1966

Occupational hearing loss : a potential hazard to rock n" roll musicians"

Calvin W. Cutright
University of Nebraska Medical Center

OCCUPATIONAL HEARING LOSS: A POTENTIAL HAZARD TO ROCK 'N' ROLL MUSICIANS

Calvin W. Cutright

A THESIS

Presented to the Faculty of

The College of Medicine of the University of Nebraska

In Partial Fulfillment of Requirements

for the Degree of Doctor of Medicine

Under the Supervision of Nancy Ann Timmons, B.S., M.A.

January 1966

Omaha, Nebraska

TABLE OF CONTENTS

ACKNOWLEDGMENTS

The author wishes to express his sincere appreciation for the excellent advice, guidance, and help given him by Miss Nancy Ann Timmons, under whose supervision this study was conducted.

He is also very grateful for the cooperation of the various niteclub owners and musicians who participated in this study and without whom the study could not have been conducted.

I. INTRODUCTION

A little more than a decade ago "someplace near despairsville" (Time, 1964) there was born a new breed of American popular music. Sired by the Country-Western style of Nashville, Tennessee, and foaled by the Blues tradition of American jazz (Lerman, 1965) from Harlem, U.S.A., this illegitimate infant of the music world was given the unlikely name "rock 'n' roll." Even as an infant it was loud and its heart beat with a driving rhythm, but the critics of that time felt, because of its lack of cultural appeal and its extreme simplicity, it would not survive five years-a very poor prognosis.

In spite of the opinion of the critics, it rapidly gained strength and, as it grew, began to assemble a formidable cadre of musicians to help in the rise to success. These talents, and especially Elvis Presley, quickly captured a loyal following of American teenagers whose support has today made rock 'n' roll a major exporter of American culture, a recent, but very successful, importer of British culture, and the undisputed king of the recording and broadcasting industries. Like it or not, it appears that rock 'n' roll has "made it" and is here to stay for some time.

Like anything prominent in the public eye, rock 'n' roll has been and is criticized both justly and unjustly by just about every would-be expert. Rock 'n' roll has been accused of ruining the American teenagers taste for legitimmate music. It has even been accused of destroying the moral fibre of America's youth and of being an agitator in the teenage rebellion against parents and society(Esquire, 1964). "Elvis", said the motivational researchers, " as the father of this menacing breed of children's crusaders, marshalled the anti-parent instinct into a kind of teenage Viet Cong" (Time, 1964). It is more probable, however, that the secret to rock 'n' roll's success lies in a variety of factors, the least of which is its role as an instrument of rebellious teens.

One of the major factors for its success could be its basic appeal to the primitive instinct of rhythm. The rhythm of rock 'n' roll is described by many as capturing the mood of our times, thus, making rock 'n' roll the folk music of the modern world (Esquire, 1965). The rhythm and loudness of rock 'n' roll portray and project a mood of gaiety and "good-times". This mood is clearly expressed in dances of the day.

The loudness is as essential to the mood of rock 'n' roll as is the rhythm, for it drives the mood of the music into the listeners' minds, pushing out other thoughts and worries.

However, this loudness which is no essential to the mood of rock 'n' roll may well become a member of the list of occupational hazards of musicians as a causal factor in occupational hearing loss.

The concept that impaired hearing may result from exposure to loud noise is not new. Rudmose (1957) noted that during the period from 1880 to 1957, at least 100 authors had written one or more papers on the subject and since that time the literature has grown tremendously. No papers could be found, however, which discussed the possibility that hearing loss could result from exposure to loud music.

It should be noted here that differentiating between noise and music is not always easy and is probably not necessary for application to the concept of noise-induced hearing loss. There are several reasons for this.

First it should be noted that an entirely acceptable definition of noise is difficult to obtain. A popular early definition was "sound without agreeable musical quality", but this definition proved to be quite unacceptable, partly because of the difficulty of defining "agreeable musical", but mostly because it did not take into consideration the fact that even agreeable musical quality may be undesirable at times (Glorig, 1958). To illustrate: On May 2, 1800, two of Beethoven's works were introduced in Vienna, the Septet and the First Symphony. A Leipzig critic of that time described the latter work as, "the confused explosions of the presumptuos effrontry of a young man". (Catlin, 1965). Thus in the words of Rosenblith (1952), "One era's noise may be the next era's music".

Secondly, it should be noted that many of today's critics feel rock 'n' roll is closer to being noise than music. No comment will be made on that observation.

Thirdly, it is generally accepted that it is the sound pressure levels, or loudness, of the sound and not the quality,or the individuals interpretation of the desirability of the sound, which, along with frequency considerations, cause noise-induced hearing loss. Thus, music, if loud enough,could cause noise-induced hearing loss.

Rock 'n' roll is inherently louder than other forms of music. One of the reasons for this lies in the fact that the instrumentation of rock 'n' roll groups consists mostly of electrically amplified instruments. This accounts for the "big sound" and enables groups such as the Beatles to almost be heard over the screams of thousands of their worshiping fans. In striving to create bigger and better sounds, the manufacturers of these amplifiers, used so extensively in rock 'n' roll, have, in order to meet competition in the growing market, developed electronic masterpieces capable of much greater volumes with better quality than their predecessors. In rock 'n' roll, these amplifiers are usually operated at near-peak volume, with the result being extremely loud music.

It is thus the purpose of this paper to attempt to establish whether or not this loud music, which constitutes the acoustical, working environment of the rock 'n' roll musicians, is capable of inducing hearing loss.

II. REVIEW OF LITERATURE

A. Hearing Loss: History and General Considerations.

According to Glorig (1958), nineteen hundred and forty-six marks the beginning of a concentrated effort to discover the relations of hearing loss to noise exposure. It was at this time the members of the Committee on Conservation of Hearing, a standing committee of the American Academy of Ophthalmology and Otolaryngology, realized that to discharge their duty properly they must make a concerted effort to contribute to the knowledge about noise induced hearing loss and its prevention. To this end the Subcommittee on Noise in Industry was established in 1947.

Before this time there was little effort to pool what information there was available and to organize research efforts.

Also in 1946, the Industrial Health Section of the American Medical Association held a meeting at which interested civilian and military groups were able to express their opinions and formulate plans for further research in the field of noise-induced hearing loss. This meeting was notable because it marked the medical profession's first wide-scale recognition of the seriousness of this problem.

Although 1946 marked the beginning of an attempt to solve the problem of noise-induced hearing loss, it also was the time when a great increase was realized in mass production following World War II and when heavy mechanization of industry and of the military produced noise in increasing , quantities as an inevitable and almost uncontrollable by-product. The recent emergence of this problem of noise affecting hearing suggests that modern man in his complex world may be more sesitive to noise than his ancestors were (Holmberg, 1965).

Hearing loss is usually classified on the basis of the anatomy and the physiology of ear, i.e. conductive, sensorineural, or a combination of these. Hearing losses may be hereditary or aquired. Occupational, or industrial, hearing loss falls into the aquired group. It may be caused by: (1) Noise exposure (2) Blows to the head or to the ears (3) Explosive blasts (4) Excessive changes in barometric pressure, and (5) Burns (chemical or physical)(Glorig, 1958).

Glorig(1958) also notes that occupational hearing loss is further divided into temporary and permanent. He describes temporary hearing loss as that hearing loss which results from one day's exposure to noise, but, from which the ear has recovered in sixteen hours elapsed time.

The general pathology of permanent noise-induced hearing loss,as described in a monograph by Glorig (1958), is a degenerative process found in the hair cell endings or, if extremely severe, complete destruction of the organ of Corti secondary to altered metabolic processes at a cellular level caused by overstimulation by noise for a long period of time.

Edward Hermann (1965) proposed a biophysical, mathematical formulation outlining the fundemental manner in which human hearing deteriorates with continuation of excessive noise exposure. It follows a first-order, first-degree differential equation:

$$\frac{dt}{-dL} = KL$$

where t= time, L= loss, and K= a constant. This may be stated as a law:

> "The rate at which noise-induced hearing loss is experienced is proportional to the amount of hearing acuity remaining to be lost."

This law is well supported by audiometric data obtained from puretone threshold responses at 4000 cycles per second. From this data, Hermann (1965) proposed that it could be hypothesized that deterioration proceeds as if noise were upon only a single type of cell or critical structure; a monocellular decay so to speak, analogous to the monoatomic decay of radioisotopes or monomolecular decomposition of a single chemical at a given temperature.

The exact pathology of temporary hearing loss is not known but, it is speculated that this type of hearing loss is due to cell-fatigue (Glorig, 1958). A subcommittee of the American Academy of Ophthalmology and Otolaryngology (1964) has studied temporary threshold shifts and concludes:

(1) The temporary elevation of auditory threshold which results from one day's exposure to noise levels of 100 decibels or more may vary from "no shift" to 35 decibels of loss.

(2) Exposure to typical industrial noise produces the largest temporary loss at 4000 and 6000 cycles per second

(3) The major portion of the temporary loss is produced during the first 1-2 hours of exposure.

(4) The amount of temporary loss is about the same for the same person from day to day but, it varies from person to person roughly according to a normal statistical distribution.

(5) The amount of temporary loss and its frequency vary with the amount and frequency location of permanent loss; i.e., the more the permanent loss, the less the temporary loss at certain frequencies.

(6) Normal hearing persons whose ears have never been exposed to noise for long periods of time, referred to as "green ears" , show more temporary shifts than normal hearing persons whose ears have been exposed for long periods of time, referred to as "ripe ears".

Diagnosis of hearing loss is made on the findings of audiometry the procedure of which is described very well in monographs by both Glorig (1958) and Sataloff (1957) but which not be covered in this paper even though it is a major part of any acoustical survey.

B. EFFECTS OF NOISE EXPOSURE

According to Glorig (1958), the effects of noise may be divided into two major groups: auditory and non-auditory. He stated that of the non-auditory effects, annoyance, irritability, inefficiency, and fatigue are the most common but, he noted that attempts to study these effects were hopelessly complicated by related factors: motivation, ventilation, physical surroundings, temperature, attitude, and a host of others.

Some of the body's stimulus receptors such as those of touch (kinetic and vibratory) and body functions such as respiration, circulation, and balance show effects that vary with intensity and frequency of noise; particularly if the frequencies are below 100 cycles per second or if the intensities range above 130 decibels. Catlin (1965) noted, however, that individuals adapt rather readily to exposure to noise, and that these physiological appear to be insignificant after such adaptation. Catlin (1965) also felt there was no direct proof substantiating the premise that the increasing noises of our civilization result in additional emotional stresses and mental illnesses. He felt, however, that is very likely that the study of the relation between noise and behavior will become increasingly important in the years to come.

The auditory effects of noise fall under the headings of auditory fatigue and acoustic trauma which are discussed earlier in this paper.

C. PSYCHOACOUSTICS

The term psychoacoustics describes the study of man's responses to sound. Man's responses to sound occur within a limited range of frequencies known as the <u>audible frequency range</u> (Glorig, 1958). This range extends from a lower limit of about 16 cycles per second to a higher limit of about 20,000 cycles per second. He noted further that man can make frequency discriminations of approximately 2-3 cycles per second. These values values vary with age, however, with hearing and discrimination in the high frequencies growing much less acute with age.

Glorig (1958) noted further that under favorable circumstances man can hear sounds so faint they might been produced by the thermal motion of molecules and yet can hear without undue distortion sounds a million million times more intense, and can determine intensity differences of one-half decibel. These capabilities, according to Glorig (1958), make the ear the most sensitive of the sense organs. It is not equally sensitive to all frequencies in the audible range but, can respond to fainter sounds in the region between 1000-4000 cycles per second.

Three <u>tolerance</u> thresholds connected with auditory function and worthy of note are: (1) The threshold of discomfort, (2) The threshold of tickle, and (3) the threshhold of pain. The sound pressure levels of these tolerances are 120 decibels, 130 decibels, and 140 decibels respectively. Glorig(1958) further noted that these thresholds vary considerably from person to person and within one person with adaptation.

D. NOISE MEASUREMENT

Sataloff (1957) classified noise for the purpose of measurement into four groups: (1) steady wideband noise, (2) steady narrowband noise, (3) single-impact noise, and (4) repetitive-impact noise. Examples of each are, respectively: the noise produced by loud tractor engines, the noise of power saws(sound above 2000 cycles per second), the firing of ammunition, and the sound of pneumatic hammering. The first two of these groups are easily measured with currently available equipment. The last two groups, however, present a problem in that the standard sound-level meter responds too slowly to record peak values. The standard sound level meters are equipped with meter damping devices slow the needlds oscillation in order that at least an average volume reading can be made in these cases. This technique was used in measuring the sound pressure levels of the rock 'n' roll music in this study.

According to Williams (1957), there are three important kinds of noise-measuring devices: (1) the sound survey meter, (2) the sound-level meter, and (3) the sound analyzer. These are listed in the order of increasing reliability. Williams felt that the sound level meter was the basic instrument for noise measurement in the field. He described it as consisting of a microphone, a calibrated attenuator, an amplifier, a series of frequency response, or weighting, networks, and a meter. Williams felt that the microphone is by far the most important single piece of the equipment, since the final result can be no better than the signal produced by the microphone.

The calibrated attenuator controls the signal from the microphone so that it remains within the limits which can be handled by the meter. The meter is usually calibrated in decibels*. (Sataloff, 1957).

The three frequency response or weighting networks, "A", "B", and, "C", provide for the human variable response to sound at different frequencies. Network "A" provides for a lower response to low-frequency noise and is recommended for use in relatively low intensity fields of around 40 decibels. Network "B" is intermediate in response and is suggested for use in intensities of around 70 decibels. Network "C" gives a flat response in all frequencies and is recommended for use in fields with intensities of around 90 decibels and above (Sataloff, 1958).

A noise analyzer consists of a set of electronic filters or of a cathode-ray oscilliscope and is used to determine the sound-pressure level within a given octave-band. This is necessary in noise measurement in order that the physiologic effects of the noise may be predicted with reasonable accuracy. The cathode-ray oscilliscope permits visualization of the waveform of the noise and is particularly useful in measuring impact noises (Sataloff, 1957).

*(A decibel is a dimensionless unit used to express a logarithemic ratio of two amounts of intensity, i.e. $20 \times \log P_1/P_2$= sound pressure level(decibels). Here P_2= 0.0002 dynes/cm^2(microbar)).

In making noise measurements, Sataloff (1957) stressed that complete data be assembled. He suggested that this should include the primary and secondary noise sources, the physical environment, the personnel exposed, the time pattern of the exposure, the identification of the equipment used, and the position of the microphone during the recording. He warned that placing the microphone too close to the head of the subject would result in abnormally high readings because of the reflection of the sound off of the subjects' head.

B.G. Churcher (1962) found that in calculating the loudness levels for musical sounds, certain corrections should be made. For making these corrections he suggested using the Stephen's method:

$$S_t = S_m + F(S - S_m)$$

where S_t= the total loudness in sones*, S_m= the loudness of the octave-band having the greatest loudness, S= the sum of the loudness of all octave-bands, and F= a constant= 0.27 (0.3).

E. ESTABLISHING DAMAGE RISK CRITERION

According to Major John L. Fletcher (1964), the damage risk criterion is a list of factors which enables predicting the possible debilitating effects of a given exposure with a rather precise degree of accuracy. He noted that a

*(The sone is defined as the loudness of a 1000cps pure-tone of 40 db above a "normal" listener's threshold)

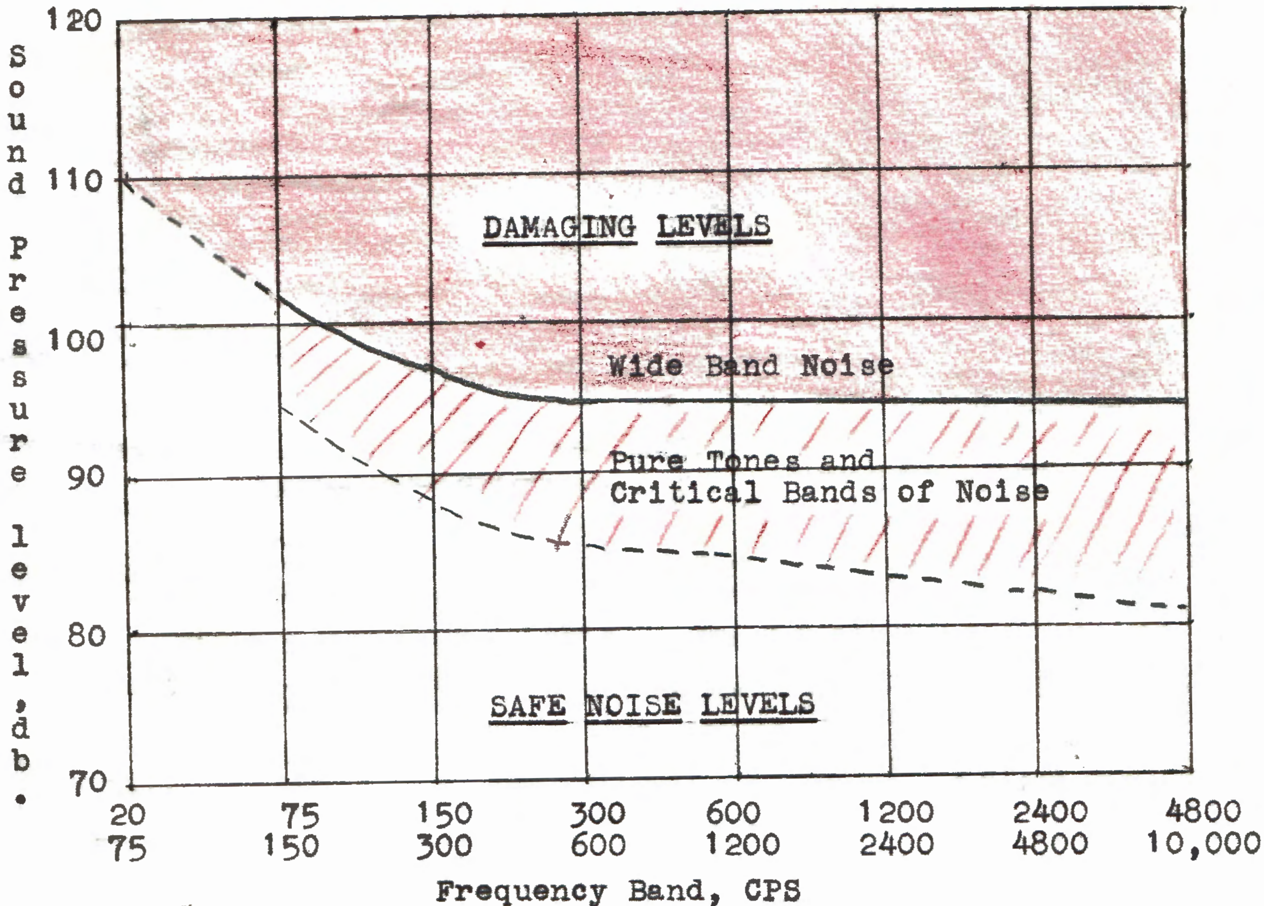
damage risk criterion indicates who to protect, to what degree, and, conversely, who can be safely omit from any hearing conservation program.

Sataloff (1957) noted that it is generally accepted that very intense noise can produce hearing loss, but, that there is considerable difference of opinion as to the boundry line, or critical noise level, which separates harmless from harmful noise. Sataloff noted that Kryter suggested long ago that tones 85 decibels and above may cause may cause some deafness, temporary or permanent, over a long term exposure. Davis in 1945 suggested that there was no rigid proof of permanent impairment of hearing from noise of less than 115 to 120 decibels and that concern about noise levels below 100 decibels was unwarrented.

Some of the difficulties in establishing a critical noise level lies in the variable susceptability of individuals and in the cumulative character of acoustic trauma (Sataloff, 1957).

Glorig (1958), Sataloff (1957), and Major Fletcher (1964) all agree that the damage risk criterion should consist of the following factors which influence the capacity of a noise to produce hearing loss: (1) The overall level of the noise, (2) its spectrum, (3) its time pattern, and (4) the duration of the individuals exposure.

Using these four factors, Rosenblith and Stevens drew up the graph below. It is the criterion outlined in this graph which will be used to interpret the data gathered in this study:



Damage-risk criterion for steady noise and for lifetime exposures, (reprinted from Rosenblith and Stevens: "Handbook of Acoustic Noise Control," vol.11, Technical Report 52-204, Wright Air Development Center, Air Research and Development Command, United States Air Force, Wright-Patterson Air Force Base, Ohio, June, 1953.)

Rosenblith noted that it is important to keep in mind that this damage risk criterion is a statistical concept and must be interpreted as such without indiscriminate application to individual situations. Furthermore, it is a very complex concept, involving variables that are incompletely understood, such as the individual susceptability to noise, its cumulative effect, and the relation of auditory fatigue to permanent deafness.(Rosenblith, 1953).

M. Thomas Summer, ~~M.D.~~ (1965) added as a simple rule of thumb that a noise hazard should be assumed to exist and a hearing conservation investigation should be done if:

(1) Difficulty exists in communication because of the noise, or

(2) Temporary hearing loss occurs after a work shift with or without ringing in the ears, or

(3) Hearing loss appears in employees working under usual conditions.

III. SOUND LEVEL MEASUREMENT AND OCTAVE-BAND ANALYSIS OF ROCK 'N' ROLL MUSIC

The plan of this study is to conduct a sound level survey and octave-band analysis in several of the Omaha, Nebraska, area night clubs which feature "live" rock 'n' roll music in order to establish whether this music presents a hazard to the musicians hearing.

The instrument which was selcted to record these measurements was the Rudmose Sound Analyzer, Model RA-100, manufactured by the Rudmose Associates of Richardson, Texas. It was made available for use in this study through the generousity of Nancy Timmons, Assistant Instructor in the Department of Speech and Hearing Pathology, College of Medicine of the University of Nebraska. It is designed especially for the non-acoustician, yet it is flexible enough to satisfy most of the needs of the expert. The Rudmose RA-100 is portable, battery operated, and completely transistorized to eliminate microphonics* and to provide reliability.

The RA-100 Sound Analyzer utilizes a high-quality, wide frequency response, dynamic microphone which may be used on extension cables up to 250 feet long without using correction factors.

There are eleven filter settings on the RA-100: The standard "A", "B", and "C" networks for over-all sound

*(<u>Microphonics</u> is used to describe a phenomenon which may cause sythetic values of sound pressure levels as the result of vibrations transmitted through the air or case of the instrument directly to the tubes of the instrument. This phenomenon is not seen in transistorized meters.)

levels and eight octave-band settings from 37.5 cycles per second to 9600 cycles per second.

The attenuator settings allow for operation of the meter in fields from 36 decibels to 140 decibels.

The meter has three damping settings: regular, slow and slower. In this study the slow setting was selected. The RA-100 is easily field-calibrated in 10 seconds which allows for frequent calibration for accuracy.

Preliminary data which was collected prior to the actual sound analysis included:

(1) A map of the room in which the measurements were made, on which, was recorded the estimated size of the room, the positions of each of the sound sources and a letter identifying it, the positions of each of the musicians and a number identifying him, was drawn.

(2) A record of the materials of which the room was constructed was made.

(3) The temperature of the room was recorded as taken on an ordinary alcohol Farenheit thermometer.

(4) A list and description of the instruments and amplifiers used by the group (which were listed by their corresponding number on the map), was made.

(5) The name of the combo and the name of the night club were recorded on a separate key and were listed on the data sheets by the numbers on the key.

(6) The average weekly exposure and total exposure to the noise was obtained and recorded

An estimation of the average height of the musicians' ears from the floor was made but not recorded. This represented the height at which the microphone was held during the analysis.

Finally, the musicians were asked the following four questions in order to establish whether or not their music met any of the standard of Summer (1965):

(1) Do you have any difficulty communicating because of the noise?

(2) Have you ever noticed a temporary hearing loss at the end of the performance?

(3) Do you ever have any ringing in your ears at the end of the performance?

(4) Do you have any hearing problems from any cause?

The answers to these questions were recorded statistically.

With this preliminary data recorded the actual sound analysis could then be made. Sound pressure levels were measured in all three sound level networks and all of the eight octave-bands in the area of each of the heads of the musicians. These measurements were recorded in the form of a graph with one curve representing each of the musicians and identified by his number.

The microphone was held at 65 inches from the floor which represented the average level of the musicians ears.

For the analysis a song was chosen at random and was not the same song for each group.

IV. SUMMARY OF DATA

There were a total of ten different survey sites and rock 'n' roll bands in this study. This represented forty- five musicians each of whom had his own eleven sound pressure values(one for each of the filter settings)which were recorded in graph form. From thèse graphs the following figures were compiled:

	Range	Mean	Mode	Median
"A".............	90-112 db.	110 db.	106 db.	106 db.
"B".............	90-114	107	110	107
"C".............	98-121	111	114	112
37.5-75 cps.....	95-115	103	102	102
75-150..........	98-114	107	108	106
150-300.........	103-117	110	110	110
300-600.........	94-122	110	112	110
600-1200........	90-122	104	100	106
1200-2400.......	90-117	102	94	105
2400-4800.......	84-111	98	92	100
4800-9600.......	80-100	93	90	95
hrs/wk. exposed.	8-32 hrs.	21 hrs.	30 hrs.	17 hrs.
total # months exposed.........	12-120 mo.	41 mo.	24 mo.	42 mo.

Because of their location behind the amplifiers, the drummers had consistently lower sound pressures as a group. Most of the sound to which the drummers were exposed was impact noise and thus,a maximum sound level could not be recored.

After compiling the data it was found that the maximum average sound pressure level was 111 decibels in the "C" over-all sound level network and 110 decibels in both the 150-300 and 300-600 cycles per second octave-bands. The maximum single sound pressure levels were found to be 122 decibels in 600-1200 and 1200-2400 cycles per second octave-bands.

The average Rock 'n' Roll musician was exposed only 21 hours per week and had been playing rock 'n' roll music for only 41 months.

The four questions asked of the musicians produced the following data:

I. Do you have difficulty communicating while playing because of the noise?

YES	NO	%
45	0	100

II. Do you notice any temporary hearing loss after finishing the dance?

YES	NO	%
38	7	84.5

III. Do you have any ringing in your ears at the end of the performance?

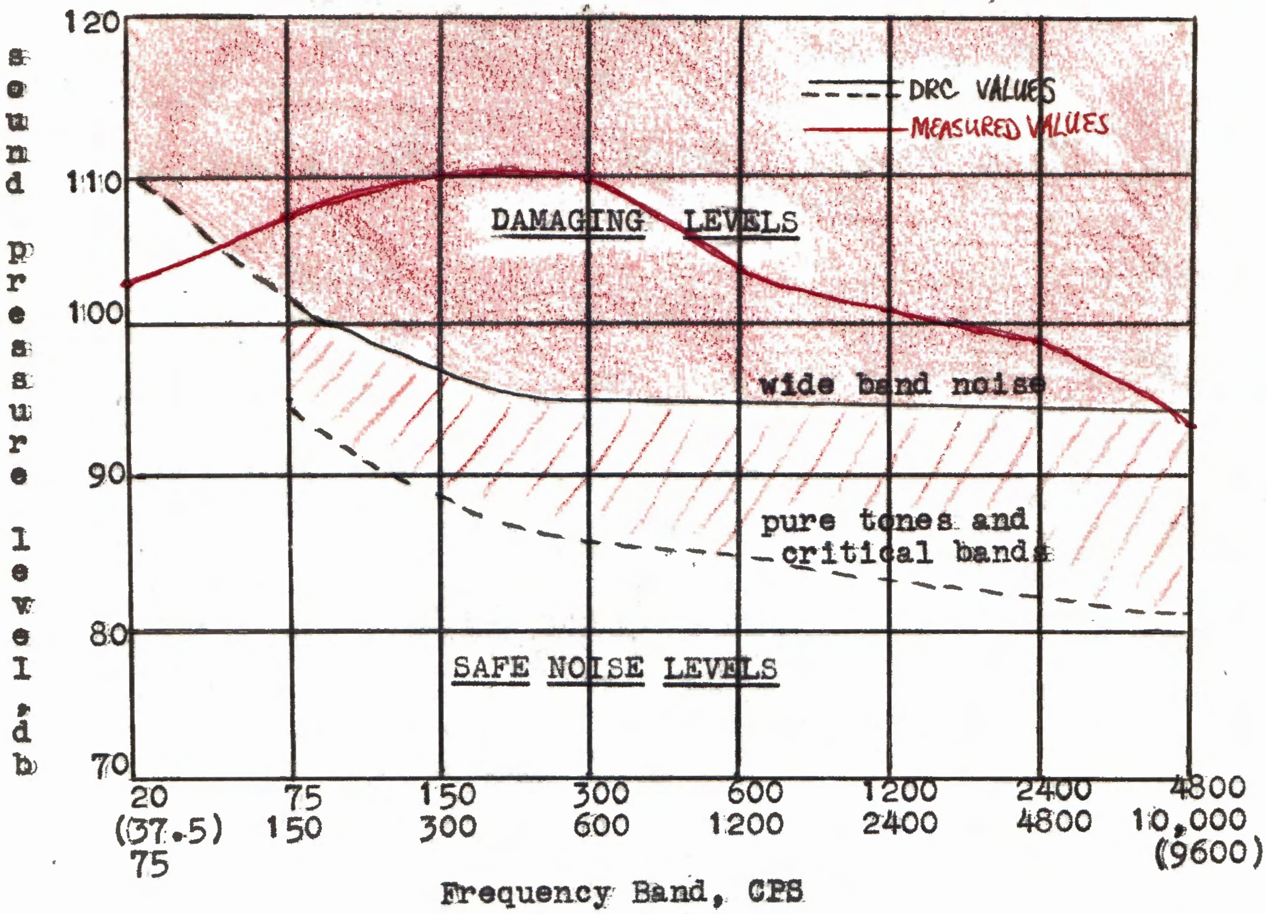
YES	NO	%
10	35	22.1

IV. Do you have any hearing problem from any cause?

YES	NO	%
2	43	4.7

The data from page 20 was then used to construct this graph:

COMPARISON OF THE AVERAGE
SOUND PRESSURE LEVELS
OF ROCK "N" ROLL MUSIC
AND THE DAMAGE RISK CRITERION
OF ROSENBLITH AND STEVENS



(Adapted from Rosenblith and Stevens: "Handbook of Acoustic Noise Control," vol.11, Technical Report 52-204 Wright Air Developement Center, Air Research and Development Command, U.S.A.F., Wright-Patterson A.F.B., Ohio, June, 1953.)

V. CONCLUSIONS

From the graph on the preceding page it can be concluded that after a life-time exposure to these sound pressure levels, the musicians would suffer noise-induced hearing losses. However, since the average weekly time of exposure was only 21 hours and the total exposure time was only 41 months it is unlikely that any of these musicians have suffered permanent hearing loss from their music. Furthermore, since being a rock 'n' roll musician is only a short term job in most cases(there was one musician who had been playing for 10 years) it is unlikely that any of these musicians will ever suffer from rock 'n' roll-induced hearing loss.

The fact that the sound pressure levels are potentially hazardous to the musicians ears is further substantiated by the fact that 85% of the musicians suffered noticible tempoary hearing loss at the end of the work day, and 22% had noticed some ringing in the ears.

It would be difficult indeed to formulate a plan of prevention of occupational hearing loss in these musicians because any form of ear protector would lessen their ability to hear intonation in the music and would have to be small enough not to be detrimental to the stage appearance of the performer. Perhaps, a little bit of the mood and "Big Sound", could be sacrificed in order to preserve precious hearing? Would the Beatles cut off their hair?

BIBLIOGRAPHY

Catlin, Francis J., 1965 "Noise and Emotional Stress." J. Chronic Dis., 18:509-518

Churcher, B.G., "Calculation of the Loudness Levels for Musical Sounds". J. Acous. Soc Am., 34: 1634-1642, 1962

Fletcher, Major John L., 1964 "Criteria for Assessing Risk of Hearing Damage", East Range Symposium, Effects of Noise in Industry, J. Occ. Med. 7:6: 281-284

Glorig, Aram Jr., 1958 "Noise and Your Ear", Monographs in Industrial Medicine, 1, New York, Grune and Stratton, 3-6, 40- 44, 80-90, 105-110.

Hermann, Edward R., 1964, "A Biophysical Law Describing Hearing Loss". Indus. Med. Surg. 34: 223-228

Holmberg, C. J., 1965,"Hearing Loss: Diagnosis and Anatomic Considerations". East Range Symposium, Effects of Noise in Industry, J. Occ. Med. 7: 4 139-144

Lerman, L., 1965 "Where's it at?" Mademoiselle 61: 74-77

Rosenblith, W.A., 1952 "The Effects of Noise Upon the Behavior of People" Proced. of 3 rd. Ann. Nat'l Noise Abatement Symp, 3:40

Rosenblith, W.A., et. al., 1953 "Handbook of Acoustic Noise Control", vol.11, Technical Report 52-204 Wright Air Developement Center, Air Research Command, U.S.A.F., Wright-Patterson A.F.B., Ohio.

Rudmose, W., 1957 "Hearing Loss Resulting from Noise Exposure", Handbook of Noise Control, Mc Graw-Hill, New York

Sataloff, Joeseph, 1957 Industrial Deafness , McGraw-Hill, New York

Summar, M. Thomas, 1965 "Hearing Conservation Programs", East Range Symposium, Effects of Noise in Industry, J. Occ. Med. 7:4: 145-146

Williams, 1957 "Priniciples of Noise Measurement", Industrial Deafness, Sataloff, 1957, Mc Graw-Hill, New York 77-83

Time, June 5, 1964, "Someplace Near Despairsville", Rock'n' Roll, Time-Life Publishers , New York, 83: 60-65

Esquire, "A Little Bit of Nowhere", Dec. 1964, 62: 102-103

<u>Guide for Conservation of Hearing in Noise</u>, (revised), 1964
Research Center Subcommittee on Conservation of Hearing, American Academy of Ophthamology and Otolaryngology, Los Angeles

APPENDIX

APPENDIX

DETAILED DATA OF SURVEY

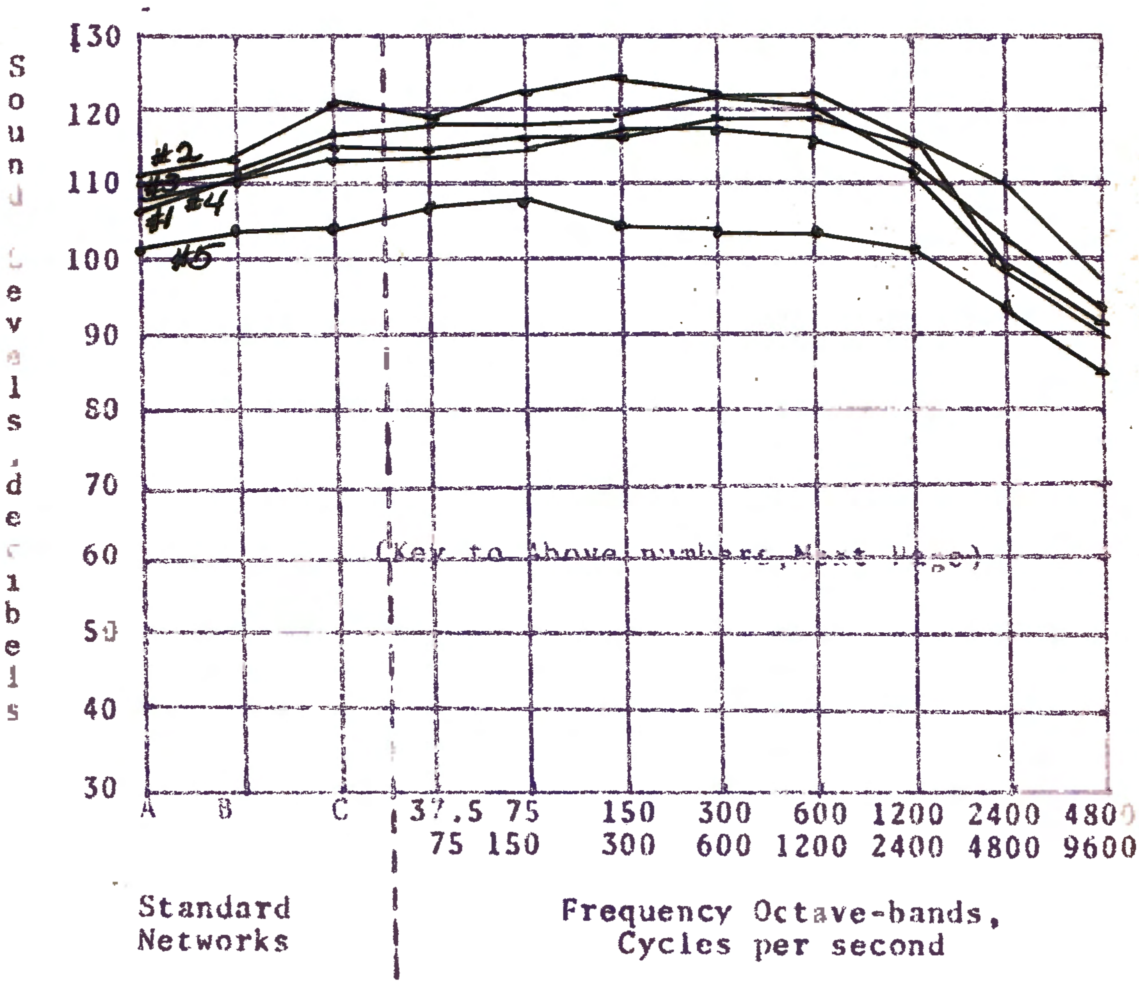
SOUND SURVEY DATA SHEET # 1

Survey Site #: 1 .Group #: 1
Date: 1/21/66 .Time: 10:30 PM Temp. 78 °F.

Instrument Data:

Meter Type: Sound Analyzer Model: Rudmose RA-100
Microphone: Dynamic Cable: None
Meter Speed: slow Meter Action: Fairly Stable

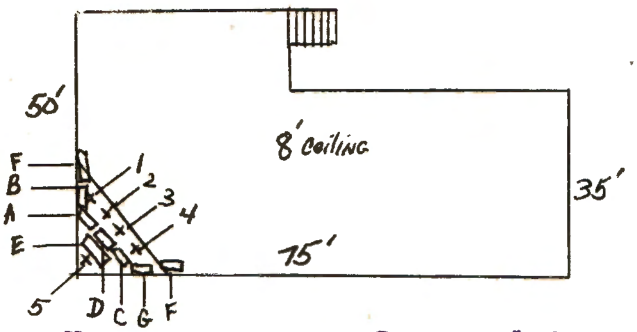
Sound Analysis Data



Sound Survey Data Sheet # 2

Survey Site #: 1 Group # 1

Map of Survey Site:



Materials

Ceiling. Roughened plaster

Floor... Vinyl Tile

Walls... Smooth Plaster

Key:

I. Sound Sources= ▭

A. Vox Super Beetle Amp; Rickenbacher, 2pick-up standard guitar

B. " "

C. (Super Beetle Amp has 2-15" speakers; 150 watt)

D. Fender Bassman Amp(1-15" speaker; 100 watt); bass guitar

E. Drums; traps; Ludwig; cymbals.

F. P.A. amp; Echoplex(100 watt, echo and reverb); 4-12" horns

G. Farfisa transistor organ(run through Super Beatle Amp)

II. Personnel= +

	Hrs/wk exposure	Total # Months Exposed
#1	14	24
#2	14	30
#3	14	24
#4	14	36
#5	14	24
#6		

SOUND SURVEY DATA SHEET # 1

Survey Site #: 2 .Group #: 2

Date: 1/21/65 .Time: 10:50 PM .Temp: 75 °F.

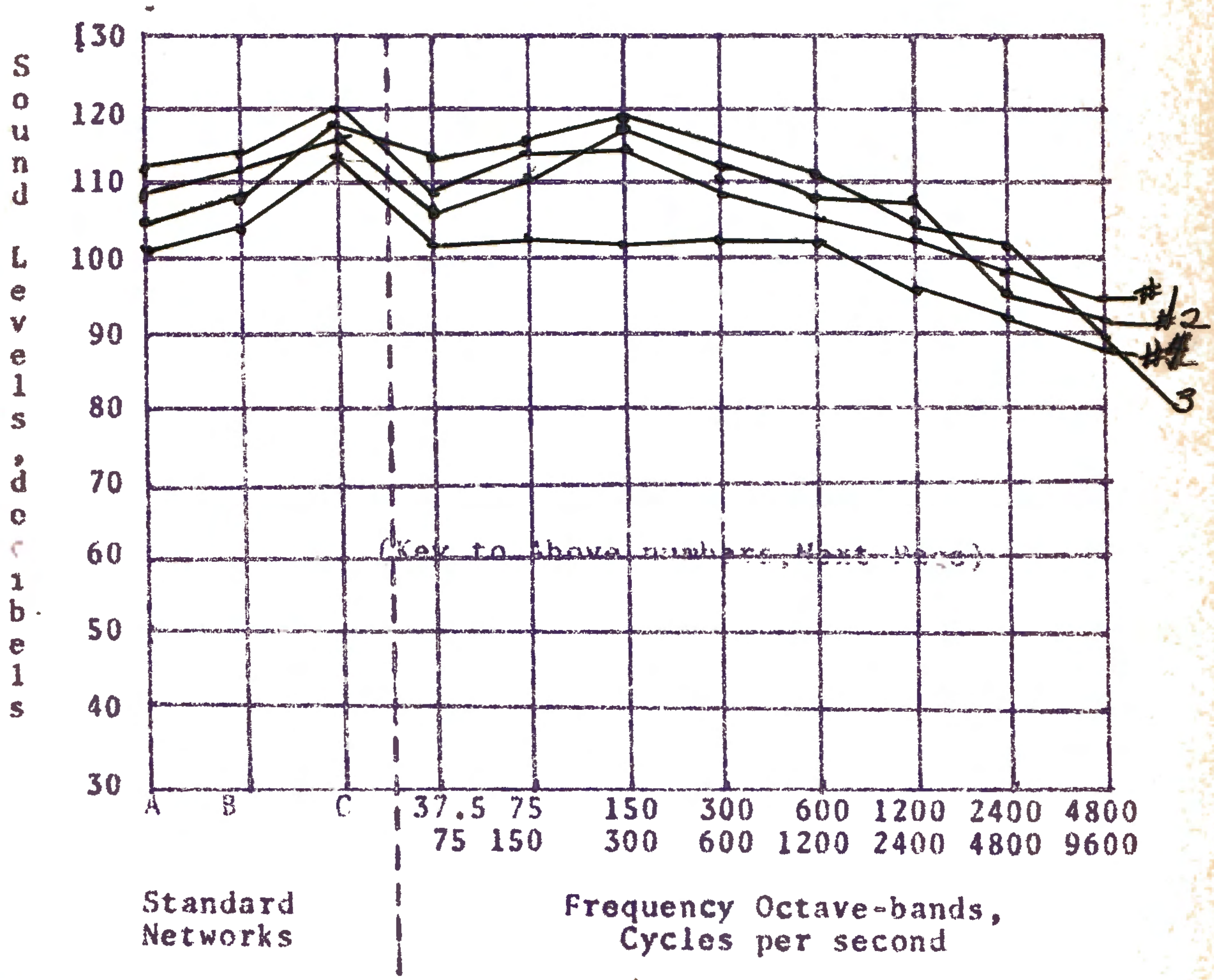
Instrument Data:

Meter Type: Sound Analyzer Model: Rudmose RA-100

Microphone: Dynamic Cable: None

Meter Speed: Slow Meter Action: Fairly Stable

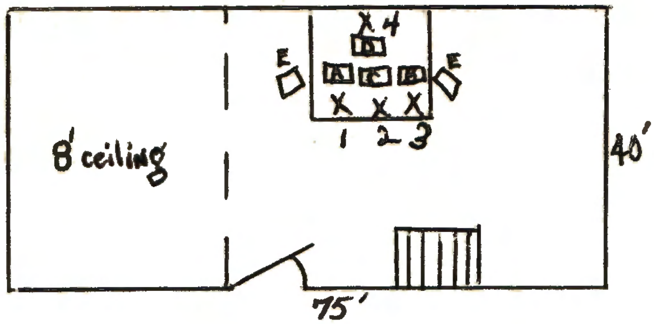
Sound Analysis Data



Sound Survey Data Sheet # 2

Survey Site #: 2 Group # 2

Map of Survey Site:



Materials

Ceiling. Acoustical Tile

Floor... Vinyl Tile

Walls... Plaster

Key: I. Sound Sources=□

A. Fender Showmwn 15;1-15" speaker;Fender Jag Standard Guitar

B. " " "

C. Fender Bassman Amp; 2-12" speakers; Fender Jazz Bass Guitar

D. Drums; traps; Slingerland

E. Bogen P.A. amp; 100watt; 4-12" horns; 3 Turner microphones

F.

G.

II. Personnel= +

	Hrs/wk exposure	Total # Months Exposed
#1	12	20
#2	12	22
#3	12	34
#4	12	30
#5		
#6		

SOUND SURVEY DATA SHEET # 1

Survey Site #: 3 .Group #: 3

Date: 1/21/66 .Time: 11:15 PM .Temp: 76 °F

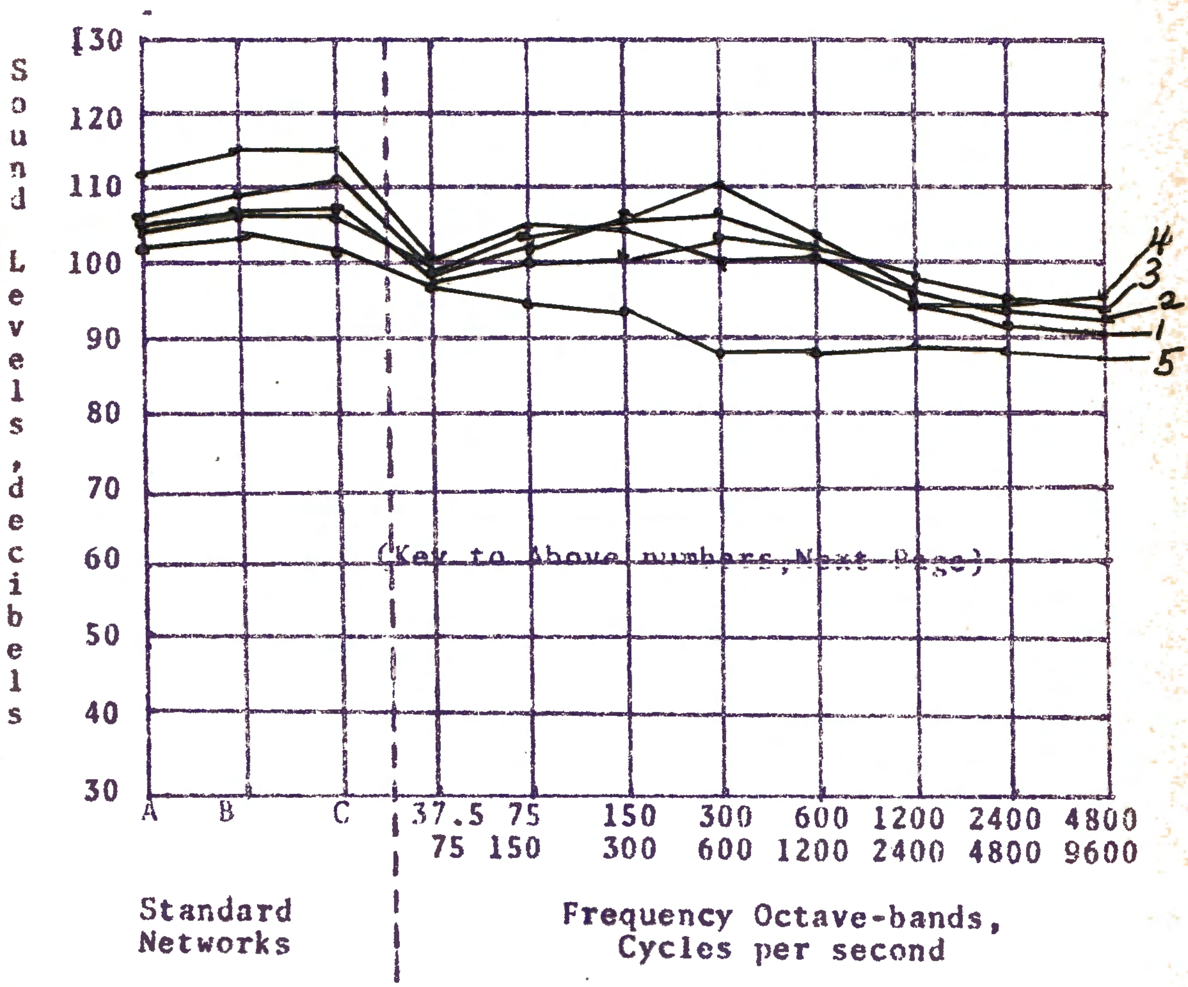
Instrument Data:

Meter Type: Sound Analyzer Model: Rudmose RA-100

Microphone: Dynamic Cable: None

Meter Speed: Slow Meter Action: Fairly Stable

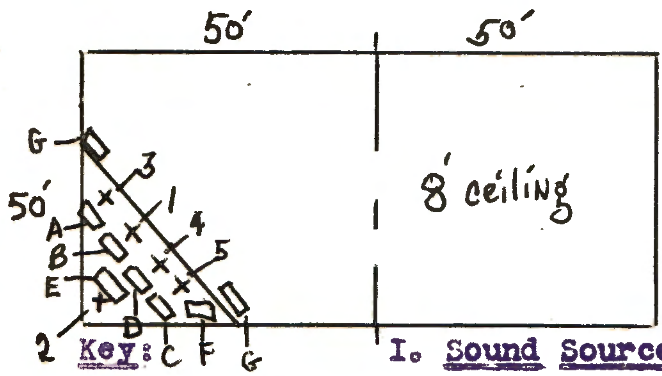
Sound Analysis Data



Sound Survey Data Sheet # 2

Survey Site #: 3 Group # 3

Map of Survey Site:



Materials

Ceiling. Armstrong Susp.

Floor... Vinyl Tile

Walls... Dry Wall

Key: I. Sound Sources=▭

A. Fender Showman 15; 1-15" speaker; 150 watt; Standard guitar

B. " " " "

C. " " " "

D. Fender Bassman; 2-12" speakers; 100 watt; 4-string BassGuit.

E. Drums; Ludwig trap set;

F. Farfisa transistor organ(powered by Showman 15)

G. 100 watt Bogen P.A. amp; 4-12" heavy-duty P.A. horns

II. Personnel= +

	Hrs/wk exposure	Total # Months Exposed
#1	17	48
#2	17	36
#3	17	30
#4	17	60
#5	17	36
#6		

SOUND SURVEY DATA SHEET # 1

Survey Site #: 4 .Group #: 4

Date: 1/22/66 .Time: 12:00 M .Temp: 79 °F.

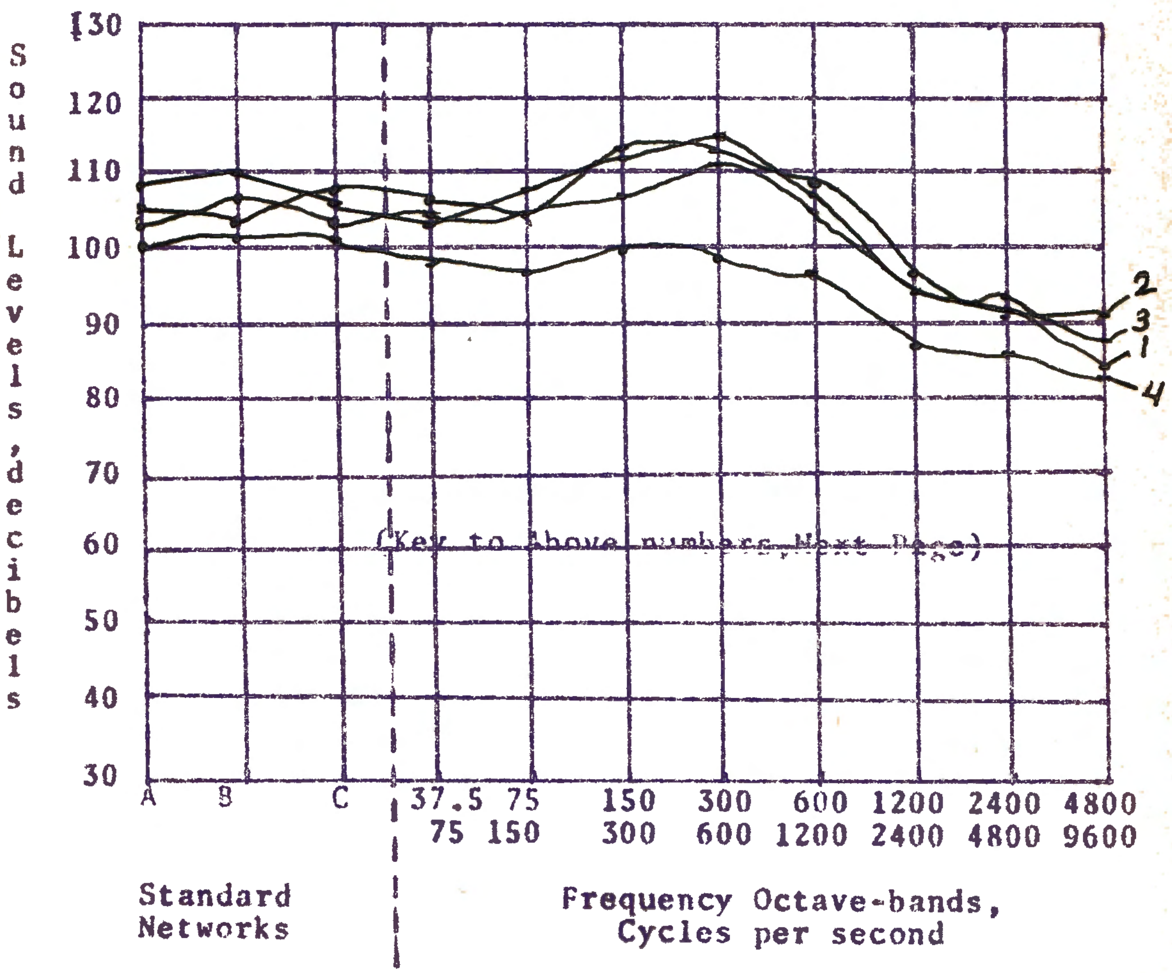
Instrument Data:

Meter Type: Sound Analyzer Model: Rudmose RA-100

Microphone: Dynamic Cable: None

Meter Speed: Slow Meter Action: Fairly Stable

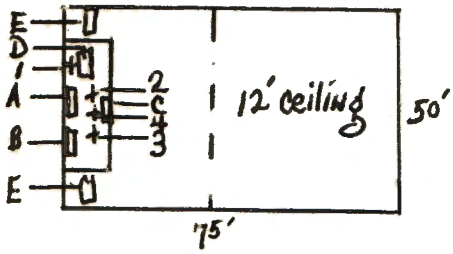
Sound Analysis Data



Sound Survey Data Sheet # 2

Survey Site #: 4 Group #: 4

Map of Survey Site:



Materials

Ceiling. Plaster

Floor... Hardwood

Walls... Plaster

Key:

I. Sound Sources= ▭

A. Fender Super Reverb Amp; 2-12" speakers; 100 watt; std gtr.

B. Fender Bassman Amp; 2-12" spkrs; 100 watt; 4-strg bss gtr

C. Olds Saxephone

D. Ludwig trap drum set

E. Bogen 100 watt P.A. amp; 4-12" heavy-duty P.A. Horns

F.

G.

II. Personnel= +

	Hrs/wk exposure	Total # Months Exposed
#1	28	120
#2	28	60
#3	28	72
#4	28	60
#5		
#6		

SOUND SURVEY DATA SHEET # 1

Survey Site #: 5 .Group #: 5

Date: 1/22/66 .Time: 11;30 PM .Temp: 79 °F.

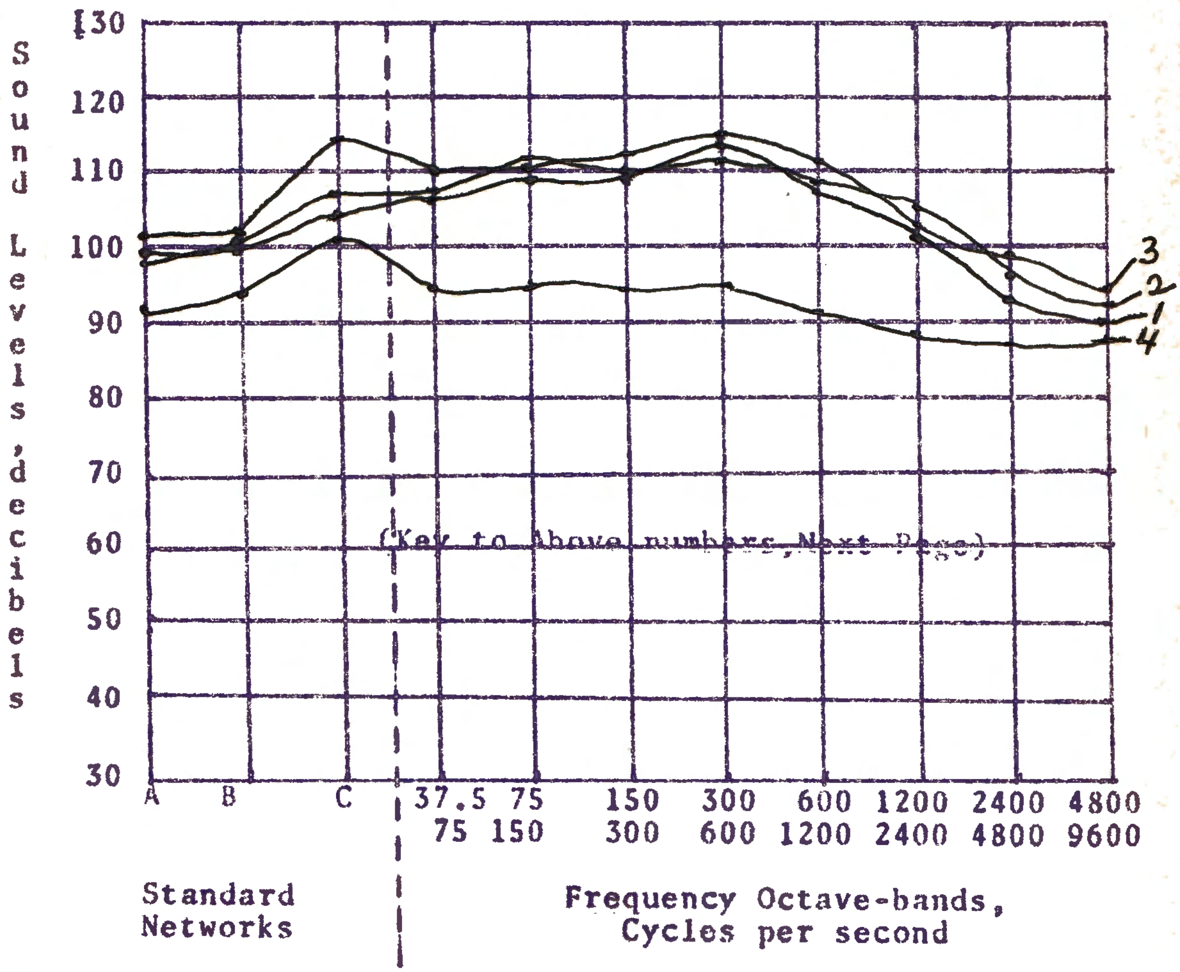
Instrument Data:

Meter Type: Sound Analyzer Model: Rudmose RA-100

Microphone: Dynamic Cable: None

Meter Speed: Slow Meter Action: Fairly Stable

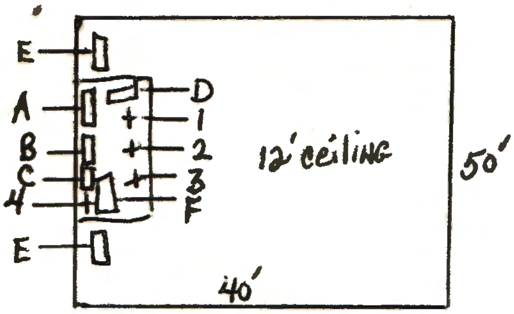
Sound Analysis Data



Sound Survey Data Sheet # 2

Survey Site #: 5 Group # 5

Map of Survey Site:



Materials

Ceiling. Acstcl tile

Floor... Carpet & wood

Walls... Plaster

Key: I. Sound Sources=▭

A. Fender Super Reverb Amp; 2-12" spkrs; 100 watt; stdrd gtr

B. " " " "

C. Fender Bassman Amp; 2-12" spkrs; 100 watt; 4-strng bss gtr

D. Hammond L-100 organ; 2-12" spkrs; 27 watt

E. Echoplex 100 watt P.A. Amp; 2-Turner mikes; 2 hvy-dty horns

F. Slingerland trap drum set

G. ___

II. Personnel= +

	Hrs/wk exposure	Total # Months Exposed
#1	30	60
#2	30	72
#3	30	96
#4	30	36
#5		
#6		

SOUND SURVEY DATA SHEET # 1

Survey Site #: 6 .Group #: 6

Date: 11/28/66 .Time: 10:30 PM .Temp: 79 °F

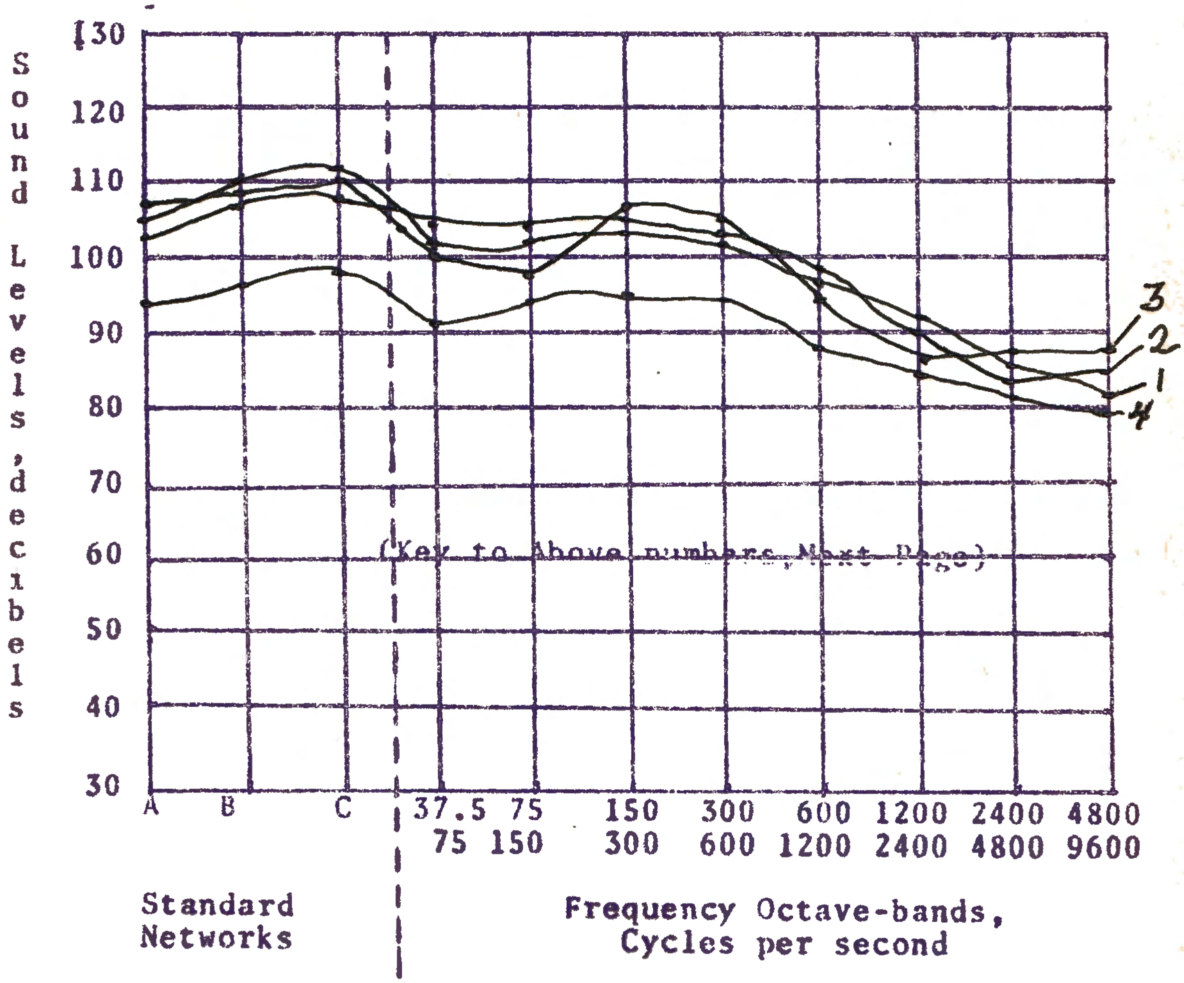
Instrument Data:

Meter Type: Sound Analyzer Model: Rudmose RA-100

Microphone: Dynamic Cable: None

Meter Speed: Slow Meter Action: Fairly Stable

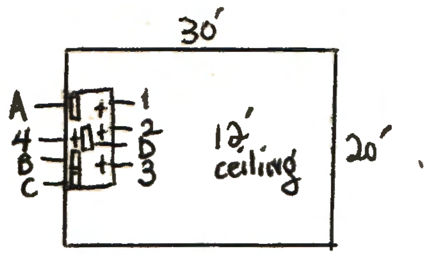
Sound Analysis Data



Sound Survey Data Sheet # 2

Survey Site #: 6 Group # 6

Map of Survey Site:



Materials

Ceiling. Plaster

Floor... Wood

Walls... Plaster

Key:

I. Sound Sources=▭

A. Fender Showman 15 amp; 1-15" spkr; 150 watt; stndrd gtr

B. " " " "

C. Fender Bassman Amp;2-12" spkrs; 100 watt; 4 string bass gtr.

D. Slingerland trap drum set;

E. 2-Electrovoise 664 mikes; run through Showman 15 amp.

F.

G.

II. Personnel= +

	Hrs/wk exposure	Total # Months Exposed
#1	8	24
#2	8	18
#3	8	30
#4	8	24
#5		
#6		

SOUND SURVEY DATA SHEET # 1

Survey Site #: 7 .Group #: 7

Date: 1/28/66 .Time: 11:45 PM .Temp: 80 °F.

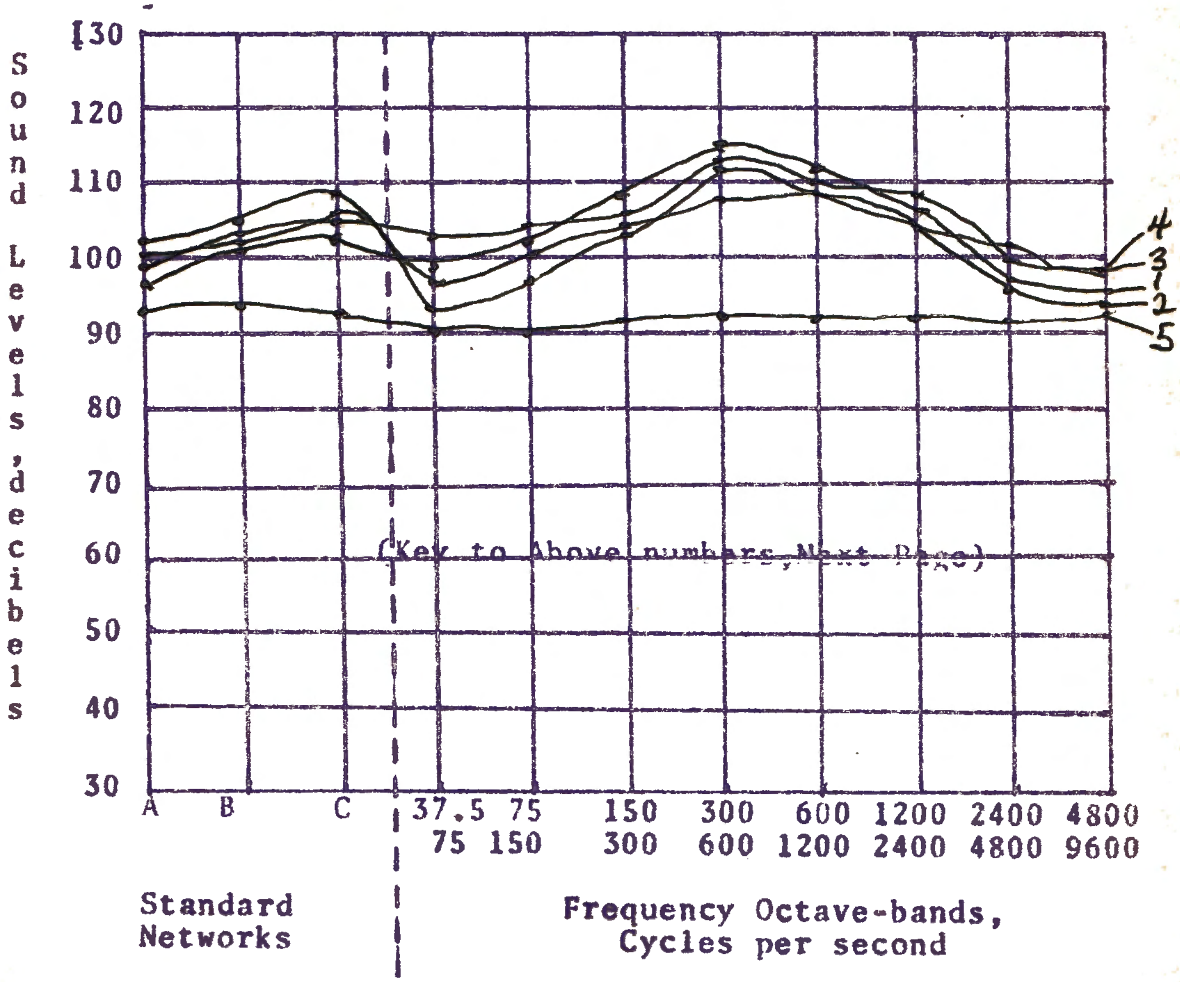
Instrument Data:

Meter Type: Sound Analyzer Model: Rudmose RA-100

Microphone: Dynamic Cable: None

Meter Speed: Slow Meter Action: Fairly Stable

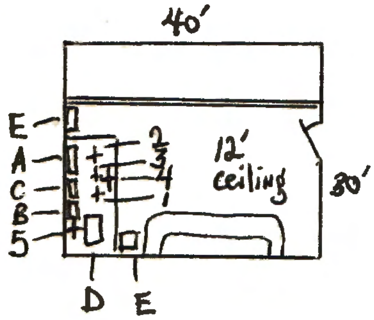
Sound Analysis Data



Sound Survey Data Sheet # 2

Survey Site #: 7 Group # 7

Map of Survey Site:



Materials

Ceiling. Acoustic Tile

Floor... Wood

Walls... Plaster

Key:

I. Sound Sources = ▭

A. Fender Showman 15 amp; 2-12" spkrs; 100 watt; stndrd gtr

B. " " " "

C. Fender Bassman Amp; 2-12" spkers; 100 watt; bass gtr.

D. Ludwig trap drum set

E. Echoplex 100 watt echo-reverb-amp; 2- Turner mikes;

F. (2- Electrovoise Column P.A. Speakers)

G.

II. Personnel = +

	Hrs/wk exposure	Total # Months Exposed
#1	32	24
#2	32	48
#3	32	42
#4	32	30
#5	32	36
#6		

SOUND SURVEY DATA SHEET # 1

Survey Site #: 8 .Group #: 8

Date: 1/29/66 .Time: 3:00 PM .Temp: 72 °F.

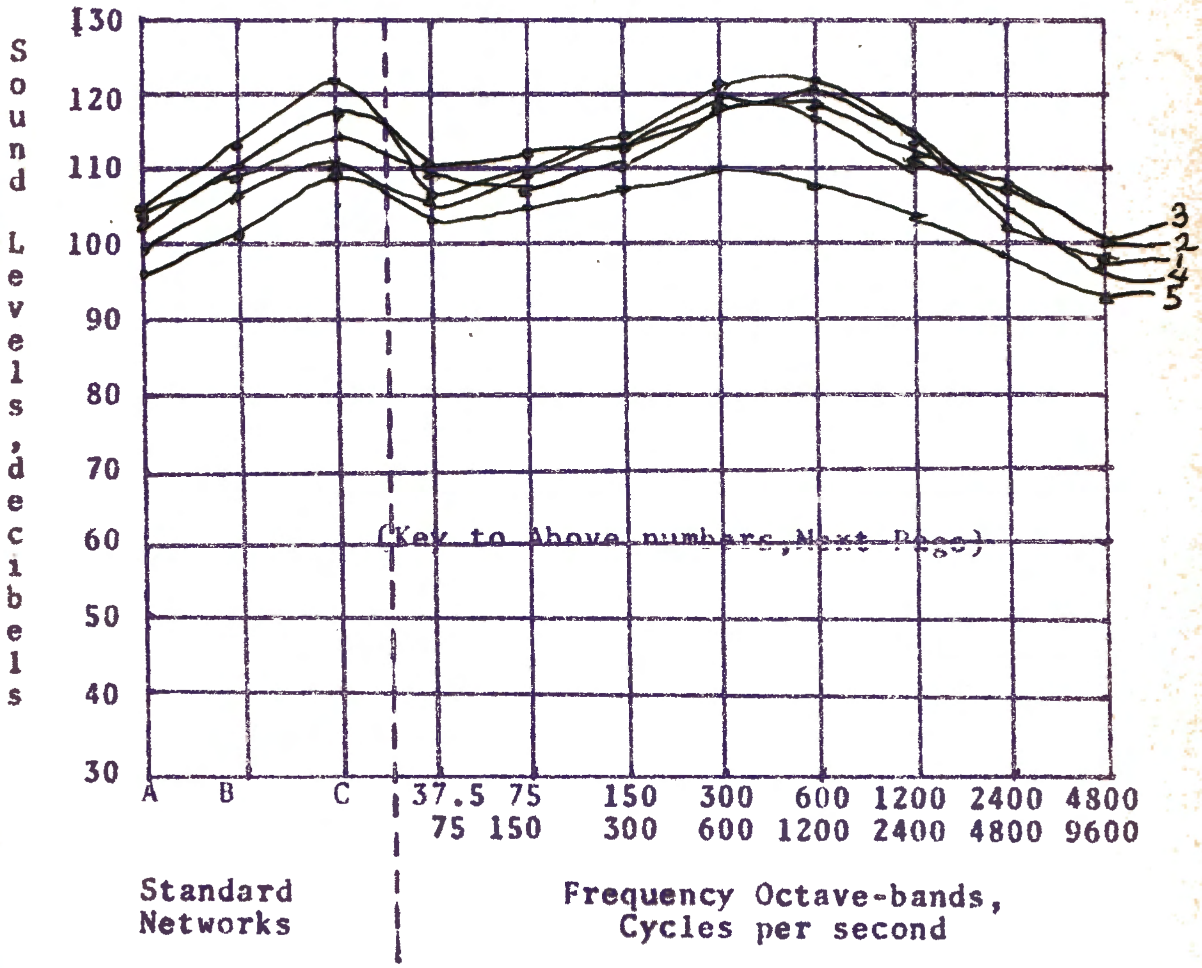
Instrument Data:

Meter Type: Sound Analyzer Model: Rudmose RA-100

Microphone: Dynamic Cable: None

Meter Speed: Slow Meter Action: Fairly Stable

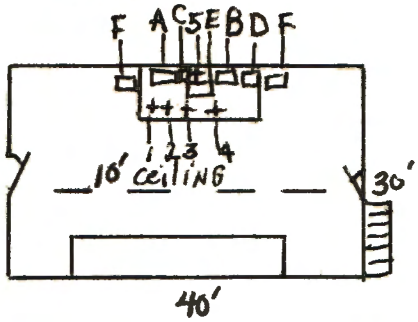
Sound Analysis Data



Sound Survey Data Sheet # 2

Survey Site #: 8 Group #: 8

Map of Survey Site:



Materials

Ceiling. Acoustic tile

Floor... Wood

Walls... Plaster

Key:

I. Sound Sources= ▭

A. Vox Super Beatle Amp;2-15" speakers; 150 watt; stndrd gtr

B. " " " "

C. " " " "

D. Showman Twin 15(Fender) Amp; 2-15" spkrs;150 watt;bss. gtr.

E. Ludwig trap drum set

F. Echoplex 100 P.A.amp-echo-reverb;2-Turner mikes;2 clmn spkrs.

G.

II. Personnel= +

	Hrs/wk exposure	Total # Months Exposed
#1	30	48
#2	30	54
#3	30	40
#4	30	60
#5	30	72
#6		

SOUND SURVEY DATA SHEET # 1

Survey Site #: 9 . Group #: 9

Date: 1/29/66 . Time: 3:45 PM . Temp: 79 °F.

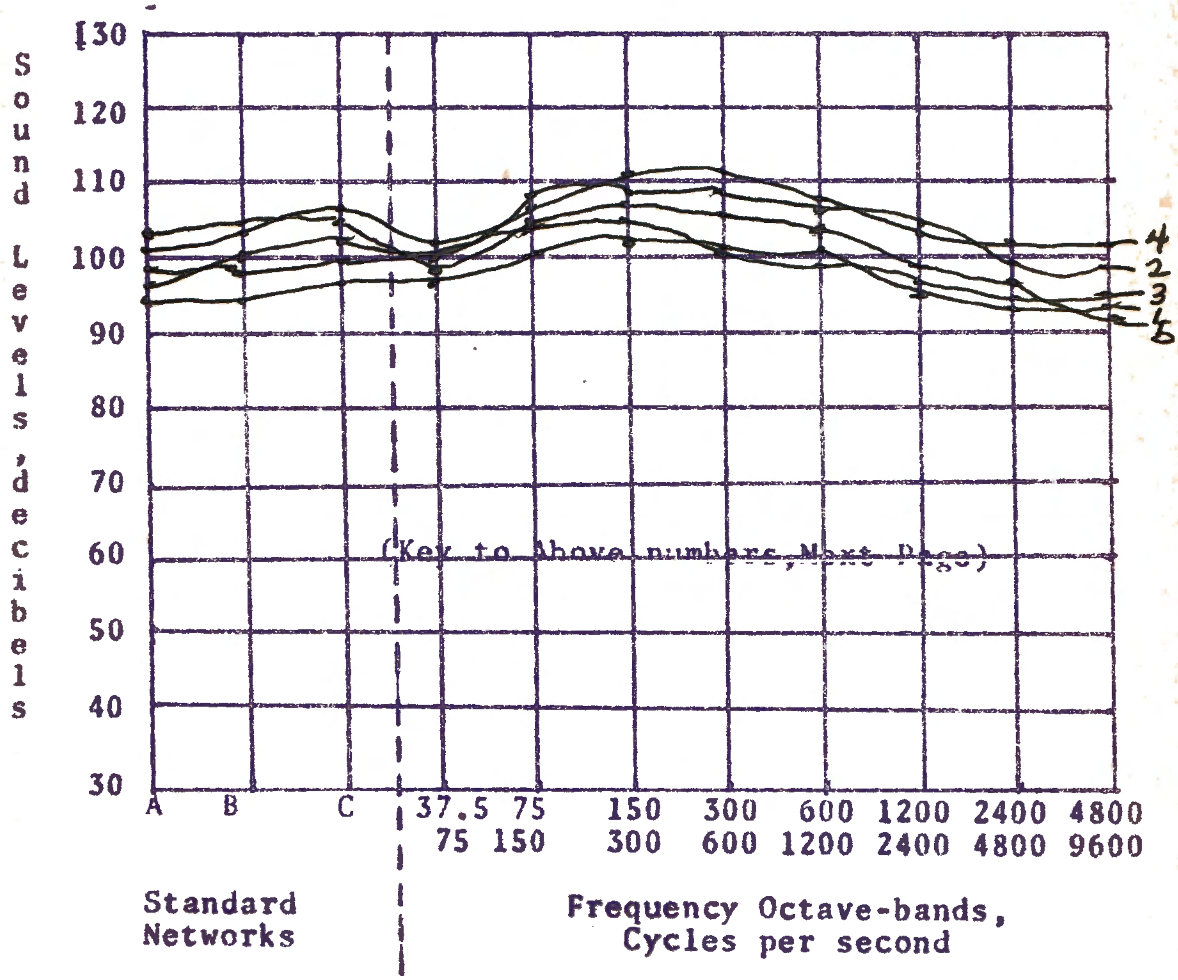
Instrument Data:

Meter Type: Sound Analyzer Model: Rudmose RA-100

Microphone: Dynamic Cable: None

Meter Speed: Slow Meter Action: Fairly Stable

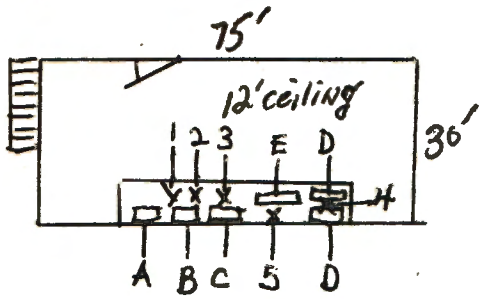
Sound Analysis Data



Sound Survey Data Sheet # 2

Survey Site #: 9 Group # 9

Map of Survey Site:



Materials

Ceiling. acoustic tile

Floor... Wood

Walls... Plaster

Key: I. Sound Sources=▭

A. Fender Tremulex amp; 2-12"spkrs; 80 watt; stndrd gtr

B. Fender Showman 15; 1-15" spkr; 100 watt; stndrd gtr

C. Fender Bassman Amp: 2-12" spkrs; 10 watt; bass gtr

D. Vox transistor organ; powered by Fender Tremulex Amp

E. Slingerland trap drum set

F. Bogen 100 watt P.A. Amp with Fender reverb; 2-clmn spkrs

G.

II. Personnel= +

	Hrs/wk exposure	Total # Months Exposed
#1	24	24
#2	24	36
#3	24	48
#4	24	30
#5	24	48
#6		

SOUND SURVEY DATA SHEET # 1

Survey Site #: 10 .Group #: 10

Date: 1/29/66 .Time: 4:00 PM .Temp: 78 °F.

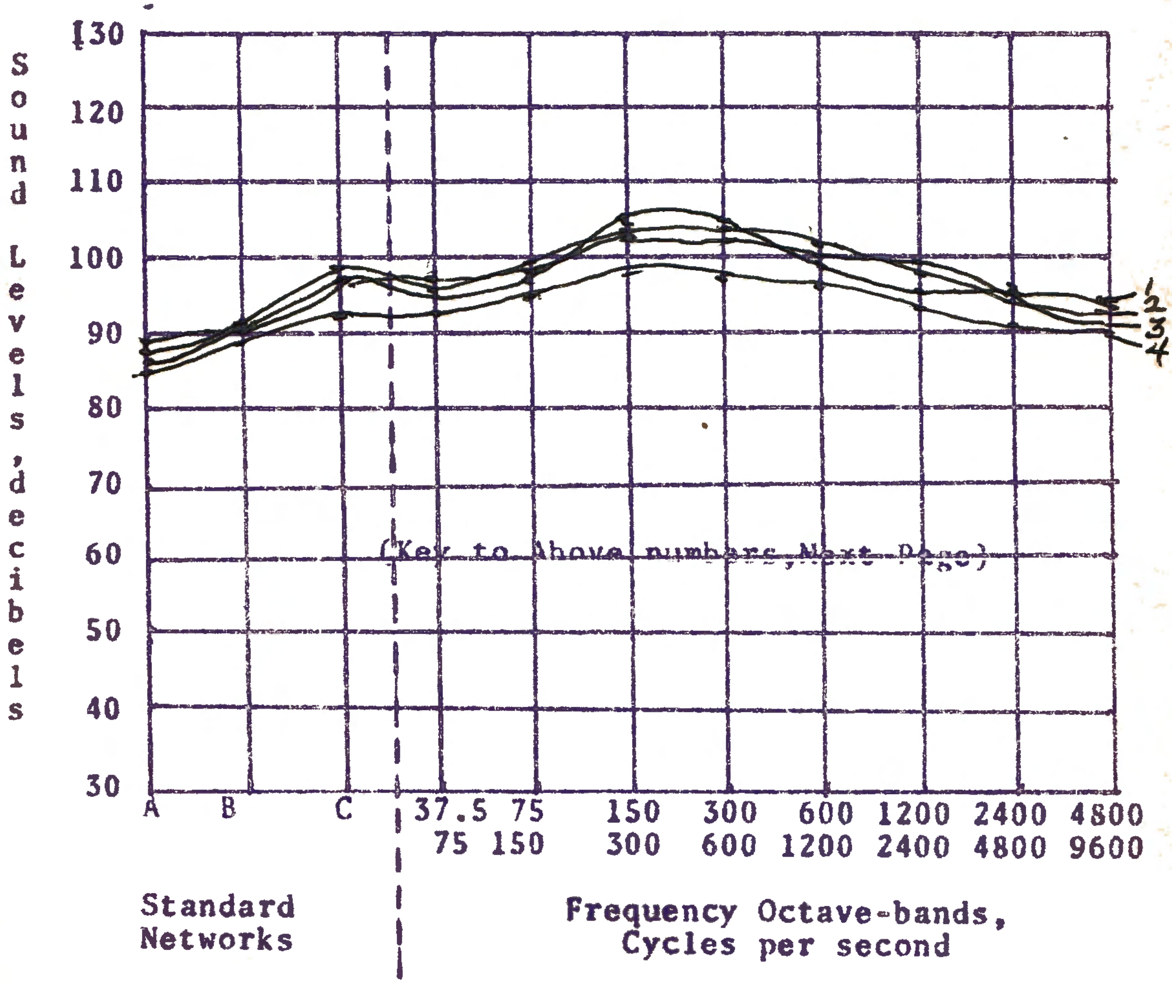
Instrument Data:

Meter Type: Sound Analyzer Model: Rudmose RA-100

Microphone: Dynamic Cable: None

Meter Speed: Slow Meter Action: Fairly Stable

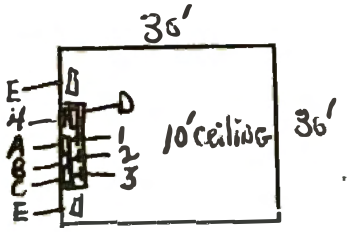
Sound Analysis Data



Sound Survey Data Sheet # 2

Survey Site #: 10 Group # 10

Map of Survey Site:



Materials

Ceiling. Acoustic Tile

Floor... Wood

Walls... Plaster

Key: I. Sound Sources= ☐

A. Ampeg 80 watt amp; 2-10" spkrs; stndrd gtr.

B. Magnatone 100 watt amp; 1-15" spkr; stdrd gtr.

C. Fender Bassman Amp; 2-12" spkrs;100 watt; bass guitar

D. Trap drum set

E. Knight 75 watt P.A. amp; 2-Electrovoice 664 mikes;2-12" spkrs.

F.

G.

II. Personnel= +

	Hrs/wk exposure	Total # Months Exposed
#1	10	18
#2	10	24
#3	10	18
#4	10	12
#5		
#6		

KEY TO SURVEY SITES AND GROUPS

Survey Sites:	Address
1. Sandy's Escape(Upper level)	61st and Binney Streets
2. Sandy's Escape(Lower level)	61st and Binney Streets
3. The Way Out Club	63rd and Ames Avenue
4. The Cave	505 South 16th Street
5. Gino's	703 South 16th Street
6. Club Louie-Louie	711 South 16th Street
7. Mickey's a go-go	707 South 16th Street
8. The New Mickey's(lower level)	4423 Dodge Street
9. The New Mickey's(upper level)	4423 Dodge Street
10. The New Mickey's(Jungle Room)	4423 Dodge Street

Musical Groups:

1. The Spyders
2. The Symmetrics
3. The Wonders
4. The Fabulous Imperials
5. The Great Imposters
6. The Continentals
7. Patty and the Sidewinders
8. Rich Claton and the Rumbles
9. Larry and the Playboy's
10. The Tiny Royals