96	-6.96	-12.49	-21.25	-35.75	-56.82
20000.	-0.218	-1.07	-2.15	-4.20	-9.53	-16.57	-27.78	-47.26	-76.34
25000.	-0.294	-1.44	-2.85	-5.46	-11.87	-19.90	-32.95	-56.21	******
31500.	-0.361	-1.76	-3.42	-6.34	-12.82	-20.36	-32.52	-54.00	******
40000.	-0.381	-1.80	-3.38	-5.85	-9.92	-13.20	-16.91	******	******
50000.	-0.300	-1.30	-2.17	-2.79	-0.50	6.81	24.32	******	******
63000.	-0.049	0.15	1.10	4.70	20.15	49.35	-23.87	******	******
80000.	0.453	3.05	7.58	18.92	57.71	99.02	******	******	******
100000.	1.184	7.42	17.23	39.52	111.13	45.80	******	******	******

SBP= -6. DB/THIRD OCTAVE   T = 277.6K (40.0F)   RH = 10.0 %

FREQ HZ	DA(F) DB/M	DISTANCE, M 5	10	20	50	100	200	400	720
4000.	0.017	-0.06	0.03	0.20	0.73	1.61	3.39	7.02	13.00
5000.	0.007	-0.11	-0.07	0.02	0.27	0.70	1.61	3.55	6.97
6300.	-0.009	-0.19	-0.22	-0.29	-0.50	-0.83	-1.39	-2.24	-3.05
8000.	-0.036	-0.32	-0.48	-0.81	-1.78	-3.34	-6.28	-11.60	-19.22
10000.	-0.076	-0.50	-0.86	-1.55	-3.61	-6.92	-13.18	-24.77	-42.07
12500.	-0.134	-0.78	-1.41	-2.66	-6.31	-12.17	-23.23	-43.98	-75.64
16000.	-0.229	-1.24	-2.32	-4.45	-10.68	-20.57	-39.31	-74.95	******
20000.	-0.350	-1.82	-3.47	-6.73	-16.17	-31.13	-59.58	******	******
25000.	-0.509	-2.58	-4.99	-9.71	-23.32	-44.86	-86.09	******	******
31500.	-0.710	-3.56	-6.91	-13.48	-32.34	-62.22	******	******	******
40000.	-0.944	-4.70	-9.16	-17.86	-42.73	-82.15	******	******	******
50000.	-1.166	-5.78	-11.27	-21.93	-52.20	-99.95	******	******	******
63000.	-1.377	-6.80	-13.22	-25.54	-60.05	******	******	******	******
80000.	-1.561	-7.62	-14.67	-27.90	-63.77	******	******	******	******
100000.	-1.698	-8.07	-15.21	-28.01	-60.72	******	******	******	******

SBP= -4. DB/THIRD OCTAVE   T = 277.6K (40.0F)   RH = 10.0 %

FREQ HZ	DA(F) DB/M	DISTANCE, M 5	10	20	50	100	200	400	720
4000.	0.017	-0.01	0.07	0.24	0.76	1.63	3.39	6.96	12.91
5000.	0.007	-0.06	-0.02	0.06	0.30	0.71	1.58	3.46	6.81
6300.	-0.009	-0.14	-0.18	-0.26	-0.49	-0.85	-1.47	-2.41	-3.28
8000.	-0.036	-0.27	-0.44	-0.78	-1.79	-3.40	-6.41	-11.82	-19.46
10000.	-0.076	-0.46	-0.82	-1.54	-3.64	-7.02	-13.37	-25.02	-42.26
12500.	-0.134	-0.75	-1.39	-2.66	-6.38	-12.32	-23.46	-44.20	-75.70
16000.	-0.229	-1.21	-2.30	-4.47	-10.78	-20.77	-39.53	-75.03	******
20000.	-0.350	-1.79	-3.47	-6.77	-16.31	-31.33	-59.72	******	******
25000.	-0.509	-2.57	-5.00	-9.77	-23.48	-45.02	-86.07	******	******
31500.	-0.710	-3.55	-6.93	-13.56	-32.48	-62.26	******	******	******
40000.	-0.944	-4.69	-9.18	-17.92	-42.77	-81.95	******	******	******
50000.	-1.166	-5.76	-11.28	-21.95	-52.08	-99.47	******	******	******
63000.	-1.377	-6.77	-13.20	-25.48	-59.66	******	******	******	******
80000.	-1.561	-7.58	-14.61	-27.70	-63.10	******	******	******	******
100000.	-1.698	-8.01	-15.06	-27.59	-59.82	******	******	******	******

SBP= -2. DB/THIRD OCTAVE   T = 277.6K (40.0F)   RH = 10.0 %

FREQ HZ	DA(F) DB/M	DISTANCE, M 5	10	20	50	100	200	400	720
4000.	0.017	0.03	0.12	0.29	0.80	1.65	3.39	6.93	12.80
5000.	0.007	-0.01	0.02	0.10	0.32	0.71	1.54	3.35	6.62
6300.	-0.009	-0.09	-0.14	-0.23	-0.48	-0.87	-1.56	-2.59	-3.54
8000.	-0.036	-0.23	-0.41	-0.76	-1.80	-3.46	-6.57	-12.08	-19.75
10000.	-0.076	-0.42	-0.79	-1.53	-3.66	-7.13	-13.59	-25.31	-42.51
12500.	-0.134	-0.71	-1.36	-2.66	-6.45	-12.48	-23.72	-44.46	-75.80
16000.	-0.229	-1.18	-2.29	-4.50	-10.90	-20.99	-39.80	-75.17	******
20000.	-0.350	-1.77	-3.47	-6.82	-16.47	-31.57	-59.91	******	******
25000.	-0.509	-2.55	-5.01	-9.84	-23.66	-45.22	-86.09	******	******
31500.	-0.710	-3.53	-6.96	-13.64	-32.64	-62.34	******	******	******
40000.	-0.944	-4.68	-9.21	-18.00	-42.84	-81.80	******	******	******
50000.	-1.166	-5.75	-11.30	-22.00	-51.99	-99.04	******	******	******
63000.	-1.377	-6.75	-13.20	-25.45	-59.35	******	******	******	******
80000.	-1.561	-7.55	-14.55	-27.52	-62.49	******	******	******	******
100000.	-1.698	-7.95	-14.93	-27.21	-58.99	******	******	******	******

SBP= 0. DB/THIRD OCTAVE   T = 277.6K (40.0F)   RH = 10.0 %

FREQ HZ	DA(F) DB/M	DISTANCE, M 5	10	20	50	100	200	400	720
4000.	0.017	0.06	0.17	0.33	0.83	1.68	3.38	6.87	12.67
5000.	0.007	0.03	0.07	0.14	0.35	0.72	1.49	3.22	6.40
6300.	-0.009	-0.05	-0.10	-0.19	-0.47	-0.90	-1.65	-2.80	-3.84
8000.	-0.036	-0.15	-0.37	-0.73	-1.81	-3.53	-6.73	-12.38	-20.10
10000.	-0.076	-0.36	-0.76	-1.51	-3.72	-7.26	-13.83	-25.65	-42.80
12500.	-0.134	-0.67	-1.34	-2.67	-6.53	-12.67	-24.03	-44.78	-75.96
16000.	-0.229	-1.15	-2.28	-4.53	-11.04	-21.24	-40.12	-75.36	******
20000.	-0.350	-1.75	-3.48	-6.88	-16.65	-31.86	-60.16	******	******
25000.	-0.509	-2.53	-5.03	-9.92	-23.87	-45.47	-86.17	******	******
31500.	-0.710	-3.53	-6.99	-13.74	-32.84	-62.47	******	******	******
40000.	-0.944	-4.67	-9.24	-18.09	-42.96	-81.71	******	******	******
50000.	-1.166	-5.74	-11.33	-22.06	-51.95	-98.67	******	******	******
63000.	-1.377	-6.74	-13.20	-25.44	-59.06	******	******	******	******
80000.	-1.561	-7.52	-14.52	-27.38	-61.92	******	******	******	******
100000.	-1.698	-7.90	-14.82	-26.87	-58.23	******	******	******	******

SBP= 2. DB/THIRD OCTAVE   T = 277.6K (40.0F)   RH = 10.0 %

FREQ HZ	DA(F) DB/M	DISTANCE, M 5	10	20	50	100	200	400	720
4000.	0.017	0.13	0.21	0.38	0.87	1.70	3.37	6.81	12.53
5000.	0.007	0.08	0.11	0.18	0.38	0.72	1.45	3.09	6.16
6300.	-0.009	-0.00	-0.05	-0.16	-0.46	-0.93	-1.76	-3.03	-4.19
8000.	-0.036	-0.14	-0.33	-0.71	-1.82	-3.60	-6.92	-12.71	-20.50
10000.	-0.076	-0.34	-0.73	-1.50	-3.77	-7.39	-14.10	-26.04	-43.17
12500.	-0.134	-0.64	-1.32	-2.67	-6.62	-12.87	-24.38	-45.16	-76.20
16000.	-0.229	-1.12	-2.26	-4.56	-11.18	-21.52	-40.49	-75.62	******
20000.	-0.350	-1.73	-3.48	-6.94	-16.85	-32.18	-60.47	******	******
25000.	-0.509	-2.52	-5.05	-10.01	-24.10	-45.78	-86.32	******	******
31500.	-0.710	-3.52	-7.02	-13.84	-33.07	-62.66	******	******	******
40000.	-0.944	-4.66	-9.26	-18.20	-43.12	-81.68	******	******	******
50000.	-1.166	-5.74	-11.36	-22.14	-51.97	-98.37	******	******	******
63000.	-1.377	-6.72	-13.21	-25.46	-58.85	******	******	******	******
80000.	-1.561	-7.49	-14.50	-27.28	-61.43	******	******	******	******
100000.	-1.698	-7.87	-14.74	-26.59	-57.55	******	******	******	******

APPENDIX D - SYMBOLS LIST

A	signal amplitude
$A(f_j)$	atmospheric transmission function at f_j
$a(f)$	pure tone absorption coefficient/meter at frequency f, $db\text{-}m^{-1}$
$a_{f.s.}$	free space absorption, $db\text{-}m^{-1}$
a_{meas}	measured absorption, $db\text{-}m^{-1}$
$A_n(x)$	heigth of the nth burst as a function of x
A_o	amplitude of the sound wave at the source
a_{tc}	corrected tube absorption, $db\text{-}m^{-1}$
a_{theor}	theoretical absorption, $db\text{-}m^{-1}$
a_{tube}	tube absorption, $db\text{-}m^{-1}$
$a(T_{ref}, RH_{ref})$	pure tone absorption coefficient at the reference temperature, T_{ref}, and relative humidity, RH_{ref}, $db\text{-}m^{-1}$
$a(T, RH)$	pure tone absorption coefficient at temperature, T, and relative humidity, RH, $db\text{-}m^{-1}$
B	empirical parameter in Sutherland's equation, 1.458×10^{-6} $kg\text{-}m^{-1}\text{-}sec^{-1}\text{-}°K^{1/2}$
b	number of segments into which the band is divided
B_i	band power for the ith band, $watts\text{-}m^{-3}$
$B_i(0)$	band power for the ith band at the source, $watts\text{-}m^{-3}$
$B_i(R)$	band power for the ith band a distance, R, from the source, $watts\text{-}m^{-3}$
$B_j(0)$	source band power level for the jth segment, $watts\text{-}m^{-3}$
$B_j(R)$	attenuated band power over the jth segment, $watts\text{-}m^{-3}$
c	speed of sound, $m\text{-}sec^{-1}$
c_j'	vibrational specific heat (of nitrogen or oxygen), $J\text{-}(kg\text{-}mole)^{-1}\text{-}°K^{-1}$
c_p	specific heat at constant pressure, $J\text{-}(kg\text{-}mole)^{-1}\text{-}°K^{-1}$
c_v	specific heat at constant volume, $J\text{-}(kg\text{-}mole)^{-1}\text{-}°K^{-1}$
f	acoustic frequency, Hz
f_i	center frequency of the ith band, Hz

f_j — a geometrically spacial frequency in the ith band, used as the lower frequency for the jth segment within the band, Hz

$f_{r,j}$ — relaxation frequency, Hz

$f_{r,N}$ — relaxation frequency of nitrogen, Hz

$f_{r,O}$ — relaxation frequency of oxygen, Hz

h — absolute humidity, molar percent

h_r — relative humidity, percent

k — slope parameter of filter function

L_i — band level of the ith term

L_{io} — band level at the source for the ith band

m — serves to characterize the slope of the source spectrum

m' — slope parameter of input spectrum

n — slope parameter of attenuation curve

P — ambient pressure, $N\text{-}m^{-2}$

P_o — reference pressure, 1.013×10^5 $N\text{-}m^{-2}$

P_{sat} — partial pressure of saturated water vapor, $N\text{-}m^{-2}$

q — one tenth of the slope of the received spectrum level, $db\text{-}decade^{-1}$

q' — one tenth of the slope of the energy density, $change\text{-}decade^{-1}$

R — propagation distance, m

$\mathcal{R}$ — universal gas constant, $J\text{-}(kg\text{-}mole)^{-1}\text{-}°K^{-1}$

r — frequency ratio between band centers

RH — relative humidity, percent

RH_{ref} — reference relative humidity

S — empirical parameter in Sutherland's equation, 110.4°K for air

S_A — slope of air attenuation curve, $db\text{-}bandwidth^{-1}$

S_B — source spectrum slope/bandwidth, $db\text{-}bandwidth^{-1}$

S_B' — slope of received spectrum, $db\text{-}bandwidth^{-1}$

S_F — filter roll off per bandwidth, $db\text{-}bandwidth^{-1}$

S_j — relaxation strength

T — temperature, °K

$T(f)$	filter transmission function at f
$T_i(f)$	filter response for the ith band (0 to 1)
$T_j(f)$	filter function at some frequency f in the jth segment
T_o	standard reference temperature, 293.15°K
t_o	length of the burst, sec
T_{01}	reference temperature, eq. (3.19), 273.16°K
T_{ref}	reference temperature, °K
$W(f)$	acoustic power spectral density at any frequency, f, $J\text{-}m^{-3}$
$W(f_j,0)$	power spectral density of the source at f_j, $J\text{-}m^{-3}$
$W(f,R)$	power spectral density at a distance, R, from the source at frequency, f, $J\text{-}m^{-3}$
W_{ref}	arbitrary reference power
x	separation between sound source and microphone, m
x_j	mole fraction of the component, 0.29048 for oxygen and 0.78084 for nitrogen
Z_{rot}	rotational collision number
α	total absorption coefficient, $nepers\text{-}m^{-1}$
α_{Cl}	classical absorption, $nepers\text{-}m^{-1}$
α_{CR}	absorption due to combined rotational relaxation and classical mechanisms, $nepers\text{-}m^{-1}$
α_{rot}	absorption due to rotational relaxation, $nepers\text{-}m^{-1}$
$\alpha_{vib,j}$	absorption due to vibrational relaxation of oxygen or nitrogen, $nepers\text{-}m^{-1}$
$\alpha_{vib,N}$	absorption due to vibrational relaxation of nitrogen, $nepers\text{-}m^{-1}$
$\alpha_{vib,O}$	absorption due to vibrational relaxation of oxygen, $nepers\text{-}m^{-1}$
$\alpha_{vib}\lambda$	absorption due to vibrational relaxation/wavelength, nepers
$\alpha\lambda$	absorption per wavelength, nepers
β	reflection coefficient for the ends of the tube
γ	ratio of specific heats
Δ	difference between band absorption coefficient and the pure tone absorption coefficient computed at band center, db

δ	number of db to be added to measured spectrum to obtain the spectrum one would have measured for the same band on a reference day
ΔL_i	band loss, db
θ_j	characteristic vibrational temperature, °K
κ	coefficient of thermal conductivity, J-(kg-mole)$^{-1}$-°K-m-sec^{-1}
λ	wavelength, cm
μ	coefficient of viscosity, kg-m-sec^{-1}
$\rho°$	equilibrium gas density, kg-m^{-3}
ω	2π times the acoustic frequency, sec^{-1}

REFERENCES

1. Duff, A. W.: The Attenuation of Sound and the Constant of Radiation of Air. Physical Review (Serial 1), 6, 129-139 (1898). And,: The Attenuation of Sound. Physical Review (Serial 1), 11, 65-74, (1900).
2. Knudsen, V. D.: The absorption of Sound in Gases. Journal of the Acoustical Society of America, 5, 112-121, (1933).
3. Kneser, H.O.: Interpretation of the Anomalous Sound Absorption in Air and Oxygen in Terms of Molecular Collisions. Journal of the Acoustical Scociety of America, 5, 122-216, (1933).
4. Greenspan, Martin: Rotational Relaxation in Nitrogen, Oxygen, and Air. Journal of the Acoustical Society of America, 31, 155-160 (1959).
5. SAE Committee A-21: Standard Values of Atmospheric Absorption as a Function of Temperature and Humidity for Use in Evaluating Aircraft Flyover Noise. Society of Automotive Engineers, Aerospace Recommended Practice ARP-866A, issued August 1964, reissued March 1975.
6. Harris, C. M.: Absorption of Sound in Air Versus Humidity and Temperature. Journal of the Acoustical Society of America, 40, 148-162, (1966).
7. Piercy, J. E.: Role of the Vibrational Relaxation of Nitrogen in the Absorption of Sound in Air. Journal of the Acoustical Society of America, 46, 602-604, (1969).
8. Monk, Robin G.: Thermal Relaxation in Humid Air. Journal of the Acoustical Society of America, 46,580-586, (1969).
9. Evans, L. B.; Bass, H. E.; and Sutherland, L. C.: Atmospheric Absorption of Sound: Theoretical Predictions. Journal of the Acoustical Society of America, 51, 1565, (1972).
10. Bass, H. E.; Evans, L. B.; and Marsh, A. H.: Background for Theoretical Equations Used to Calculate Atmospheric Absorption of Sound. Background document for proposed American National Standards Institute Standard S1-57, (1976). Published in Physical Acoustics, Warren P. Mason, Ed. (Academic Press, New York).

11. Sutherland, L. C.; Piercy, J. E.; Bass, H. E.; and Evans, L. B.: Method for Calculating the Absorption of Sound by the Atmosphere. Journal of the Acoustical Society of America, 56, 51, (1975).

12. Bass, H. E.; and Sutherland, L. C.: On the Rotational Collision Number for Air at Elevated Temperatures. Journal of the Acoustical Society of America, 59, (1976).

13. Sutherland, L. C.: Review of Experimental Data in Support of a Proposed New Method for Computing Atmospheric Absorption Loss. Department of Transportation Report TST-75-87, (1975).

14. Bass, H. E.; and Keeton, Roy G.: Ultrasonic Absorption in Air at Elevated Temperatures. Journal of the Acoustical Society of America, 58, 110-112, (1975).

15. Bass, H. E.; Keeton, Roy G.; and Williams, David: Vibrational and Rotational Telaxation in Mixtures of Water Vapor and Oxygen. Journal of the Acoustical Society of America, 60, (1976).

16. Kuhl, W.; Schodder, G. R.; and Shroder, F. K.: Condenser Transmitters and Microphones with Solid Dielectric for Airborne Ultrasonics, Acustica, 4, 519 -532 (1954).

17. Kirchhoff, G.: Ann. Physik (Leipzig), 134, 177-193, (1868). See also: Theory of Sound by Lord Rayleigh, topic 348, p. 319 (Dover Publications Inc. New York, 1945).

18. Shields, F. Douglas; Lee, K. P.; and Wiley, W. J.: Numerical Solution for Sound Velocity and Absorption in Cylindrical Tubes. Journal of the Acoustical Society of America, 37, 724-729, (1965).

19. Shields, F. Douglas; and Faughn, Jerry: Sound Velocity and Absorption in Low-Pressure Gases Confined to Tubes of Circular Cross Section. Journal of the Acoustical Society of America, 46, 158-163 (1969). And: Shields, F. Douglas: An Acoustical Method for Determining the Thermal and Momentum Accomodation of Gases on Solids. Journal of Chemical Physics, 62, 1248-1252, (1975).

20. Herzfeld, K. F.; and Litovitz, T. A.: Absorption and Dispersion of Ultrasonic Waves, (Academic Press, Inc., New York, 1959) p. 231.

E-8908

*U.S. GOVERNMENT PRINTING OFFICE: 1977 - 735-004/13