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State University of New York at Plattsburgh
Auditory Research Laboratories

Report No. ARL 88-3

The Effects of Blast Trauma (Impulse Noise)
on Hearing: A Parametric Study

Annual Report

Roger P. Hamernik
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Robert I. Davis
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George A. Turrentine

July 23, 1988

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The Research Foundation of the
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ABSTRACT

Of this research

There are three broad goals to this contract. The first and primary goal is to study the effects of high level blast wave exposure on the conductive and sensory structures of the mammalian ear. This includes the use of the evoked potential to measure hearing thresholds and tuning curves prior to and after exposure to various blast wave exposures. Parameters of the blast waves studied include intensity, spectral composition, number of impulses and repetition rate. Correlations among hearing measures, exposure variables and histology are to be developed. The second objective is to develop a series of blast wave generation devices which are suitable for the laboratory simulation of a wide spectrum of blast waves. The third objective is to develop a suitable set of software and a PC-based computer system which will interact with crystal and capacitive microphones to capture and analyze blast waves.

During the second year of this contract the following progress toward these goals has been made: (a) the Lamont 5-inch diameter shock tube operating on a mechanical quick release valve principle was installed in the laboratory and calibrated at 150, 155 and 160 dB peak SPL; (b) interactive and analytical software that has been under development for the past two years has been completed; (c) thirty animals have been exposed to the mid-frequency (1.0 kHz) energy-content blast waves. While it is too premature to discuss these results, the results to date indicate that these blast waves are substantially more hazardous to hearing than are the low-frequency (0.125 kHz) energy-content waves reported on previously (see Hamernik et al., 1988, Rpt I). There were two surprising features of these data. First, the variability in hearing measures associated with exposures to the low frequency waves does not seem to be affecting the animals exposed to the mid-frequency waves. That is, preliminary hearing loss measures are consistent across animals in any given exposure paradigm. Second, the slowest repetition rate for the 10X condition consistently produces the most severe effects. (d) A set of rules have been developed and implemented on the DEC MicroPDP-11/73 microcomputer system which will systematically calculate tuning curve variables such as Q10dB; high frequency slope and low frequency slope. An analysis of 650 tuning curves using this system has shown that there are systematic changes in tuning curve morphology that are related to the degree of permanent threshold shift. Furthermore, these changes are correlated with outer sensory cell losses in a frequency specific manner.

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FOREWORD

Disclaimer

Citations of commercial organizations and trade names in this report do not constitute an official Department of the Army endorsement or approval of the products or services of these organizations.

Animal Use

In conducting the research described in this report, the investigators adhered to the "Guide for the Care and use of Laboratory Animals," prepared by the Committee on Care and Use of Laboratory Animals of the Institute of Laboratory Animal Resources, National Research Council (DHHS Publication No. (NIH) 86-23, revised 1985).

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I. TECHNICAL PROGRESS

A. "LAMONT" 5-INCH DRIVER SOURCE: In the first year of the current project, a conventional shock tube using high and low pressure chambers separated by a diaphragm was employed to create the blast waves to which chinchilla were exposed. The highest frequency-content energy for the conventional tube was approximately 0.125 kHz. Two additional shock tubes were installed during the second year of this project. These tubes use an entirely different operating principle and produce blast waves with much different spectral distributions of energy.

Description: The "Lamont air-gun" 5-inch driver source is shown schematically in Figure 1. This device is essentially a shock tube driver section which uses a fast acting valve to rapidly discharge a high pressure air reservoir instead of bursting a diaphragm as in a conventional shock tube. Similar devices, which operate on a completely different scale, have been developed for use in sonic boom studies (e.g., see NASA SP-180 - Second Conference on Sonic Boom Research, 1968). The "Lamont" air gun was designed at the Lamont Geological Observatory of Columbia University for the purpose of producing undersea explosive discharges for use in Geological research. This driver, when coupled to an expansion section and an acoustic horn, is capable of generating well-controlled high sound pressure level blast waves. The "Lamont" driver while obsolete for the purpose for which it was developed, has the advantage of producing a discharge directed in the axial direction. Commercially available air guns (e.g., Western Geophysical) generally produce radial discharges which are less suitable for laboratory operations. Engineers at the National Acoustics Laboratory of Australia designed an axial discharge device (Kenna, 1982) for use in blast wave research. However, their design has proved to be unreliable.

The "Lamont" driver uses a simple design with only one moving part. An aluminum piston is sealed in a steel casing by a series of "o" rings. The piston's geometry is such that two volumes are created within the steel casing. When low pressure air (P_L) enters the larger of the two volumes the piston is fully retracted and seated against the Teflon™ seal on the base plate. In this position, the smaller volume is sealed from the outside by an "o" ring and high pressure air (P_H) can charge the smaller volume. The seal is maintained by the proper balance between P_L and P_H . The gun is discharged by rapidly bleeding off P_L , which causes the piston to move forward breaking the seal. When discharged at sufficient pressure into an expansion section a shock wave is formed within several diameters downstream.

The two air guns in our laboratory operate in the range of 200-3000 psi with P_L typically $1/7 P_H$ and have compression section volumes of approximately 4 cu. in. and 10 cu. in. The volume, diameter and charge pressure of the driver will determine the strength of the shock wave and other characteristics of the wave system developed in the expansion section.

Calibration of "Lamont" Source: The pressure-time configuration of the 160 dB peak SPL wave produced by the "Lamont" 5-inch driver is shown in Figure 2 along with the A-weighted waveform which was reconstructed from the A-weighted FFT amplitude spectrum without any phase correction. The top panels of Figures 3 and 4 illustrate the relative and absolute energy spectra of this wave while the lower panels show the A-weighted spectra. The "Lamont" driver produces a second peak trailing the primary wave by approximately 26 ms. The total energy in the entire 33 ms analysis window is displayed in Table I with the energies of the primary and

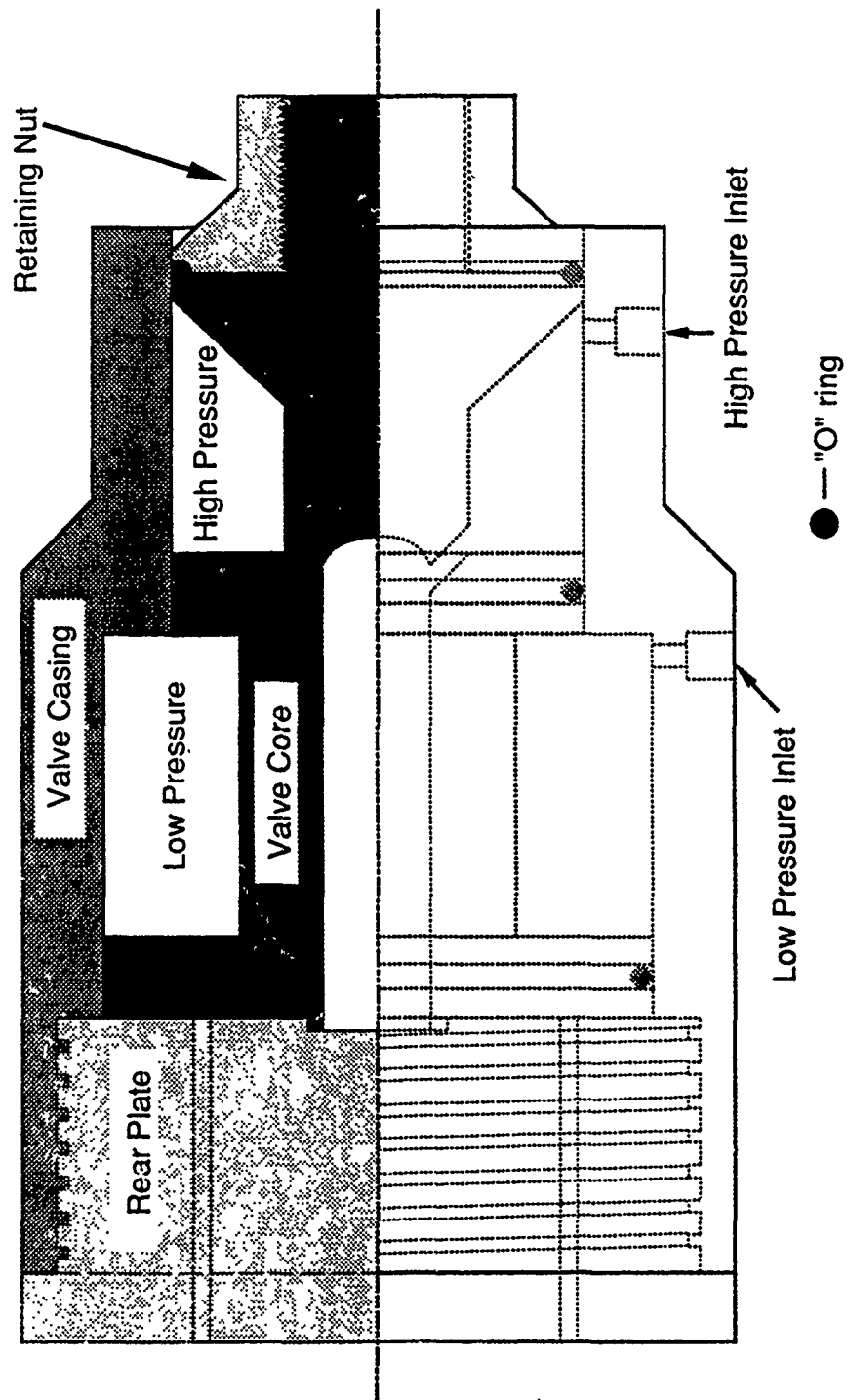


Figure 1. Schematic of the Lamont Quick-acting Valve.

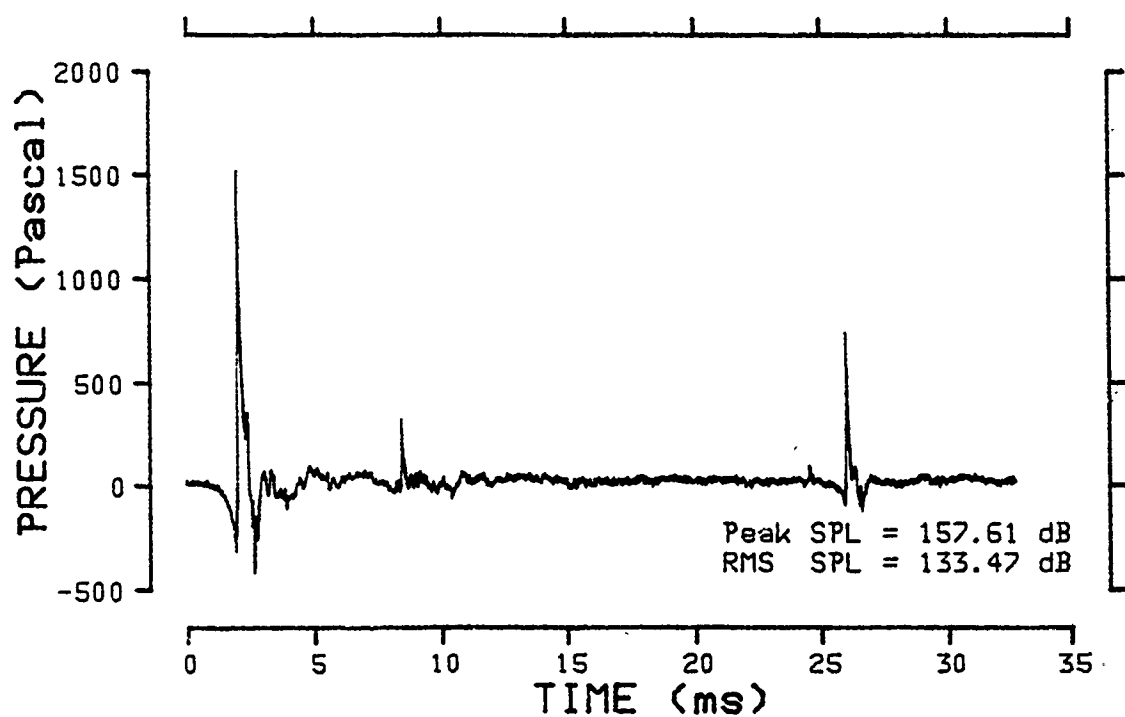
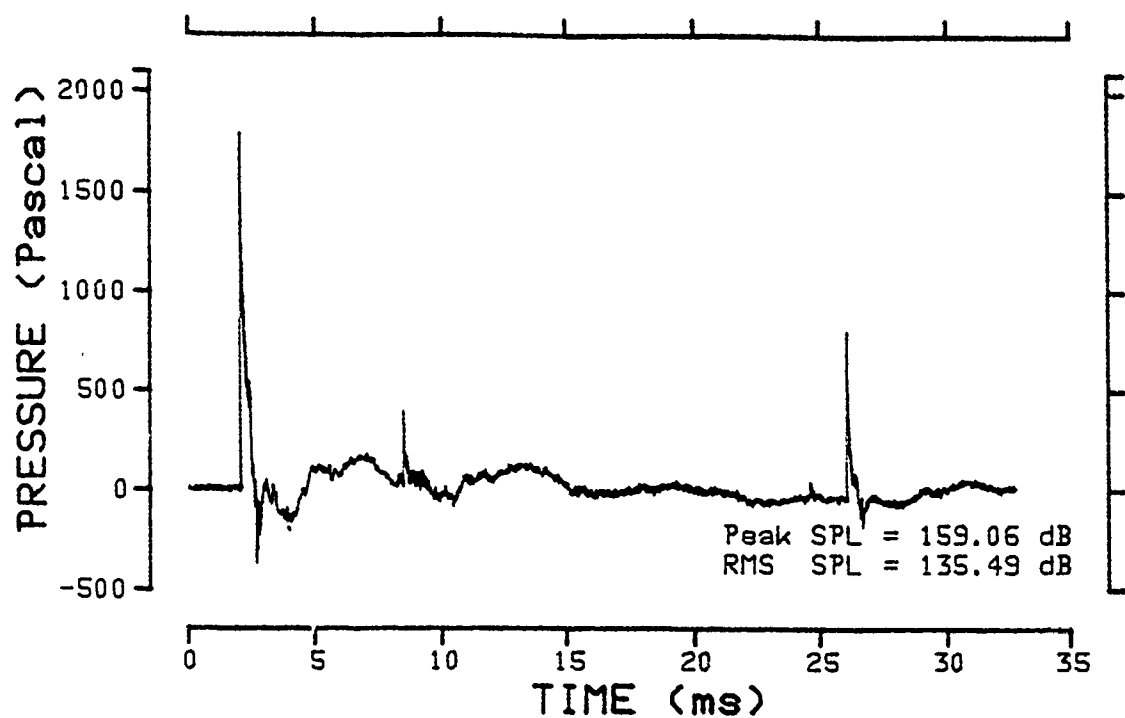


Figure 2. Pressure-time waveforms for the 160 dB peak SPL blast wave from the 5-inch "Lamont" shock tube. Upper trace is the actual recording. Lower trace is the waveform reconstructed from the A-weighted FFT amplitude spectrum without changing phase.

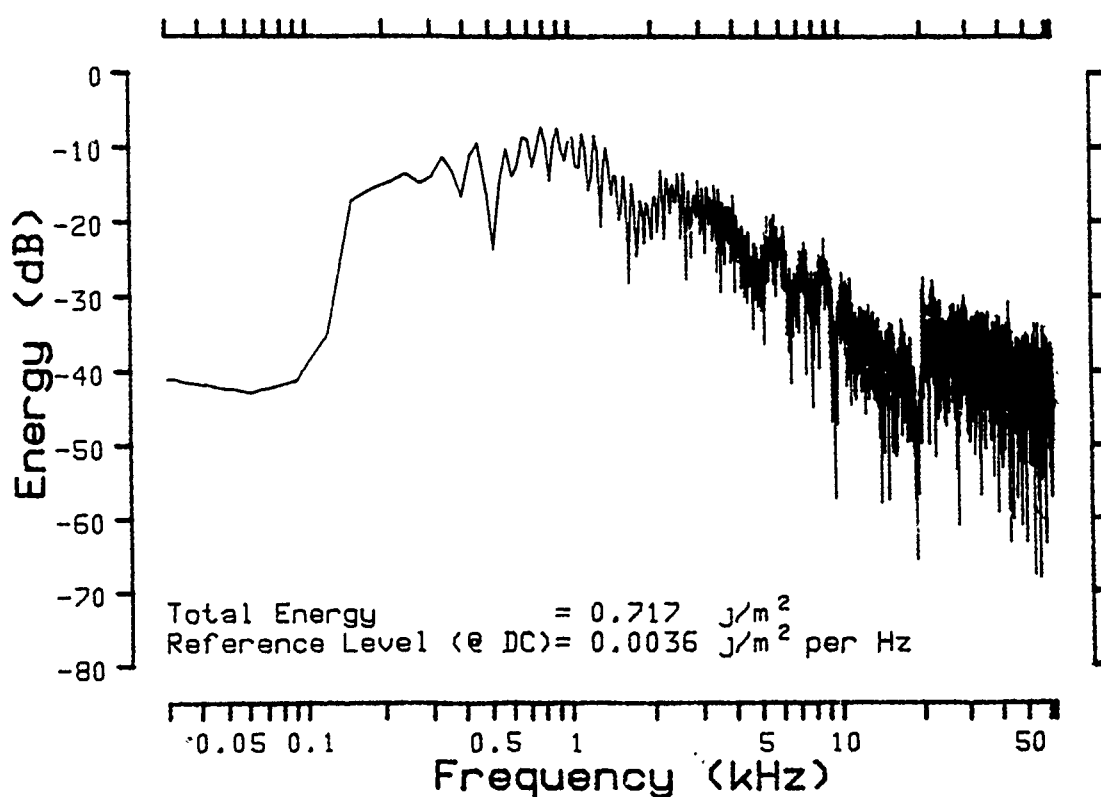
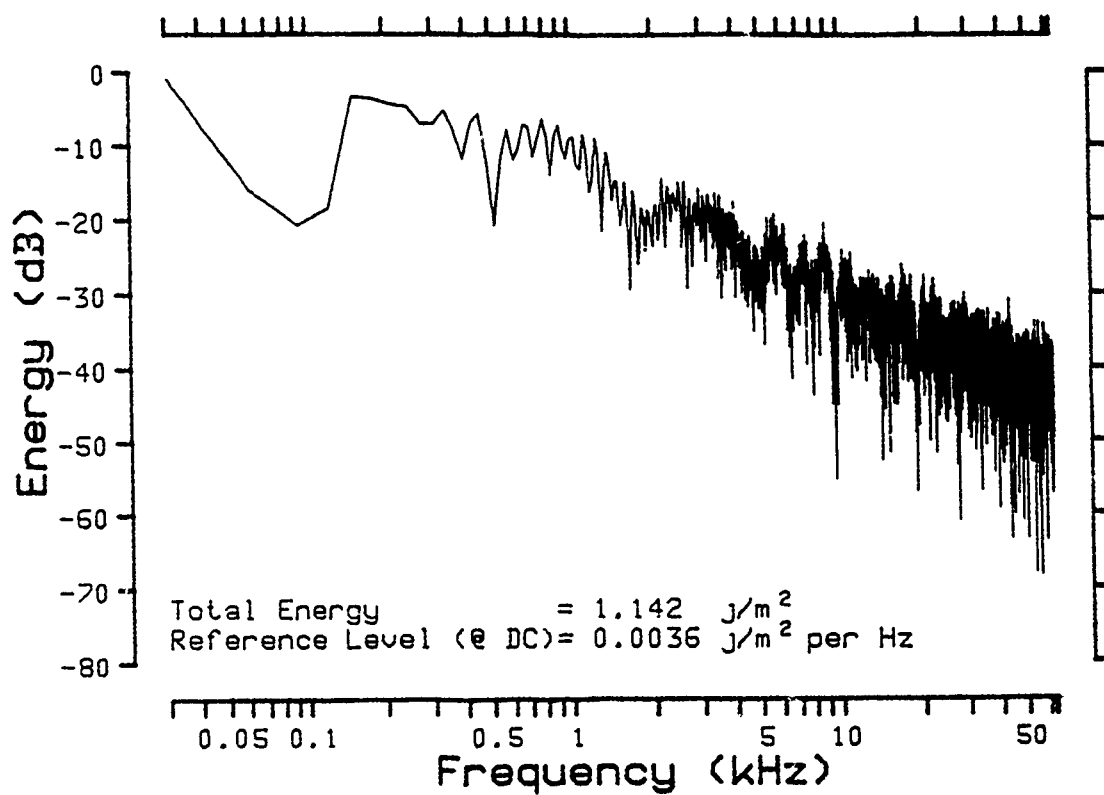


Figure 3. The unweighted (upper) and A-weighted (lower) energy spectra for the 160 dB peak SPL blast wave.

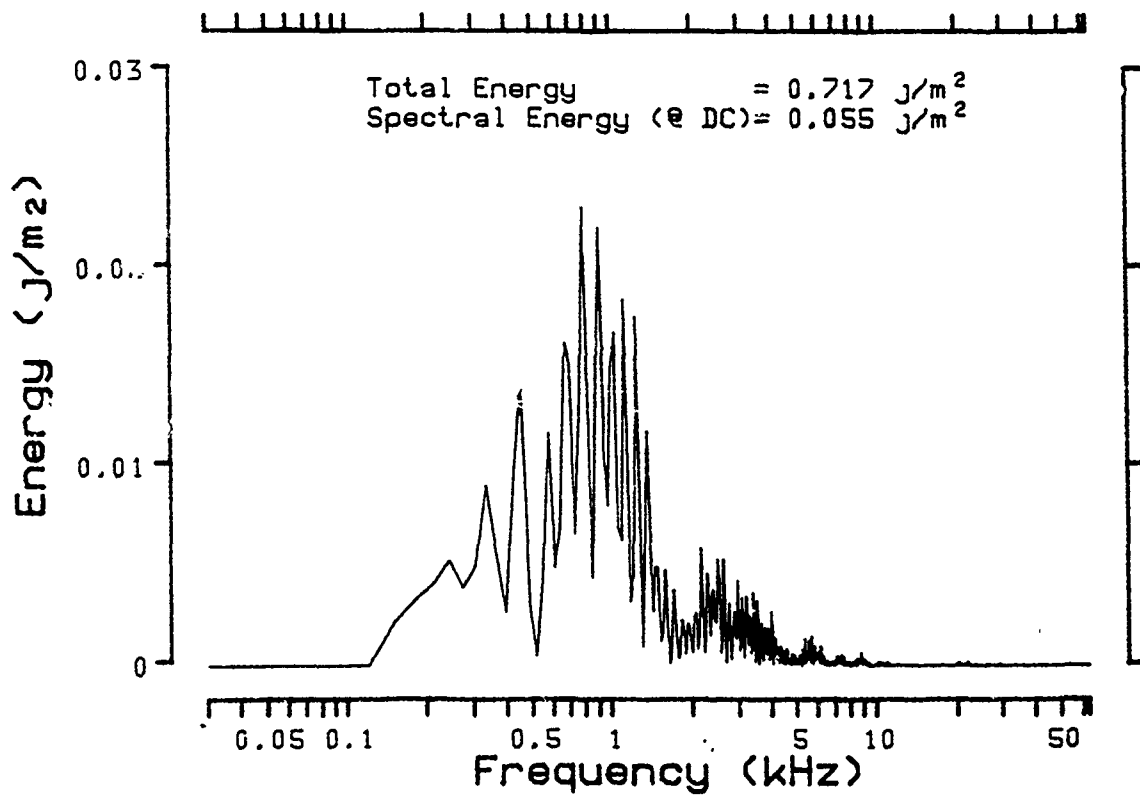
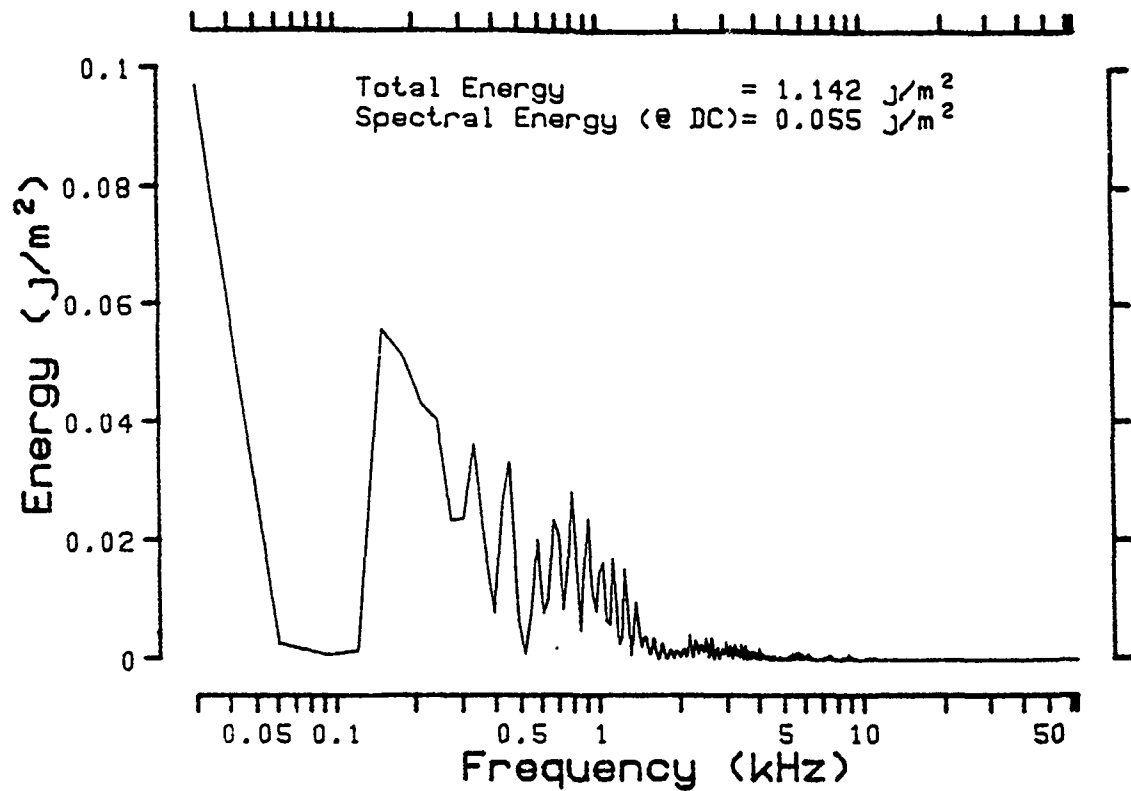


Figure 4. The unweighted (upper) and A-weighted (lower) energy spectra for the 160 dB peak SPL blast wave in absolute units.

secondary waves. The second peak contains approximately one-tenth the energy of the primary wave. The bar graph shown in Figure 5 compares the octave band energy distribution of the 160 dB peak SPL waves produced by the "Lamont" driver and the conventional shock tube (see Report I). The unweighted comparison of these two waves shows that the wave produced by the conventional shock tube contains a great deal more energy than the "Lamont" driver waveform. However, when the same comparison is made after an A-weighting is performed, the total energies of the two waves are similar but the peaks in the energy distribution are located at two different octave band frequencies, i.e., 0.250 kHz and 1.0 kHz for the conventional tube and the "Lamont" source respectively. Comparison figures are also presented in Table II. Figure 6 illustrates the mounting and installation of the "Lamont" 5-inch driver.

B. ADDITIONAL AUDITORY EVOKED POTENTIAL STATION: Another complete and independent evoked potential system has been installed. This system is shown schematically in Figure 7. The addition of this second system allows for a single individual to test two animals simultaneously, thus allowing more animals to be tested. At present our capacity is 15 animals/month.

C. SOFTWARE: Interactive software that has been under development for the past two years has been completed. At present two Digital Equipment Corporation (DEC) MicroPDP-11/73 microcomputers, a Macintosh II and three Compaq 286 Deskpro personal computers (PC) can communicate with the host DEC MicroPDP-11/73. Thus all the anatomical data which results from the morphometric software routines; the evoked potential threshold data; three tuning curve variables and the stimulus variables can all be interrelated. For example, sensory cell variables such as total losses, octave band losses etc. can be compared with total energy of the stimulus, octave band energies weighted or unweighted. Similarly, thresholds can be handled in a variety of ways; i.e. averaged over several frequencies; taken at each octave, and compared with cell losses in that octave or with the energy of the stimulus at the same octave etc. (See Report I for a detailed description.)

This capability will now allow us to proceed uninhibited with the primary objectives of collecting data from exposure paradigms using the remaining three blast wave sources; i.e. the two quick acting valve tubes and the spark discharge. We have begun to routinely run 15 animals/month using this newly created system. This will allow us to complete the additional 315 animal exposures over the course of the final three years of the contract.

II. SCIENTIFIC PROGRESS

"LAMONT" DRIVER EXPOSURES: The top panel of Figure 8 summarizes the threshold shift measured immediately after exposure (TS_0) to the set of 160 dB peak SPL exposures of 10 blast waves. These data, obtained from the 5-inch "Lamont" driver which produces blast waves with maximal energies in the 1 kHz octave band, are compared to results obtained using the conventional shock tube which produces a blast wave with maximal energy in the 0.125 kHz octave band (bottom panel). The TS_0 data for the 1.0 kHz and the 0.125 kHz driver are systematic in showing that for these exposure conditions the slowest repetition rate of 1 blast wave/10 min. produces the largest threshold shift. This is a surprising and unexpected result. When repetition rates are greater than one per second, one expects that the middle ear reflex will have a protective effect on the threshold shifts that are produced. However, with the most rapid repetition rate that we have used, one per six seconds,

Table I

Total Energy in the 160 dB Blast Wave Generated by the Lamont Tube
for three different analysis windows

Analysis Window (msec)		Total Energy (J/m ²)
Full	(0 - 32.768)	1.14
1st half	(0 - 16.384)	1.02
2nd half	(16.385 - 32.768)	0.12

Table II

Total unweighted and A-weighted energies for 160 dB peak SPL blast
waves from conventional and 5-inch "Lamont" shock tubes.

Device	Weight	Absolute Energy (J/m ²)			Relative Energy (dB) re: 1J/m ²		
		1X	10X	100X	1X	10X	100X
Lamont	None	1.14	11.35	113.48	0.55	10.55	20.55
	A	0.80	7.97	79.65	-0.99	9.01	19.01
Conventional	None	4.37	43.70	436.99	6.40	16.40	26.40
	A	0.72	7.24	72.36	-1.41	8.60	18.60

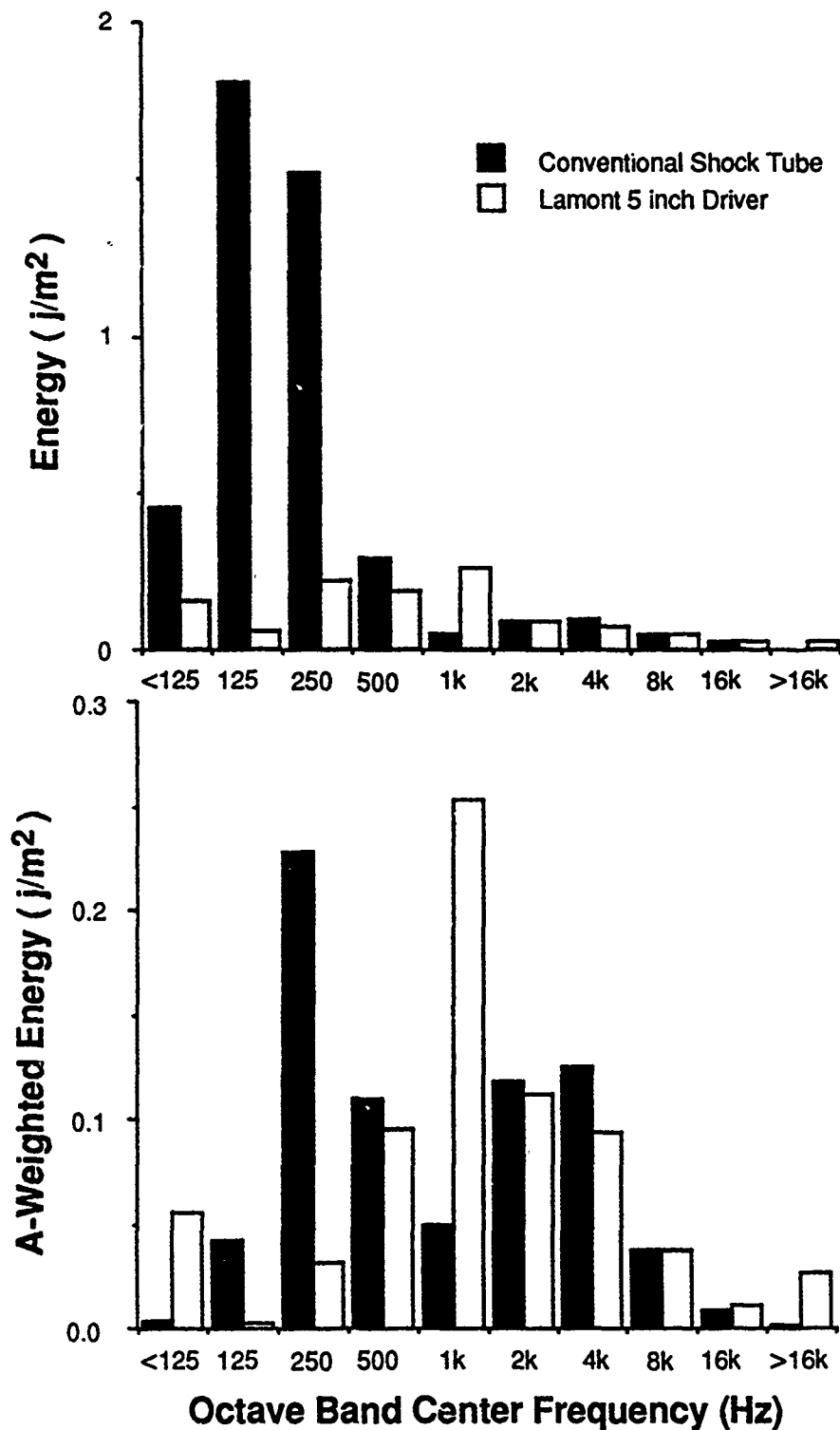


Figure 5. Unweighted (upper) and A-weighted (lower) octave band energies of 160 dB peak SPL blast waves for the conventional and 5-inch "Lamont" shock tubes.

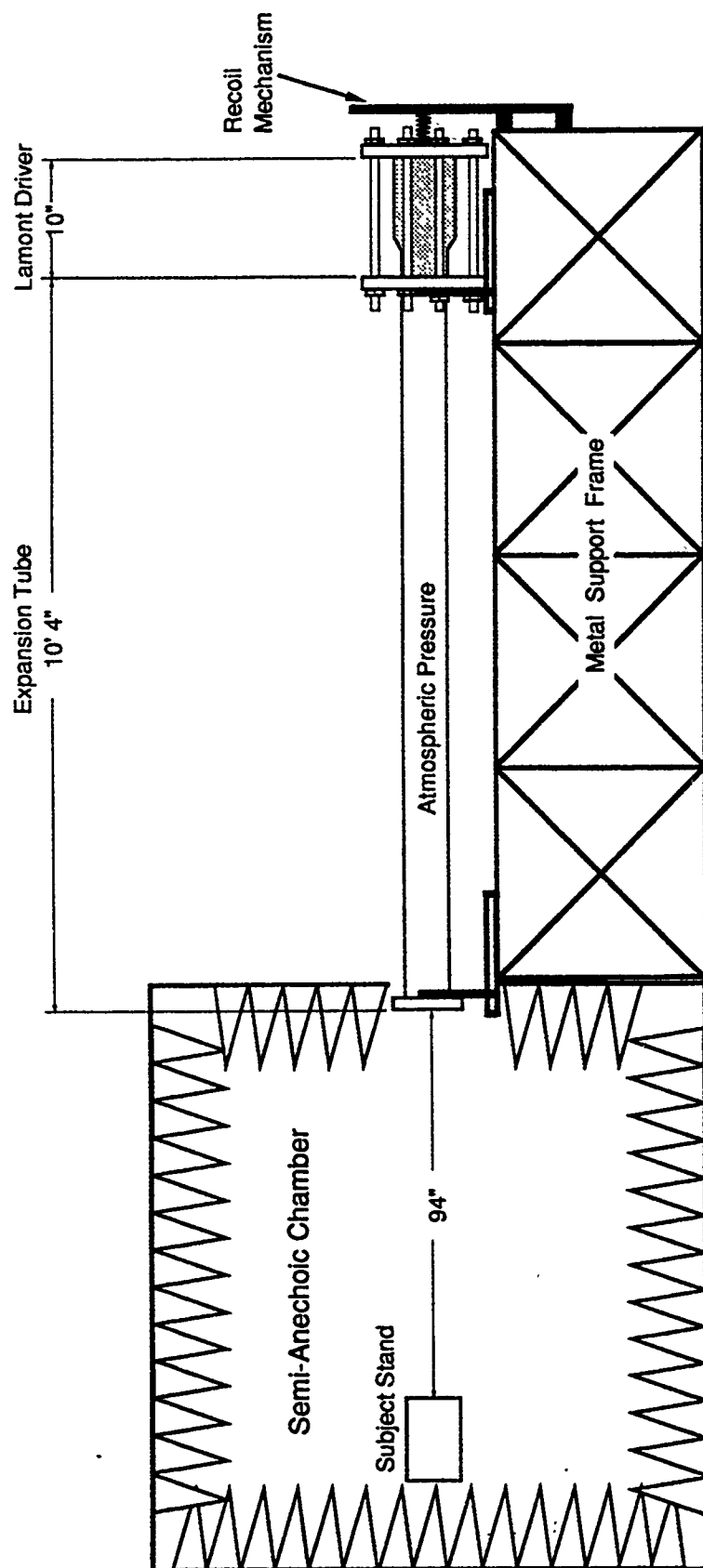


Figure 6. Schematic Side View of the Lamont Shock Tube

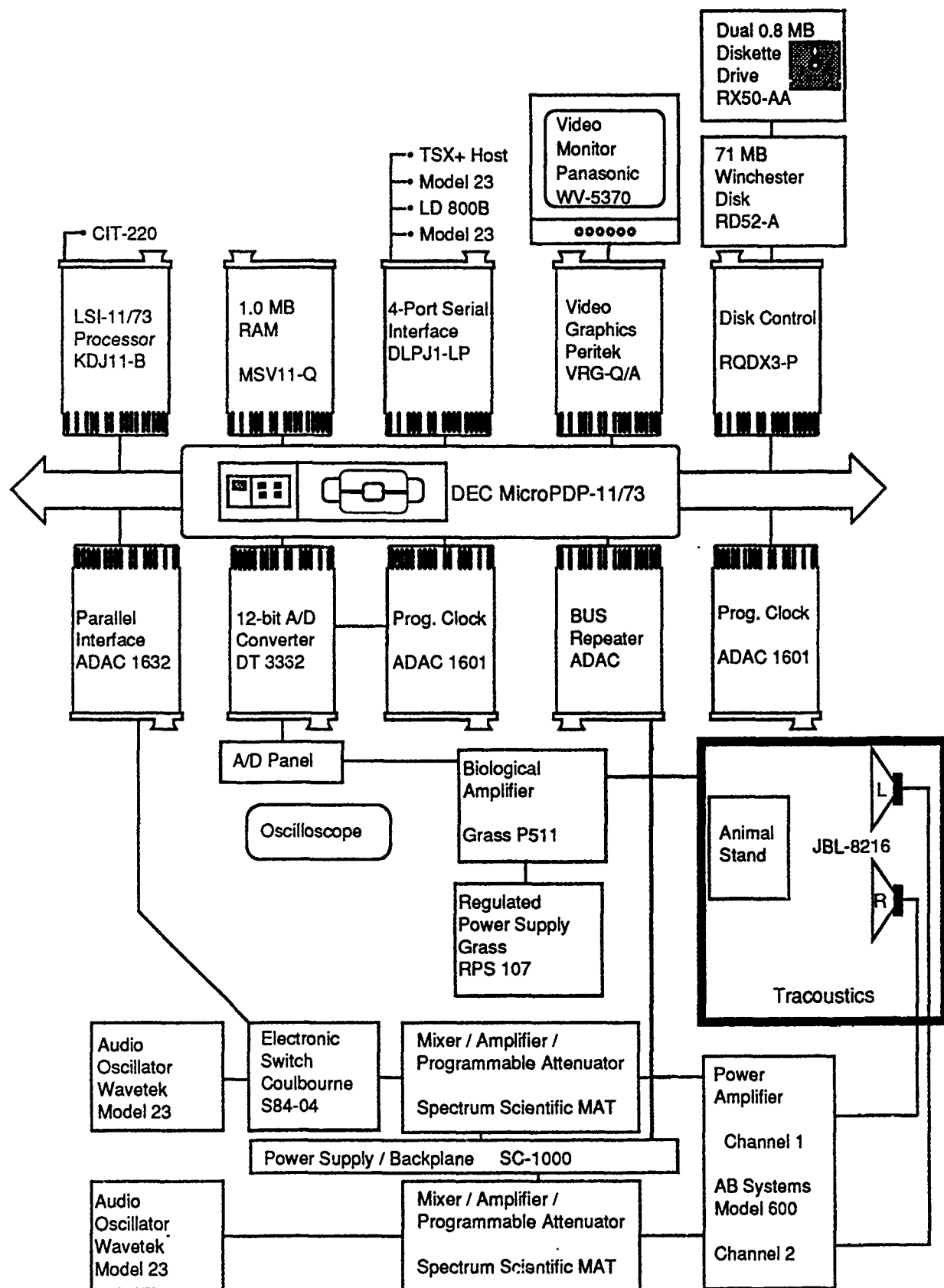


Figure 7. Schematic representation of second evoked potential laboratory computer system.

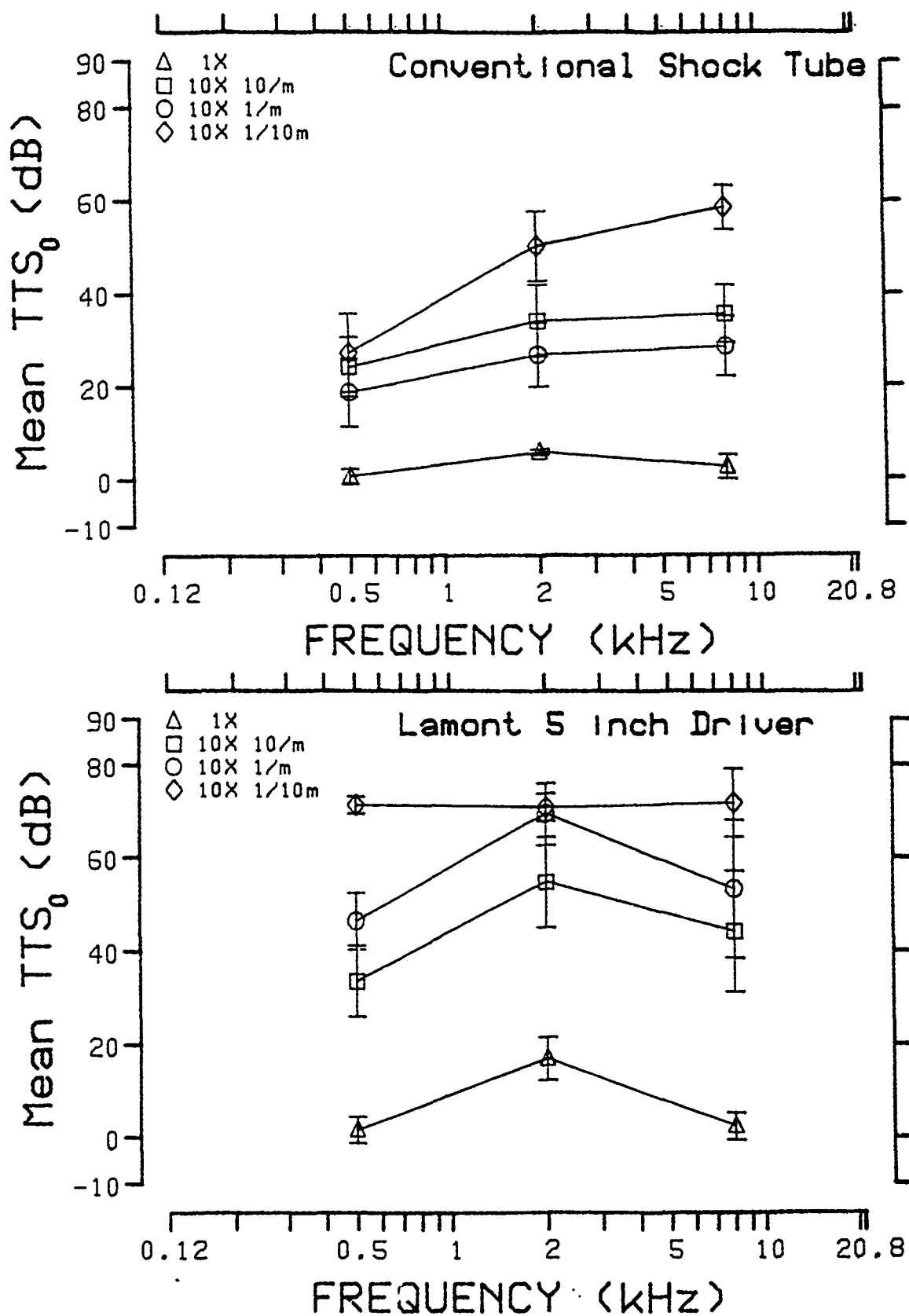


Figure 8. Mean TTS_0 for groups of animals exposed to ten 160 dB peak SPL blast waves from a conventional (upper) or 5-inch "Lamont" (lower) shock tube.

the reflex should not be a factor. Thus the repetition rate effect seen in Figure 7 probably reflects the vulnerability of the biological recovery process in the cochlea. While these results are unusual and contrary to the limited data published in the past, the effect is consistent across two very different blast wave sources. However these conclusions are only preliminary and valid only for the initial threshold shift. The PTS and sensory cell loss data which have not yet been completed must yield comparable data before we can be confident in this result.

The differences between the initial threshold shifts using the two different blast wave sources must be related to the energy content of the blast waves. For the "Lamont" tube, the total energy in ten 160 dB presentations is 11.4 J/m²; in the 1.0 kHz octave band the total energy is 2.6 J/m²; while the total A-weighted energy is 8.0 J/m². For the conventional shock tube the corresponding energies are: Total energy = 43.7 J/m²; total energy in the 1 kHz octave band = 0.5 J/m²; total A-weighted energy = 7.2 J/m². Thus, the increased effect seen with the "Lamont" driver would appear to be related to energy levels at specific octave bands and not to the total energy or to the commonly used parameter of total A-weighted energy. It should also be noted that the greatest shift is seen at the 2.0 kHz test frequency, i.e., at a frequency above the peak of the wave spectrum. The 2.0 kHz data for the 10X, 1/10m exposure could be higher than that shown in Figure 8 but at the 2.0 kHz frequency we are at the upper limit of our test system. The 0.5 and 8.0 kHz data are within the range of our system and therefore are accurate means. Thus, the 1/10m data, in reality, follows the configuration of the other three exposures presented in Figure 8.

EVOKED POTENTIAL TUNING CURVES

INTRODUCTION: Attempts at correlating hearing loss with hair cell loss have met with varying degrees of success. Some investigators have found threshold shifts of 30 - 50 dB with outer hair cell loss (e.g., Moody et al., 1976; Ryan and Dallos, 1975) while others have reported little or no hearing loss with significant OHC loss (Hunter-Duvar and Elliott, 1973; Henderson et al., 1974). Still others have reported hearing losses of 20 - 40 dB with little hair cell loss (Lindquist et al., 1954; Hunter-Duvar and Elliott, 1972). Some of the differences may be due to subtle forms of anatomical damage which are difficult to relate to hearing loss patterns, (e.g., isolated, mid-cochlear hair cell lesions versus lesions that extend continuously from base toward the apex of the cochlea). In the case of an isolated lesion, it is possible for the excitation pattern in the cochlea to spread from a damaged region of the cochlea into one that is normal as intensity increases. Thus, the spread of excitation could potentially obscure the correlations between hair cell loss and hearing loss.

One psychophysical method for estimating the underlying spread of excitation involves the use of psychophysical tuning curves. Psychophysical tuning curves are plots (usually an asymmetrical "V" shape) (see Figure 9) which indicate the levels and frequencies of masking tones which prevent the detection of a low level probe tone that is fixed in frequency (Vogten, 1974; Zwicker, 1974). The assumption is that the probe tone excites only a limited region of units along the basilar membrane. Masking presumably occurs when the masking stimulus invades the excitatory region of the probe. Frequencies above and below the probe become effective maskers only at high intensities. Quantitative estimates of the spread of excitation are obtained from the width and depth of the tuning curve tip.

Psychophysical tuning curves have been obtained from human listeners with impaired hearing. In general, when there is an elevation in threshold, the

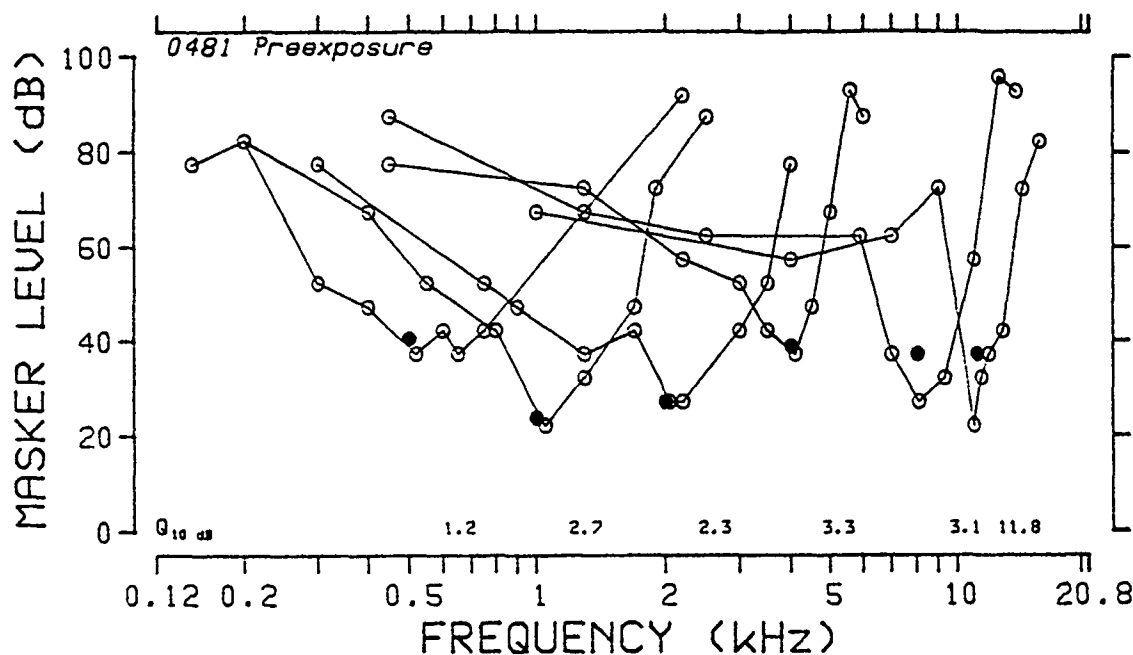


Figure 9. Typical preexposure AEP tuning curves from one animal.

psychophysical tuning curve becomes wider (Wightman et al., 1977; Hoekstra and Ritsma, 1977) and in some cases the low frequency tail of the tuning curve becomes lower, i.e., frequencies below the probe become more effective maskers than normal (Leshowitz and Linstrom, 1977). These results suggest that at intensities near threshold the excitation pattern is relatively broad in impaired listeners. In contrast, there are results from chinchillas treated with Kanamycin, which show normal tuning curve bandwidths with hearing losses up to 30 - 50 dB (Dallos et al., 1977). The Dallos results were correlated with pure OHC losses. The discrepancies between the data from chinchilla and man could simply reflect differences in the underlying cochlear pathologies, i.e., pure OHC versus a mixture of OHC and IHC losses. Since histological data has been unavailable in human studies, there is no way to substantiate this. Thus, there is a need for further studies correlating tuning curve shape with a variety of cochlear histopathologies induced with noise and drugs. The blast wave exposures that we have used generated a variety of complex patterns of inner and outer hair cell loss. Such cochleas present a unique opportunity to study the frequency selectivity of the cochlea and how it is changed by various types of hair cell loss. The shapes of psychophysical tuning curves in hearing impaired persons may ultimately be used to predict the pattern or type of cochlear pathology (i.e., OHC versus IHC loss). The results are also relevant to theoretical problems in auditory research, namely the role of OHC's and IHC's in hearing, i.e., is frequency selectivity determined at the level of the IHC or are the OHC involved with frequency resolution? This, then, is the rationale for obtaining TC's on the animals from this study. However, collecting a psychophysical tuning curve with behavioral measures requires considerable time, consequently we have developed methods to obtain auditory evoked potential (AEP) tuning curves. While changes in tuning characteristics have been observed following a NIPTS, the total number of animals published is very small and the range of PTS's examined is

relatively narrow. The data in this report were obtained from 107 noise exposed chinchillas from which approximately 650 TC's were obtained. It should be noted that this TC sample represents one of the largest accumulations of this type of data in existence. Changes in the morphology of the TC have been related to the degree of PTS and the extent of the sensory cell loss.

METHODS:

Data Collection: The evoked potential tuning curves are obtained using a simultaneous masking paradigm (McGee et al., 1976; Salvi et al., 1982). The probe duration is 20 ms and the intensity is set at 15 dB sensation level. A continuous tone masker is increased over a 35 dB range in an intensity series similar to that used for threshold testing, i.e., at a low enough masker level a clear evoked response is obtained; as masker intensity is increased the response either eventually disappears (i.e., is effectively masked), or persists until the output limitation of the instrumentation is reached (i.e., between 85 - 95 dB). Masked threshold is taken as the intensity mid-way between the lowest intensity where a response was present and the next highest intensity where it was absent. Masking at frequencies above and below the probe tone produces a "V"-shaped tuning curve similar to psychophysical tuning curves (Salvi et al., 1982). AEP tuning curves are measured at each octave frequency from 0.5 kHz to 8 kHz and at 11.2 kHz before exposure and at 30-days post exposure (following threshold determination). During the past year, we have developed a computer-based set of rules to quantify the morphology of the TC's. The technique has been refined for incorporation into our experimental protocol and is described below.

Tuning Curve Analysis: The evoked potential tuning curves were analyzed in two different ways. First, each of the six tuning curves for each animal was analyzed independently. Second, when animals were divided into groups (i.e., by amount of PTS), mean tuning curves were computed by averaging the masking functions for all the animals in the group.

A. Individual Tuning Curves: Three parameters were computed for each individual tuning curve: Q_{10dB} , high-frequency slope, and low-frequency slope. The first statistic, Q_{10dB} , is defined as the characteristic frequency divided by the bandwidth of the tuning curve 10 dB higher than the threshold at that characteristic frequency, i.e.,

$$Q_{10dB} = \frac{CF}{f_2 - f_1} \quad (1)$$

where CF is the characteristic frequency, i.e., the frequency (in Hz) of the lowest point (in dB) on the tuning curve; and f_2 and f_1 represent the frequencies at which the masking function crosses a line 10 dB higher than the threshold at CF. The high- and low-frequency slopes (in dB per octave) represent the slope of the tuning curve function taken from CF toward the higher- or lower-frequency maskers.

These three variables are computed because the tuning curve is considered to be an analogue to an electrical filter. However, the response of an electrical filter can be measured with a high degree of resolution. Single-unit tuning curves obtained from VIII nerve fibers likewise are measured with a resolution of up to 20 to 50 frequencies per octave. Evoked response tuning curves, however, are measured using only approximately 10 frequencies. Of those ten frequencies, not all are

always able to mask the response to the probe, particularly following an exposure that produces a large PTS. Therefore, in computing the individual tuning curve statistics reported in this report, it was necessary to institute a number of rules that would allow us to describe as accurately as possible the frequency selectivity of the auditory system as measured by the evoked potential in animals with normal thresholds as well as in those with varying amounts of PTS. This was not a straightforward task since the morphology of the tuning curve in ears with cochlear damage can be very atypical.

If the tuning curve is thought to be an analogue to an electrical filter, it seemed reasonable to fix the value of the characteristic frequency to that of the masker closest to the probe (see Figure 10). Thus, the CF was defined for the purpose of calculating Q_{10dB} and high- and low-frequency slopes as the masker frequency closest to the probe tone on the high frequency side. The masker frequencies for each of the six probe tones were chosen to provide an estimate of the masking function for a broad frequency region around the probe. Thus, the maskers were selected based upon what is currently known about tuning in the auditory system, and the limitations of testing time and the equipment employed. Table III presents the masking frequencies employed for each probe.

Table III

Evoked Potential Tuning Curve Probe and Masker Frequencies (in kHz)

Probe		Masker Frequencies									
0.5	0.15	0.20	0.30	0.40	0.52*	0.60	0.65	0.75	1.30	2.20	
1.0	0.15	0.20	0.40	0.55	0.80	1.05*	1.30	1.70	1.90	2.50	
2.0	0.30	0.75	0.90	1.30	1.70	2.05*	2.20	3.00	3.50	4.00	
4.0	0.45	1.30	2.20	3.00	3.50	4.10*	4.50	5.00	5.60	6.00	
8.0	0.45	1.30	2.50	5.90	7.00	8.10*	9.30	11.00	12.70	14.00	
11.2	1.00	4.00	7.00	9.00	11.00	11.50*	12.00	13.00	14.50	16.00	

* indicates the frequency used as CF for calculation of tuning curve statistics.

The use of only ten masker frequencies results in several problems when trying to calculate tuning curve statistics. Most of these problems can be resolved by using many more masking frequencies. However, even the use of just 10 masker frequencies is extremely time consuming, typically requiring an hour to obtain only one tuning curve. These problems most often occur when the masking function does not resemble the "typical" tuning curve as might be the case when the subject has a large permanent threshold shift (PTS) (e.g., > 20 dB). This often results in an inability to completely mask the probe with the extreme low and high frequency

maskers (i.e., masked thresholds is beyond the SPL output of the instrumentation.) Therefore, the statistics were computed using rules that we felt most accurately described the underlying tuning of the auditory system.

Figure 10 depicts idealized normal and abnormal evoked potential tuning curves and is used in the following description. For the "normal" tuning curve, the low-frequency slope was computed using the masked thresholds at CF and the two frequencies immediately below CF (i.e., points labeled D, E, and F, where F is defined as CF). Only three points were employed since the low-frequency side of many tuning curves (especially at higher frequencies) appears to consist of two legs of different slopes. The low-frequency slopes reported in this report represent the slope of the low-frequency leg of the tuning curve adjacent to the CF. A simple linear regression of threshold and log frequency resulted in a slope and intercept. If, because of measurement error or with pathological tuning curves, the low-frequency slope was positive or zero (see below), the value reported in our analyses is zero. The numerical values for the low-frequency slope, which has a negative value, are presented in this report as absolute values only.

The high-frequency slope was computed using the all the masker frequencies above the probe frequency for which a masked threshold could be measured (i.e., the points labeled F, G, H, J, and K). Thus, the linear regression coefficients were calculated using two to five or six masked thresholds. The high-frequency slope also is reported in dB per octave. As was the rule with the low-frequency slope, a value of zero was reported for any high-frequency leg with a negative slope.

Values of Q_{10dB} may be calculated using the low- and high-frequency slopes as described above. However, in certain circumstances, these calculations resulted in values that were not representative of the actual tuning (represented by the concept of Q_{10dB}). Therefore, the values of Q_{10dB} were calculated independently of the slopes in order to provide a more accurate estimate of the "tuning" of the auditory system at a particular frequency region. As noted above, the value of CF was taken as the masker frequency immediately above the probe tone frequency. The values of f_2 and f_1 were calculated using a linear regression of two adjacent points which represented the crossing of a fence 10 dB above the masked threshold of the probe in the presence of the CF masker. (The points labeled D and E were used to compute f_1 and points G and H to compute f_2 .) [The values of Q_{10dB} reported in the three volume tabulation of data submitted with the previous report (Hamernik et al., 1988, Report I) do not fix the CF at the masker frequency immediately above the probe frequency. Instead, the CF for those calculations was the (first) lowest masked threshold in the masking function. We feel that the values reported in the appendix of this report are a more accurate estimate of the actual tuning for these probe frequencies than are the figures reported in the volumes of compiled data.]

As noted above, under some circumstances, particularly when a subject had large amounts of PTS, values of f_2 and/or f_1 could not be estimated accurately. An example of this problem is the case where the masker frequency immediately above CF is unable to mask the probe tone. Therefore, the two points needed for our analysis to compute f_2 or f_1 do not exist. In this circumstance, Q_{10dB} is not calculated and is defined as "missing data" in subsequent inferential statistical analyses. The lower portion of Figure 10 depicts a tuning curve for which some of the variables can not be computed. The low-frequency slope, computed using a regression line through the points P, Q, and R, is positive and thus a zero slope is assigned. A high-frequency slope however can be computed using points R through V. Although f_1

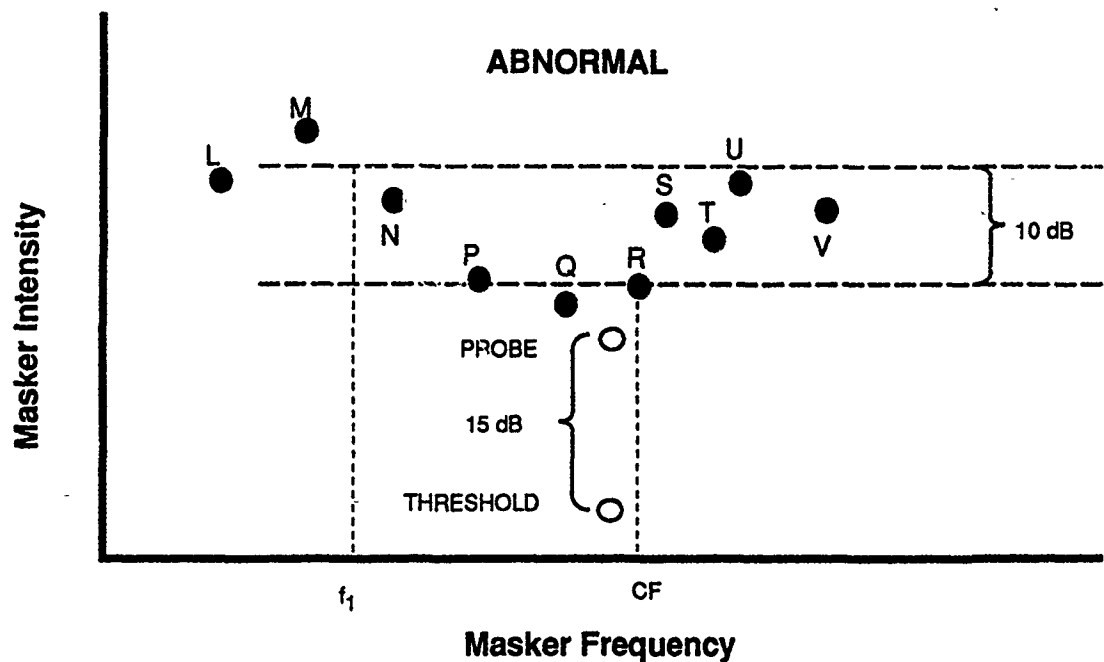
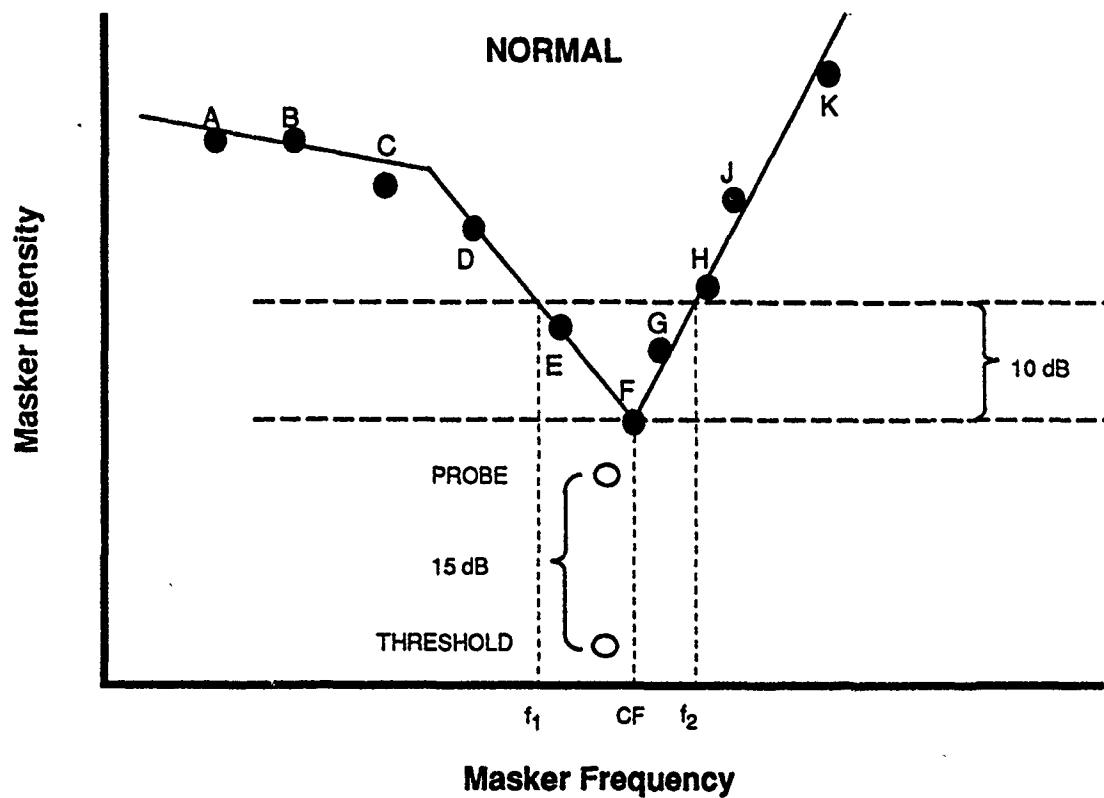


Figure 10. Idealized tuning curves used to illustrate the calculation of tuning curve statistics.

can be computed using points M and N, the masking function above CF (point R) does not go above the 10 dB line (fence). Thus, f_2 and consequently Q_{10dB} cannot be computed and is thus set to a "missing" data value.

B. Mean Tuning Curves: In addition to the individual TC statistics, mean tuning curves for groups of animals were computed by averaging the masker levels required to just mask the response to the probe presented at 15 dB above threshold. Therefore, the problems caused by measurement error in computing the mean tuning curve variables are minimized or eliminated. The slopes were computed using the same rules as were applied to individual tuning curves. However, the calculations of Q_{10dB} from mean tuning curves differed from those employed for the individual tuning curves. The values f_1 and f_2 for the mean tuning curves were computed using the regression variables calculated when determining the low- and high-frequency slopes of the mean tuning curve (instead of using only the two points adjacent to the 10 dB fence).

RESULTS: Figure 11 illustrates the mean AEP TC's obtained on 107 chinchillas at the probe frequencies of 0.5, 1.0, 2.0, 4.0, 8.0 & 11.2 kHz. The mean preexposure Q_{10dB} 's and the general slopes of these curves are virtually identical to these reported by Salvi et al. (1982) in the chinchilla. The sharpness of tuning increases as the signal frequency is increased and the low and high frequency slopes (LFS & HFS) are steepened. The LFS ranged from 20-50 dB/oct and the HFS ranged from 25-90 dB/oct. These figures are also in general agreement with the published behavioral data on the chinchilla. These three variables however, may not be independent since the calculation of the three variables may use the same data points.

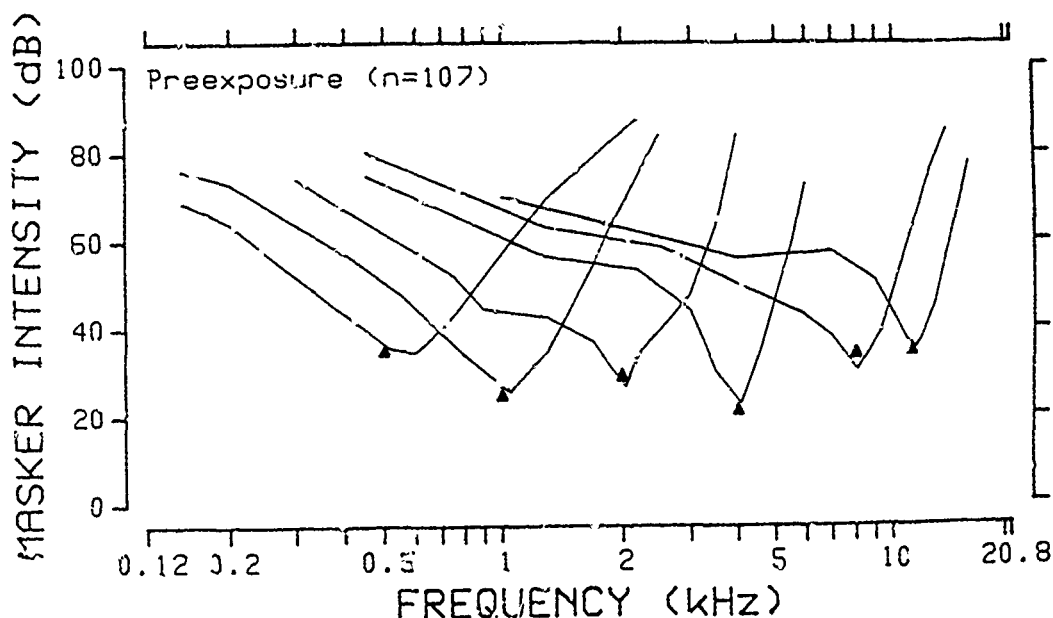


Figure 11. Mean AEP tuning curves collected from 107 chinchillas.

To get a visual impression of how the TC's change as PTS increases each animal was segregated at each frequency by the amount of PTS that the animal incurred. Bins containing animals that had PTS of less than 10 dB, between 10-20, 20-30, 30-40 and > 40 dB were formed for each test frequency. These data are shown in Figure 12. The ordinate and abscissa represent the intensity and frequency of a continuous tone that just masks the probe tone which is indicated with a solid symbol. From this figure, we can see the effect of an increasing PTS on the morphology of the mean TC at each probe frequency. When PTS is less than 10 dB, the morphology is identical (namely the Q_{10dB} the HFS and LFS) to the mean preexposure TC. In the 10-20 dB PTS group there is a general elevation of the TC and only a slight reduction in Q_{10dB} however in the 20-30 dB group the TC's are visibly broadened. This broadening is more pronounced in the 30-40 dB group. We can see a clear systematic detuning of the mean TC as the degree of PTS increases. The data from those animals having PTS > 40 dB have not been shown. Beyond 40 dB, the TC's were either flat or beyond the range of the instrumentation's ability to completely mask the probe tone.

It is important to note that the level of the probe tone was fixed at 15 dB SL for both the pre and post exposure TC's. Thus the SPL of the probe could be up to about 50 dB higher in some postexposure animals. Since the probe level may present a confounding variable which can influence TC characteristics, we examined the effects of a high probe level to determine to what extent the morphology of the TC is level dependent. Basically, we need to understand the effect of a high probe level before we can properly evaluate TC's in pathologic cochleas. Figure 13 shows the mean TC variables of the preexposure group and a control group whose TC's were obtained with a 35 dB SL probe tone at each probe frequency. We can see that the higher probe level resulted in either no change in the TC at all or an increase in the sharpness of the TC. Therefore, the changes previously described in the PTS TC's would at most represent an underestimate of the effects of a PTS.

In Figures 14 through 16, the percent change in Q_{10dB} and in the HFS and LFS with sensory cell loss as a function of the degree of PTS at probe frequencies of 1.0, 2.0, 4.0 & 8.0 kHz are shown. The total mean sensory cell loss was determined within the octave band region centered around the probe frequency. It should be noted that the IHC losses are in general very small, being no greater than 20% for PTS of up to 40 dB. However, the OHC shows a near total loss once PTS exceeds roughly 30 dB. Generally, as the amount of PTS increases beyond 10 dB, the percent change in Q increases, reflecting a reduction in Q_{10dB} . Also, as the amount of PTS increases beyond 10 dB, the relationship between percent change in Q_{10dB} and sensory cell loss seems to vary somewhat with probe frequency. At the low frequency (i.e. at 0.5 kHz - not shown and 1.0 kHz) Q_{10dB} does not appear to be particularly sensitive to sensory cell loss while at the high frequencies (8.0 kHz and 11.2 kHz not shown) Q_{10dB} appears to be very sensitive to outer hair cell (OHC) losses. At the two mid-frequencies shown, the changes in Q_{10dB} parallel the OHC loss.

The HFS data are shown in Figure 15. The same general trends in the results that were described for Q_{10dB} , are seen in the HFS data as PTS increases beyond 10 dB. That is, there is a general decrease in the HFS as PTS increases. At the low frequencies (1.0 kHz and below) the HFS slope seems relatively insensitive to the OHC loss while at the three higher frequencies the HFS seems to parallel the OHC loss.

Similarly for the LFS data, illustrated in Figure 16, as PTS increases the LFS decreases. At the 1.0, 2.0 and 4.0 kHz test frequencies, the LFS parallels the OHC loss,

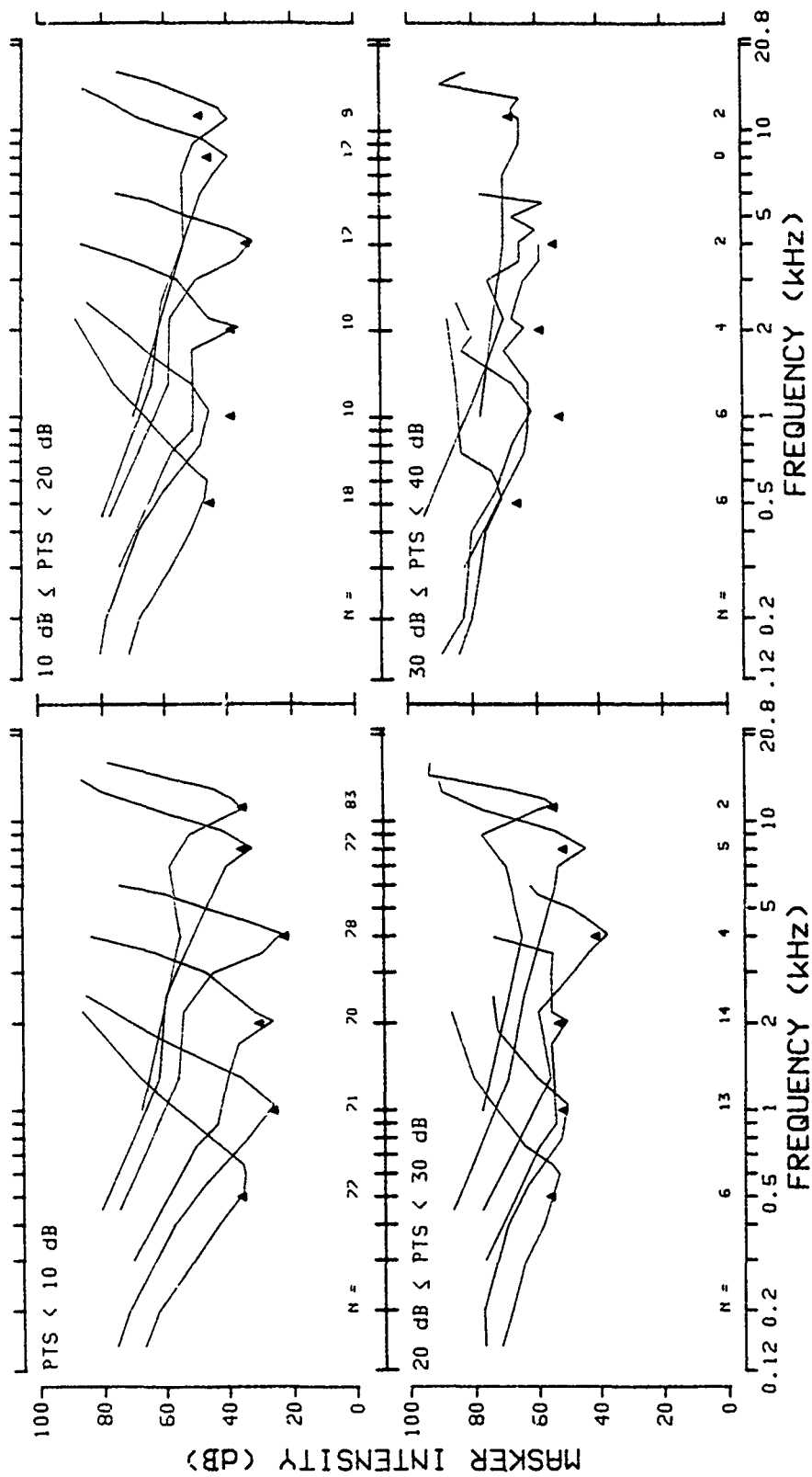


Figure 12. Mean AEP tuning curves segregated by amount of PTS.

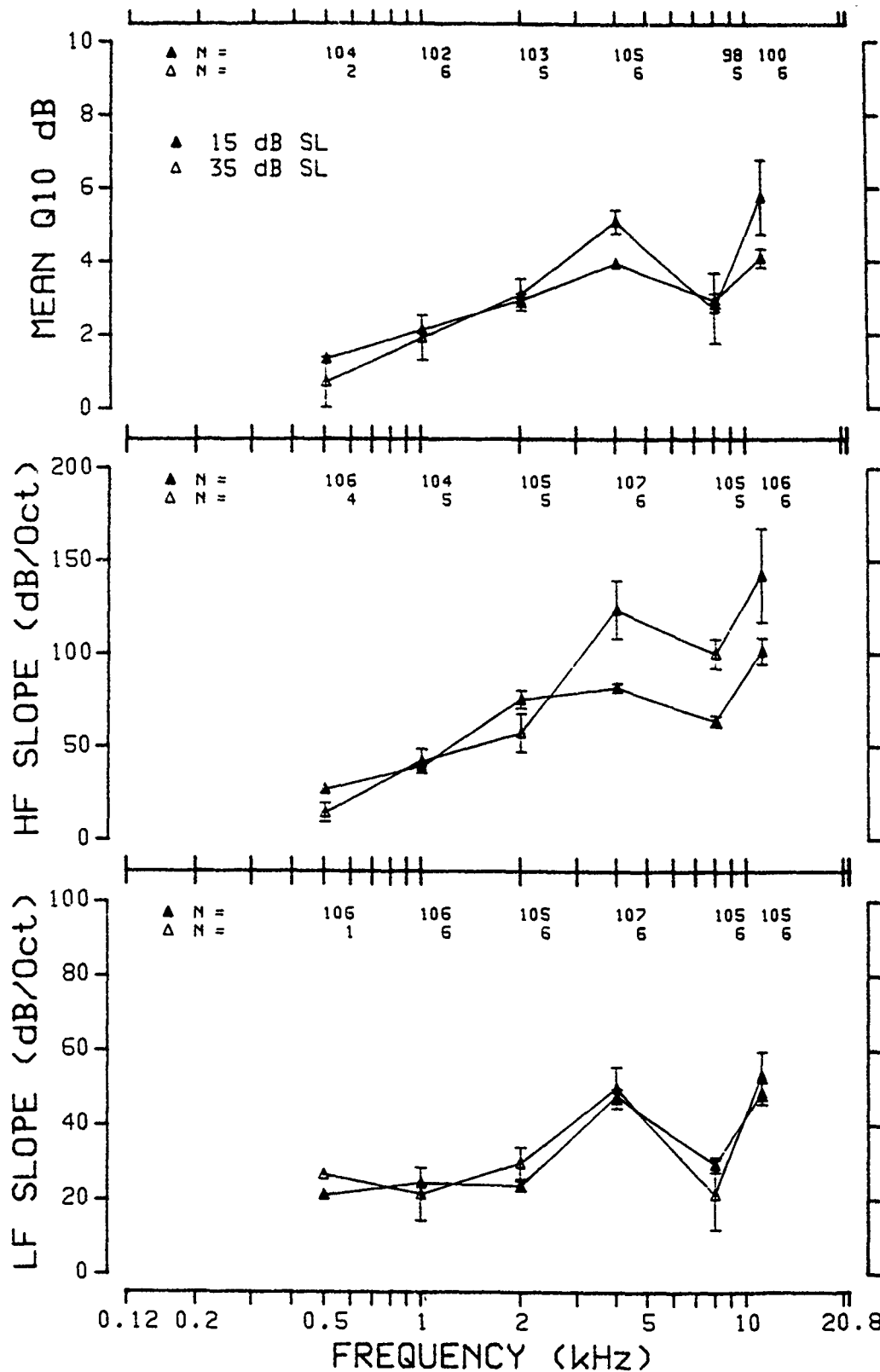


Figure 13. Comparison of the tuning curve statistics for probe tones presented at 15 and 35 dB above threshold. Upper panel illustrates Q_{10dB} ; center panel illustrates high frequency slope; and lower panel illustrates low frequency slope.

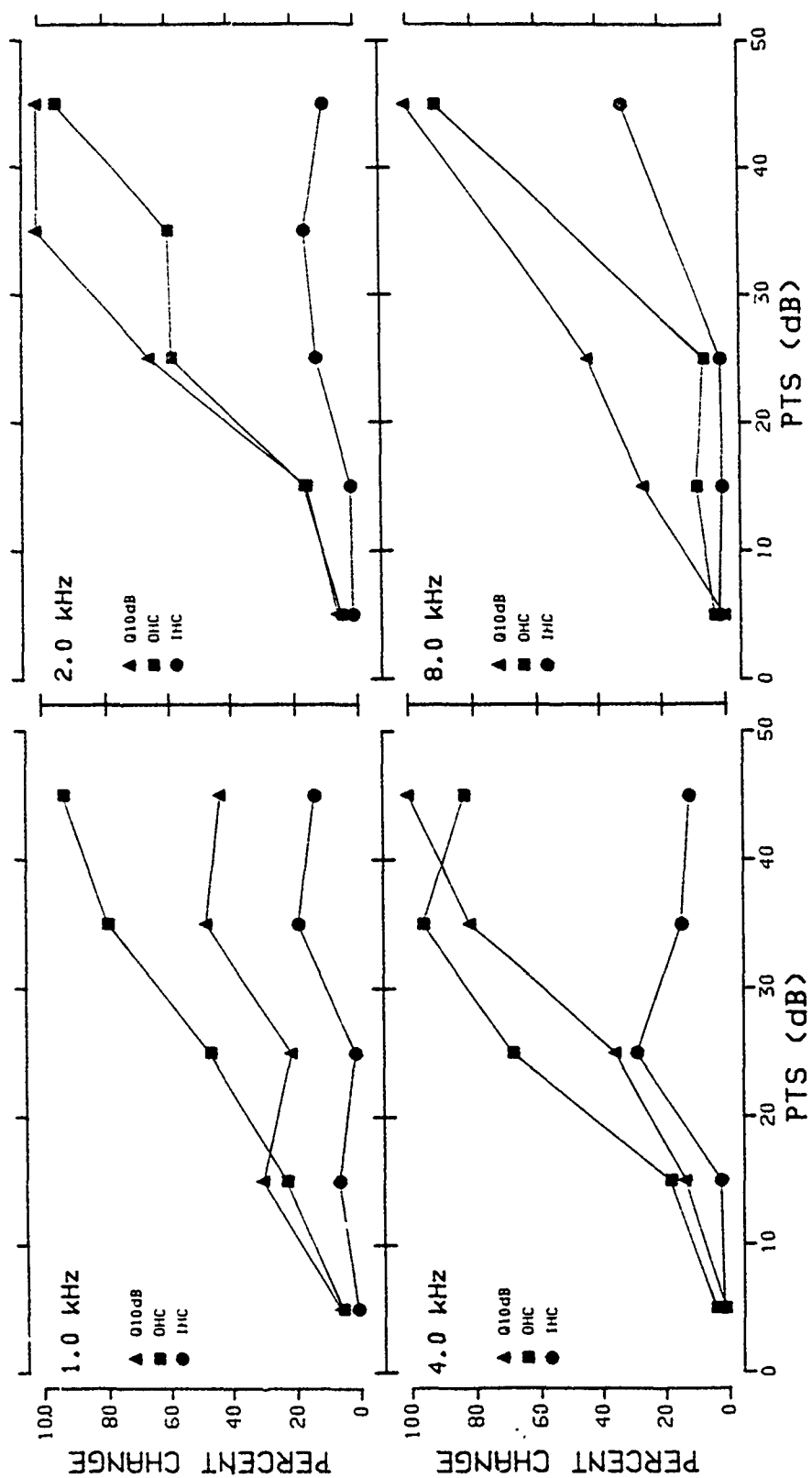


Figure 14. Percent change in Q10dB and sensory cell loss as a consequence of increased PTS.

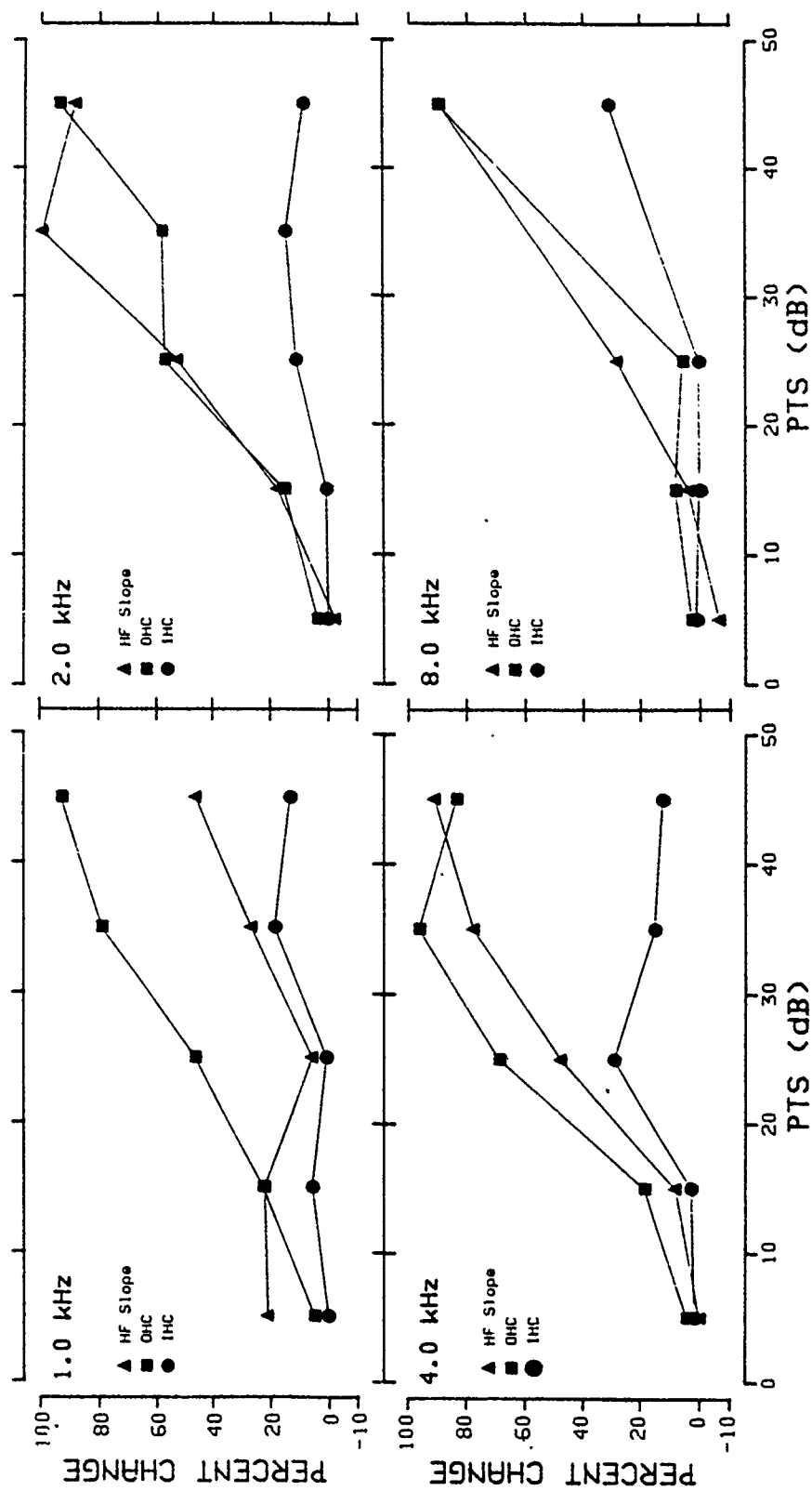


Figure 15. Percent change in high frequency slope and sensory cell loss as a consequence of increased PTS.

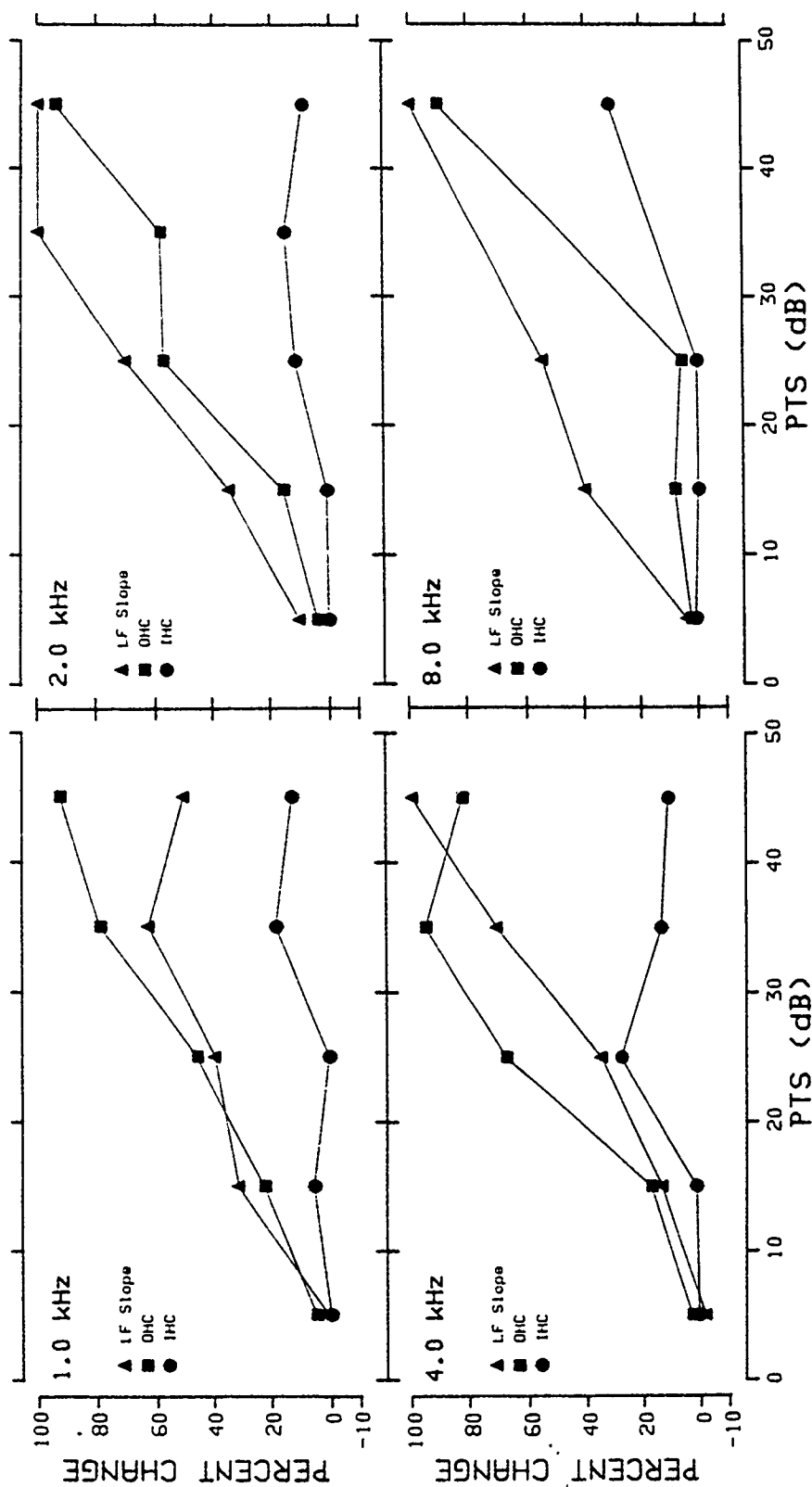


Figure 16. Percent change in low frequency slope and sensory cell loss as a consequence of increased PTS

while at the higher test frequency (8.0 kHz) the LFS seems very insensitive to the condition of the cochlea.

CONCLUSIONS: From the results obtained from the evoked potential tuning curves, the following conclusions may be made:

1. When PTS is below 10 dB, there is little sensory cell damage and no measurable change in the evoked potential TC morphology.
2. There is a systematic change in the 3 variables used to quantify the tuning curve (i.e. Q_{10dB} , low and high frequency slope) as PTS increases above 10 dB.
3. Changes in TC characteristics at the 2.0 and 4.0 kHz frequencies are highly correlated with OHC losses. At the lower (0.5 and 1.0 kHz) and higher (8.0 & 11.2 kHz) test frequencies the relation is not as straight forward.
4. When PTS exceeds 40 dB, there is a complete loss of OHC and tuning is essentially eliminated.

A complete summary of the tuning curve data that were used in developing these results are enclosed in the Appendix of this report. These turning curve figures supercede those that are tabulated in the three volumes of compiled data included with the previous report (Hamernik et al., 1988, Report I). The Appendix data reflect values obtained with the new TC protocol that was described above. The new rules that we recently incorporated do not yield the types of inconsistencies that were found in the calculation of the original TC data.

III. BIBLIOGRAPHY

- Dallos, P., Ryan, A., Harris, D., McGee, T., and Ozdamar, O. (1977). Cochlear frequency selectivity in the presence of hair cell damage. In: *Psychophysics and Physiology of Hearing*, E.F. Evans and J.P. Wilson (eds.). Academic Press, London. pp. 249-262.
- Hamernik, R.P., Ahroon, W.A., Davis, R.I., Hsueh, K.D. and Turrentine, G.A. (1988). The Effects of Blast Trauma (Impulse Noise) on Hearing: A Parametric Study. Annual Summary Report I. State University of New York at Plattsburgh, Auditory Research Laboratory Report No. ARL 88-2.
- Henderson, D., Hamernik, R.P. and Sitler, R.W. (1974). Audiometric and histological correlates of exposure to 1-msec noise impulses in the chinchilla. *J. Acoust. Soc. Am.* 56: 1210-1221.
- Hoekstra, A. and Ritsma, F.J. (1977). Perceptive hearing loss and frequency selectivity. In: *Psychophysics and Physiology of Hearing*, E.F. Evans and J.P. Wilson (eds.). Academic Press. pp. 263-282.
- Hunter-Duvar, I.M. and Elliot, D.N. (1972). Effects of intense auditory stimulation: Hearing losses and inner ear changes in the squirrel monkey. *J. Acoust. Soc. Am.* 52: 1181-1192.
- Hunter-Duvar, I.M. and Elliot, D.N. (1973). Effects of intense auditory stimulation: Hearing losses and inner ear changes in the squirrel monkey. *J. Acoust. Soc. Am.* 52: 1179-1183.
- Kenna, L.C. (1982). High-level impulsive noise source. *J. Acoust. Soc. Am.* 71: 483-486.
- Leshowitz, B.G. and Lindstrom, R. (1977). Measurements of nonlinearities in listeners with sensorineural hearing loss. In: *Psychophysics and Physiology of Hearing*, E.F. Evans and J.P. Wilson (eds.). Academic Press. pp. 263-282.
- Lindquist, S.E., Neff, W.D. and Schudnecht, H.F. (1954). Stimulation deafness: A study of hearing losses resulting from exposure to noise of blast impulses. *J. Comp. Physiol. Psychol.* 47: 406.
- McGee, R., Ryan, A. and Dallos, P. (1976). Psychophysical tuning curves of chinchillas. *J. Acoust. Soc. Am.* 60: 1146-1150.
- Moody, D.B., Stebbins, W.C., Johnsson, L.G. and Hawkins, J.E. (1976). Noise induced hearing loss in the monkey. In: *The Effects of Noise on Hearing*, D. Henderson, R.P. Hamernik, D.S. Dosanjh and J.H. Mills (eds.). Raven Press, NY. pp. 309-325.
- NASA (1968). Second Conference on Sonic Boom Research. SP-180.
- Ryan, A. and Dallos, P. (1975). Effects of absence of cochlear outer hair cells on behavioral auditory thresholds. *Nature* 253: 44-46.
- Salvi, R.J., Ahroon, W.A., Perry, J.W., Gunnarson, A.D. and Henderson, D. (1982). Comparison of Psychophysical and Evoked-Potential Tuning Curves in the Chinchilla. *Am. J. Otolaryngol.* 3: 408-416.

- Vogten, L.L.M. (1974). Puretone masking: A new result from a new method. In: Facts and Models in Hearing. E. Zwicker and E. Terhardt (eds). Springer-Verlag, NY. pp. 142-155.
- Wightman, F., McGee, T. and Kramer, M. (1977). Factors influencing frequency selectivity in normal and hearing impaired listeners. In: Psychophysics and Physiology of Hearing, E.F. Evans and J.P. Wilson (eds). Academic Press, London. pp. 295-310.
- Zwicker, E. (1974). On a psychoacoustical equivalent of tuning curves. In: Facts and Models in Hearing. E. Zwicker and E. Terhardt (eds). Springer-Verlag, NY. pp. 133-141.

IV. PUBLICATIONS RESULTING FROM THIS CONTRACT

- Hamernik, R.P., Patterson, J.H., Turrentine, G.A. and Ahroon, W.A. (1988). The quantitative relation between sensory cell loss and hearing thresholds. Hearing Research (in press).
- Hamernik, R.P. and Ahroon, W.A. (1988). Effects of high-level impulse noise intensity, number, and rate on hearing. J. Acoust. Soc. Am. 84 (A) in press.
- Hamernik, R.P., Ahroon, W.A. and Patterson, J.H. (1988). Threshold recovery functions following impulse noise trauma. J. Acoust. Soc. Am. 84 (in press).
- Davis, R.I., Ahroon, W.A. and Hamernik, R.P. (1988). Changes in frequency selectivity in the chinchilla following a noise induced permanent threshold shift. J. Acoust. Soc. Am. 83: S116 (A).

Appendix

Individual and Group Tuning Curve Statistics from:

The Effects of Blast Trauma (Impulse Noise)
on Hearing: A Parametric Study

150 dB 1X

INDIVIDUAL TUNING CURVE STATISTICS

Probe Frequency 0.5 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	PTS
2071	1.659	30.2	18.6	1.659	31.8	25.0	0.0
2073	1.288	23.1	19.0	1.744	20.6	18.8	1.2
2084	0.587	21.8	12.6	1.129	20.1	38.0	-14.2
2090	0.707	14.8	25.6	3.613	33.0	31.2	-1.7
Mean	1.060	22.5	18.9	2.036	26.4	28.2	-3.6
S.D.	0.503	6.3	5.3	1.086	7.0	8.2	7.1

Probe Frequency 1.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	PTS
2071	1.768	47.0	21.8	1.779	56.2	21.3	-1.7
2073	1.316	37.4	19.0	2.100	33.3	15.7	-2.5
2084	2.100	49.5	21.3	2.100	51.1	26.9	-7.5
2090	1.837	48.8	21.3	1.983	51.9	22.9	-5.0
Mean	1.755	45.7	20.8	1.991	48.1	21.7	-4.2
S.D.	0.326	5.6	1.2	0.151	10.2	4.6	2.6

Probe Frequency 2.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	PTS
2071	1.577	17.2	38.1	4.100	62.0	30.1	-3.3
2073	1.615	38.9	15.1	3.253	53.9	21.2	-1.0
2084	6.041	59.6	13.3	1.615	68.1	15.1	-4.2
2090	1.799	76.4	16.8	1.244	64.5	31.9	-10.0
Mean	2.758	48.0	20.8	2.553	62.2	24.6	-4.6
S.D.	2.191	25.6	11.6	1.351	6.0	7.9	3.8

150 dB 1X

INDIVIDUAL TUNING CURVE STATISTICS

Probe Frequency 4.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
2071	3.654	116.3	33.2	2.733	87.8	22.1	-3.3
2073	2.285	85.3	11.0	3.009	85.7	22.1	-1.7
2084	3.489	111.0	44.3	2.474	92.4	10.9	-2.1
2090	3.255	87.7	33.2	3.532	91.4	22.3	-1.7
Mean	3.170	100.1	30.4	2.937	89.3	19.3	-2.2
S.D.	0.613	15.9	13.9	0.453	3.1	5.7	0.8

Probe Frequency 8.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
2071	0.975	48.5	0.0	1.007	76.8	0.0	-3.3
2073	1.484	72.3	11.2	3.001	80.6	21.3	4.2
2084	3.522	50.2	21.3	5.286	66.3	9.5	6.2
2090	2.132	70.5	21.8	2.002	56.2	21.8	1.7
Mean	2.028	60.4	13.6	2.824	70.0	13.1	2.2
S.D.	1.102	12.7	10.3	1.832	11.0	10.4	4.1

Probe Frequency 11.2 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
2071	2.431	103.4	30.2	2.793	81.0	50.6	-10.0
2073	4.137	83.5	50.6	5.116	134.7	65.7	-10.8
2084	*****	115.1	0.0	3.581	110.2	88.3	-0.7
2090	3.799	55.3	50.6	4.531	104.0	70.2	1.7
Mean	3.456	89.3	32.8	4.005	107.5	68.7	-5.0
S.D.	0.903	26.2	23.9	1.026	22.1	15.5	6.4

150 dB 10X 10/M

INDIVIDUAL TUNING CURVE STATISTICS

Probe Frequency 0.5 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	PTS
0510	1.659	18.1	25.0	1.345	48.5	25.4	0.0
0511	1.345	21.9	25.4	0.865	19.4	12.6	-1.7
0512	1.486	37.1	25.2	3.182	53.6	37.8	-5.0
0513	1.284	26.3	6.8	0.968	24.9	12.6	3.3
0524	1.486	25.5	18.8	1.038	15.2	18.8	0.0
Mean	1.452	25.8	20.2	1.480	32.3	21.4	-0.7
S.D.	0.146	7.1	8.0	0.968	17.5	10.6	3.0

Probe Frequency 1.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	PTS
0510	4.635	71.3	19.6	3.136	63.5	31.9	-3.3
0511	2.476	44.4	26.3	1.664	47.7	27.4	0.0
0512	1.664	60.1	27.4	4.532	84.9	20.7	8.3
0513	2.100	53.2	26.9	3.591	50.3	31.9	0.0
0524	1.081	40.8	27.4	2.079	68.0	25.7	6.7
Mean	2.391	54.0	25.5	3.000	62.9	27.5	2.3
S.D.	1.357	12.3	3.4	1.156	15.0	4.7	4.9

Probe Frequency 2.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	PTS
0510	3.199	57.9	30.1	1.615	45.9	15.1	-5.0
0511	0.932	15.9	16.0	5.249	54.9	29.2	2.9
0512	2.699	61.4	21.2	1.577	33.9	5.2	3.3
0513	4.100	50.7	38.1	2.112	68.2	30.1	-6.7
0524	2.278	58.0	16.0	2.288	48.7	29.2	5.0
Mean	2.641	48.8	24.3	2.568	50.3	22.0	-0.1
S.D.	1.172	18.8	9.7	1.530	12.6	10.8	5.3

150 dB 10X 10/M

INDIVIDUAL TUNING CURVE STATISTICS

Probe Frequency 4.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	PTS
0510	4.100	134.2	88.6	5.059	120.1	88.7	-3.3
0511	2.980	91.4	55.3	3.171	76.6	55.3	0.0
0512	3.766	76.8	77.4	3.706	94.5	66.4	0.0
0513	3.255	124.0	33.2	3.621	124.2	55.3	1.7
0524	4.100	111.6	55.4	3.171	115.4	55.3	8.3
Mean	3.640	107.6	62.0	3.745	106.1	64.2	1.3
S.D.	0.506	23.5	21.6	0.775	20.1	14.5	4.3

Probe Frequency 8.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	PTS
0510	3.880	69.2	31.3	5.993	114.4	31.3	0.0
0511	2.132	76.7	22.4	3.721	92.5	9.5	6.7
0512	3.522	103.4	10.1	2.750	94.7	21.3	6.7
0513	1.799	35.0	21.8	3.880	100.8	31.3	0.0
0524	1.673	65.1	33.0	3.514	68.6	42.5	10.0
Mean	2.601	69.9	23.7	3.971	94.2	27.2	4.7
S.D.	1.025	24.6	9.2	1.211	16.6	12.4	4.5

Probe Frequency 11.2 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	PTS
0510	4.531	112.1	70.2	2.695	72.1	50.6	0.0
0511	15.385	90.9	49.8	11.497	142.5	34.7	0.0
0512	2.511	86.3	30.2	7.287	102.5	44.5	-1.7
0513	8.945	104.2	70.2	2.531	106.8	46.1	0.0
0524	7.475	98.3	70.2	3.405	40.1	45.3	6.7
Mean	7.769	98.4	58.1	5.483	92.8	44.2	1.0
S.D.	4.940	10.3	17.9	3.880	38.6	5.8	3.2

150 dB 10X 1/M

INDIVIDUAL TUNING CURVE STATISTICS

Probe Frequency 0.5 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
1010	1.176	40.9	0.0	2.126	31.0	17.6	11.7
1094	1.317	17.3	5.2	2.311	31.3	17.4	8.3
1104	0.679	19.2	11.2	2.311	23.0	30.2	11.7
1128	1.960	28.0	17.6	1.219	16.9	5.2	-5.0
1231	1.082	30.1	16.3	1.507	20.8	10.1	-3.3
Mean	1.243	27.1	10.1	1.895	24.6	16.1	4.7
S.D.	0.466	9.5	7.5	0.502	6.4	9.4	8.2

Probe Frequency 1.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
1010	4.123	54.9	34.8	1.837	63.0	15.2	6.7
1094	2.412	31.0	19.7	1.185	25.2	21.4	10.0
1104	1.334	29.5	43.2	1.795	51.8	26.4	8.3
1128	2.412	53.0	30.9	2.706	49.7	25.8	1.7
1231	1.536	46.0	23.4	1.353	37.2	17.2	3.3
Mean	2.363	42.9	30.4	1.775	45.4	21.2	6.0
S.D.	1.101	12.0	9.3	0.591	14.5	5.0	3.5

Probe Frequency 2.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
1010	10.577	60.9	55.1	6.304	33.4	41.8	8.3
1094	0.826	26.9	0.5	1.535	41.5	3.7	5.0
1104	2.702	49.7	20.6	2.531	24.7	20.6	-1.7
1128	6.311	30.3	32.9	0.702	11.7	12.6	-5.0
1231	4.993	28.4	20.2	7.382	70.5	51.2	-3.3
Mean	5.082	39.2	25.9	3.691	36.4	26.0	0.7
S.D.	3.725	15.2	20.0	2.974	22.1	19.9	5.7

150 dB 10X 1/M

INDIVIDUAL TUNING CURVE STATISTICS

Probe Frequency 4.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
1010	7.245	108.0	80.0	2.292	71.1	24.3	8.3
1094	2.583	68.6	24.5	1.678	64.1	2.0	11.7
1104	4.828	93.5	57.6	3.520	68.7	46.6	6.7
1128	2.316	70.0	15.4	3.522	110.4	24.5	5.0
1231	5.938	67.5	66.6	1.603	59.2	0.0	1.7
Mean	4.582	81.5	48.8	2.523	74.7	19.5	6.7
S.D.	2.128	18.3	27.7	0.950	20.5	19.1	3.7

Probe Frequency 8.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
1010	*****	90.6	*****	7.527	84.8	27.2	10.0
1094	4.376	73.0	37.8	0.834	53.5	7.1	10.0
1104	2.866	65.9	28.9	4.412	45.1	38.9	-3.3
1128	5.144	63.7	60.8	5.672	70.7	60.2	11.7
1231	*****	30.1	85.5	2.912	24.5	47.3	16.0
Mean	4.129	64.7	53.2	4.272	55.7	36.1	8.9
S.D.	1.159	22.0	25.3	2.562	23.3	20.2	7.2

Probe Frequency 11.2 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
1010	3.833	98.9	28.1	2.441	83.3	8.5	3.3
1094	3.215	86.3	59.0	3.393	95.0	48.5	1.7
1104	3.364	78.4	48.5	4.602	53.3	62.8	-1.7
1128	2.944	86.9	33.4	2.462	45.4	48.5	-1.7
1231	9.378	98.0	35.5	8.461	60.9	50.6	8.3
Mean	4.547	89.7	40.9	4.272	67.6	43.7	2.0
S.D.	2.720	8.7	12.6	2.503	20.9	20.6	4.1

150 dB 10X 1/10M

INDIVIDUAL TUNING CURVE STATISTICS

Probe Frequency 0.5 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
0502	1.553	36.6	25.4	1.486	26.0	25.2	-6.7
0504	1.118	30.7	19.0	1.017	32.8	12.8	0.0
0505	1.011	33.2	19.0	1.325	44.9	18.8	-1.7
0507	2.600	33.3	25.2	1.156	22.9	12.8	-5.0
0509	1.345	31.7	25.4	0.885	20.1	12.4	10.0
Mean	1.526	33.1	22.8	1.174	29.3	16.4	-0.7
S.D.	0.636	2.2	3.5	0.239	9.9	5.6	6.5

Probe Frequency 1.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
0502	2.100	37.7	21.3	2.476	52.7	26.3	0.0
0504	1.689	48.0	26.9	2.557	54.8	32.5	-3.3
0505	1.768	45.3	21.8	2.557	43.5	21.3	0.0
0507	1.837	48.6	21.3	1.779	37.4	26.9	0.0
0509	2.476	40.0	20.7	3.136	46.5	37.5	1.7
Mean	1.974	43.9	22.4	2.501	47.0	28.9	-0.3
S.D.	0.320	4.8	2.5	0.483	7.0	6.2	1.8

Probe Frequency 2.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
0502	3.026	62.1	14.2	1.590	42.7	23.0	-3.3
0504	1.894	40.2	23.0	2.190	62.7	31.0	0.0
0505	1.615	35.2	15.1	*****	8.3	0.9	5.0
0507	1.753	58.6	7.1	1.173	35.6	7.1	6.7
0509	2.445	38.3	20.4	0.866	31.5	7.1	8.3
Mean	2.147	46.9	15.9	1.455	36.2	13.8	3.3
S.D.	0.584	12.5	6.2	0.573	19.6	12.6	4.9

150 dB 10X 1/10M

INDIVIDUAL TUNING CURVE STATISTICS

Probe Frequency 4.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
0502	2.522	99.3	33.0	3.129	78.9	55.5	-1.7
0504	2.890	84.8	44.3	4.100	90.2	66.5	-3.3
0505	3.056	91.8	33.1	2.890	99.6	44.3	0.0
0507	3.435	84.5	44.4	3.660	104.7	55.4	0.0
0509	3.056	70.3	33.1	2.352	74.0	22.0	3.3
Mean	2.992	86.1	37.6	3.226	89.5	48.7	-0.3
S.D.	0.330	10.7	6.1	0.678	13.1	16.9	2.5

Probe Frequency 8.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
0502	1.233	48.9	10.6	1.664	74.0	11.2	-5.0
0504	3.001	84.7	21.3	5.291	94.9	40.8	-4.6
0505	4.576	91.8	20.1	4.576	91.8	8.9	0.0
0507	4.152	66.7	31.9	4.824	67.7	10.1	6.7
0509	1.459	68.6	0.0	1.088	66.9	0.0	6.7
Mean	2.884	72.1	16.8	3.489	79.1	14.2	0.7
S.D.	1.520	16.8	12.0	1.956	13.4	15.5	5.7

Probe Frequency 11.2 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
0502	1.586	48.5	5.3	1.451	43.5	16.6	0.0
0504	5.670	163.6	70.2	4.843	135.5	60.4	-3.7
0505	3.771	116.2	40.0	5.750	112.1	64.9	0.0
0507	4.471	151.4	65.7	5.750	129.5	64.9	0.0
0509	2.566	84.5	35.5	5.609	110.5	60.4	0.0
Mean	3.613	112.8	43.3	4.681	106.2	53.4	-0.7
S.D.	1.597	47.5	26.2	1.845	36.7	20.7	1.7

150 dB 100X 10/M

INDIVIDUAL TUNING CURVE STATISTICS

Probe Frequency 0.5 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
0525	3.182	25.4	31.4	0.836	28.2	12.6	1.7
0528	1.288	24.2	25.6	1.651	38.6	25.2	5.0
0530	1.011	21.9	19.0	1.298	25.9	44.2	-3.3
0536	2.436	39.9	31.4	2.198	5.1	25.4	1.7
0538	1.288	39.1	19.0	1.713	34.8	19.0	5.0
Mean	1.841	30.1	25.3	1.539	26.5	25.3	2.0
S.D.	0.929	8.7	6.2	0.507	13.0	11.8	3.4

Probe Frequency 1.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
0525	3.570	50.7	36.9	2.476	38.6	15.1	-1.7
0528	4.170	47.7	31.3	4.170	64.9	31.3	3.3
0530	3.570	77.5	48.1	3.136	61.8	31.9	0.0
0536	2.371	82.0	31.3	1.467	52.7	21.8	0.0
0538	2.371	60.1	25.7	3.570	53.2	31.3	3.3
Mean	3.210	63.6	34.7	2.964	54.2	26.3	1.0
S.D.	0.804	15.5	8.5	1.040	10.2	7.5	2.2

Probe Frequency 2.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
0525	2.593	46.6	22.1	4.568	44.1	22.1	0.0
0528	2.596	68.7	39.9	3.579	58.4	36.3	13.3
0530	2.042	48.6	23.0	1.894	38.9	23.0	-6.7
0536	2.082	71.5	23.0	2.077	60.0	15.1	-3.3
0538	2.415	54.0	15.1	6.153	65.1	12.4	-1.7
Mean	2.345	57.9	24.6	3.654	53.3	21.8	0.3
S.D.	0.269	11.5	9.2	1.780	11.2	9.3	7.7

150 dB 100X 10/M

INDIVIDUAL TUNING CURVE STATISTICS

Probe Frequency 4.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
0525	3.390	81.1	55.2	6.294	90.2	77.8	-1.7
0528	6.093	83.3	77.6	6.093	98.9	66.6	6.7
0530	4.100	103.4	66.5	6.093	97.2	77.6	-11.7
0536	3.236	111.3	66.4	4.754	107.0	77.5	5.0
0538	5.059	126.6	88.7	3.297	101.7	55.4	0.0
Mean	4.376	101.1	70.9	5.306	99.0	71.0	-0.3
S.D.	1.200	19.2	12.7	1.280	6.1	9.9	7.2

Probe Frequency 8.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
0525	6.528	88.9	30.7	3.982	103.3	53.7	3.3
0528	3.159	62.6	32.5	3.522	50.2	21.3	15.0
0530	5.286	88.4	54.3	5.286	103.1	20.7	-1.7
0536	2.717	56.1	21.8	4.576	88.7	42.5	-1.7
0538	1.233	80.0	11.2	3.735	80.0	31.3	-1.7
Mean	3.785	75.2	30.1	4.220	85.1	33.9	2.7
S.D.	2.111	15.1	15.9	0.715	21.9	14.2	7.2

Probe Frequency 11.2 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
0525	3.789	91.0	45.3	3.771	86.7	40.0	-6.7
0528	11.497	98.1	49.8	3.612	84.1	61.2	3.3
0530	3.046	99.4	50.6	7.700	110.9	14.3	0.0
0536	5.223	98.9	90.6	3.168	80.0	80.8	3.3
0538	3.372	97.2	80.8	4.728	112.7	85.3	1.7
Mean	5.385	97.0	63.4	4.595	94.9	56.3	0.3
S.D.	3.516	3.4	20.7	1.826	15.7	29.5	4.2

150 dB 100X 1/M

INDIVIDUAL TUNING CURVE STATISTICS

Probe Frequency 0.5 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
1365	2.193	33.7	18.8	1.987	28.3	25.0	21.7
1448	*****	13.0	18.8	1.300	31.7	18.8	-1.7
1510	0.757	26.6	12.6	0.997	32.3	18.8	-1.7
1539	*****	*****	*****	*****	*****	*****	28.3
1564	*****	0.0	6.2	0.766	22.8	6.2	3.3
1597	0.745	21.3	6.0	1.227	16.8	12.6	30.8
Mean	1.232	18.9	12.5	1.255	26.4	16.3	13.5
S.D.	0.833	13.0	6.3	0.460	6.6	7.1	15.2

Probe Frequency 1.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
1365	2.100	52.3	21.3	1.698	36.4	10.6	23.3
1448	*****	*****	10.6	1.589	47.5	10.6	3.3
1510	2.557	34.2	21.3	1.649	41.1	16.2	1.7
1539	*****	*****	*****	*****	*****	*****	21.7
1564	*****	*****	8.1	*****	14.3	1.7	18.3
1597	1.578	44.0	21.8	1.275	8.2	16.2	21.7
Mean	2.078	43.5	16.6	1.553	29.5	11.1	15.0
S.D.	0.490	9.1	6.7	0.190	17.2	5.9	9.8

Probe Frequency 2.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
1365	*****	*****	*****	9.252	48.2	27.4	20.0
1448	5.339	49.2	29.7	3.579	81.7	40.3	6.7
1510	6.881	65.0	51.4	6.881	45.8	27.4	3.3
1539	*****	*****	*****	*****	*****	*****	8.3
1564	2.699	50.9	21.2	*****	0.0	6.2	23.3
1597	4.015	55.1	28.3	0.746	41.8	0.0	26.7
Mean	4.734	55.1	32.7	5.114	43.5	20.3	14.7
S.D.	1.792	7.1	13.0	3.728	29.1	16.7	9.8

150 dB 100X 1/M

INDIVIDUAL TUNING CURVE STATISTICS

Probe Frequency 4.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
1365	*****	37.2	55.4	2.487	104.4	22.0	16.7
1448	2.809	128.9	55.3	4.100	102.7	55.4	-5.0
1510	4.606	85.0	55.5	4.100	70.5	44.4	6.7
1539	*****	*****	*****	*****	*****	*****	11.7
1564	3.255	42.2	33.2	3.255	90.2	33.2	1.7
1597	3.706	87.8	66.4	*****	*****	*****	3.3
Mean	3.594	76.2	53.2	3.486	91.9	38.8	5.8
S.D.	0.768	37.6	12.1	0.776	15.6	14.4	7.7

Probe Frequency 8.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
1365	*****	*****	42.5	3.095	72.0	21.8	10.0
1448	*****	*****	73.5	4.252	57.9	44.2	-5.0
1510	1.771	22.6	33.0	3.258	69.9	43.1	1.7
1539	*****	*****	*****	*****	*****	*****	8.3
1564	3.570	82.7	44.2	4.305	65.8	10.1	5.0
1597	2.652	60.0	33.6	*****	*****	*****	-8.3
Mean	2.664	55.1	45.4	3.727	66.4	29.8	1.9
S.D.	0.899	30.4	16.5	0.640	6.2	16.7	7.3

Probe Frequency 11.2 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
1365	*****	34.7	11.4	2.891	103.4	65.7	1.7
1448	4.728	127.3	85.3	*****	*****	*****	5.0
1510	3.130	53.7	52.8	7.475	92.0	70.2	1.7
1539	*****	*****	*****	*****	*****	*****	11.7
1564	2.083	32.8	50.6	2.980	79.7	45.3	5.0
1597	4.633	79.7	110.2	*****	*****	*****	10.0
Mean	3.644	65.6	62.1	4.449	91.7	60.4	5.8
S.D.	1.272	39.3	37.6	2.621	11.9	13.3	4.2

150 dB 100X 1/10M

INDIVIDUAL TUNING CURVE STATISTICS

Probe Frequency 0.5 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
0553	2.080	39.1	31.6	1.411	15.7	19.0	-1.7
0556	1.089	25.3	12.4	0.968	26.7	12.6	-1.7
0557	1.288	25.4	19.0	1.659	35.0	31.4	-3.3
0558	1.870	29.8	19.0	1.486	31.0	18.8	1.7
0559	3.613	36.8	44.0	1.033	38.1	12.6	3.3
Mean	1.988	31.3	25.2	1.311	29.3	18.9	-0.3
S.D.	0.995	6.4	12.6	0.299	8.7	7.7	2.7

Probe Frequency 1.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
0553	1.779	47.0	32.5	2.738	50.6	36.9	0.0
0556	2.557	59.0	43.6	2.931	53.1	25.2	1.7
0557	2.738	66.1	31.3	3.570	70.5	42.5	-6.7
0558	2.100	50.7	26.9	2.557	38.3	32.5	0.0
0559	2.557	51.1	32.5	2.851	44.4	32.5	-1.7
Mean	2.346	54.8	33.3	2.929	51.4	33.9	-1.3
S.D.	0.395	7.7	6.2	0.384	12.1	6.4	3.2

Probe Frequency 2.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
0553	3.579	56.0	28.3	4.325	52.2	52.3	0.0
0556	4.100	33.7	14.2	1.615	30.0	15.1	3.3
0557	4.041	65.5	29.2	3.324	65.5	22.1	-3.3
0558	1.722	69.0	15.1	3.199	78.6	30.1	0.0
0559	5.249	49.1	29.2	1.190	51.7	0.0	8.3
Mean	3.738	54.7	23.2	2.731	55.6	23.9	1.7
S.D.	1.284	14.1	7.9	1.297	18.1	19.3	4.4

150 dB 100X 1/10M

INDIVIDUAL TUNING CURVE STATISTICS

Probe Frequency 4.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
0553	3.084	110.5	55.2	2.728	108.4	44.1	1.7
0556	5.760	70.4	55.6	4.232	73.3	66.4	-1.7
0557	3.532	123.6	66.5	3.236	72.4	66.4	0.0
0558	3.038	69.9	66.4	3.255	96.7	44.2	5.0
0559	3.129	87.2	77.6	4.412	109.6	99.5	5.0
Mean	3.708	92.3	64.3	3.573	92.1	64.1	2.0
S.D.	1.163	24.1	9.3	0.719	18.2	22.7	3.0

Probe Frequency 8.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
0553	3.094	80.4	21.3	2.058	69.9	21.8	-1.7
0556	1.484	63.6	1.1	1.357	52.2	10.6	5.0
0557	8.900	109.8	52.0	7.282	90.1	52.0	-1.7
0558	5.286	107.4	31.9	4.305	67.8	43.7	0.0
0559	4.576	76.4	42.5	3.001	56.4	43.7	3.3
Mean	4.668	87.5	29.8	3.601	67.3	34.3	1.0
S.D.	2.780	20.3	19.7	2.336	14.8	17.3	3.0

Probe Frequency 11.2 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
0553	2.563	70.1	45.3	2.714	71.1	40.0	0.0
0556	2.241	74.7	55.9	3.405	74.0	45.3	0.0
0557	3.771	91.3	40.0	3.527	106.4	75.5	0.0
0558	3.007	92.6	50.6	3.446	109.9	101.2	0.0
0559	5.116	80.3	65.7	3.188	88.6	65.7	8.3
Mean	3.339	81.8	51.5	3.256	90.0	65.5	1.7
S.D.	1.147	10.0	9.9	0.328	17.9	24.6	3.7

155 dB 1X

INDIVIDUAL TUNING CURVE STATISTICS

Probe Frequency 0.5 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
1933	1.038	33.6	25.6	1.134	26.8	25.4	-6.7
1961	1.120	27.9	25.0	0.757	26.8	12.6	6.7
1975	1.486	28.8	31.6	0.938	27.3	25.6	0.0
2016	1.769	25.8	24.8	1.349	33.3	25.0	-3.3
2076	0.700	28.0	12.8	2.436	33.5	31.4	-1.7
Mean	1.222	28.8	23.9	1.323	29.5	24.0	-1.0
S.D.	0.414	2.9	6.8	0.660	3.5	6.9	4.9

Probe Frequency 1.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
1933	1.768	46.9	21.8	2.851	44.0	21.3	0.0
1961	1.216	45.8	16.8	1.315	42.0	16.8	3.3
1975	1.837	48.6	27.4	1.315	47.4	16.8	3.3
2016	2.476	47.4	31.9	3.591	53.6	26.3	0.0
2076	2.557	46.1	21.3	1.551	32.4	16.8	-10.0
Mean	1.971	47.0	23.8	2.125	43.9	19.6	-0.7
S.D.	0.554	1.1	5.9	1.039	7.8	4.2	5.5

Probe Frequency 2.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
1933	1.238	44.0	23.9	8.309	40.1	0.0	3.3
1961	4.568	36.3	38.1	1.418	43.8	31.0	-1.7
1975	4.568	57.4	46.1	*****	*****	*****	-1.7
2016	2.772	50.4	14.2	4.568	32.4	38.1	-3.3
2076	2.608	50.8	31.0	3.418	70.0	14.2	-5.0
Mean	3.150	47.8	30.7	4.428	46.6	20.8	-1.7
S.D.	1.424	8.0	12.4	2.896	16.3	17.1	3.1

155 dB 1X

INDIVIDUAL TUNING CURVE STATISTICS

Probe Frequency 4.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	PTS
1933	4.100	72.8	33.3	4.100	91.9	44.4	-3.3
1961	2.469	52.6	22.1	4.100	66.3	33.3	0.0
1975	6.768	112.6	66.6	3.489	114.1	44.3	1.7
2016	4.420	48.2	55.3	3.129	52.5	55.5	10.0
2076	2.469	41.9	22.2	1.636	46.7	33.1	-1.7
Mean	4.045	65.6	39.9	3.291	74.3	42.1	1.3
S.D.	1.770	28.7	20.1	1.014	28.3	9.3	5.2

Probe Frequency 8.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	PTS
1933	4.305	83.1	43.7	2.819	48.2	33.0	5.0
1961	3.941	71.5	33.0	1.704	51.9	33.6	-8.3
1975	1.664	68.7	11.8	2.717	70.4	22.4	3.3
2016	5.286	76.1	43.1	7.799	94.6	75.5	-5.0
2076	1.588	60.5	21.8	5.192	86.9	54.9	-13.3
Mean	3.357	72.0	30.7	4.046	70.4	43.9	-3.7
S.D.	1.655	8.4	13.8	2.457	20.6	21.3	7.8

Probe Frequency 11.2 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	PTS
1933	0.960	86.5	0.0	*****	2.8	78.6	-1.7
1961	6.718	77.3	55.1	4.062	77.1	35.5	-1.7
1975	*****	*****	*****	0.871	71.6	0.0	6.7
2016	2.091	60.0	35.5	*****	*****	*****	-3.3
2076	5.238	62.5	0.0	11.496	105.2	95.1	-11.7
Mean	3.751	71.6	22.6	5.477	64.2	52.3	-2.3
S.D.	2.681	12.5	27.3	5.452	43.5	43.0	6.5

155 dB 10X 10/M

INDIVIDUAL TUNING CURVE STATISTICS

Probe Frequency 0.5 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
1534	0.885	23.2	18.8	0.947	24.7	25.2	0.0
1700	3.182	31.1	25.0	2.080	32.8	25.2	-3.3
1716	0.724	24.1	12.5	1.769	25.2	31.2	10.0
1718	*****	11.0	18.8	1.235	24.1	0.0	8.3
1759	1.559	28.3	31.4	1.030	24.0	0.0	11.7
Mean	1.612	23.5	21.3	1.412	26.1	16.3	5.3
S.D.	1.123	7.7	7.2	0.492	3.8	15.1	6.6

Probe Frequency 1.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
1534	1.607	57.9	21.8	1.929	58.9	26.9	-1.7
1700	*****	*****	*****	1.205	46.2	11.2	-5.0
1716	1.689	49.5	21.3	1.121	30.0	11.2	15.0
1718	1.768	38.2	21.8	1.589	37.0	10.6	16.7
1759	1.445	47.4	16.2	1.032	19.9	5.6	21.7
Mean	1.627	48.3	20.3	1.375	38.4	13.1	9.3
S.D.	0.138	8.1	2.7	0.375	15.0	8.0	11.9

Probe Frequency 2.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
1534	3.199	73.5	22.1	4.100	77.6	22.1	3.3
1700	4.015	68.5	20.4	4.100	68.9	22.1	-3.3
1716	2.039	64.2	22.1	2.121	64.7	37.2	5.0
1718	6.041	38.5	29.2	9.200	71.4	26.5	3.3
1759	5.247	55.2	50.5	8.309	43.8	19.5	10.8
Mean	4.108	60.0	28.9	5.566	65.3	25.5	3.8
S.D.	1.593	13.7	12.5	3.037	12.9	7.0	5.1

155 dB 10X 10/M

INDIVIDUAL TUNING CURVE STATISTICS

Probe Frequency 4.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
1534	3.951	66.7	44.3	3.226	114.6	44.3	0.0
1700	4.754	92.5	44.4	3.489	116.8	44.3	8.3
1716	2.733	103.4	22.2	3.654	98.1	33.2	11.7
1718	3.255	70.4	33.2	2.733	101.0	22.2	3.3
1759	2.733	72.6	22.2	3.654	100.5	33.2	7.1
Mean	3.485	81.1	33.3	3.351	106.2	35.4	6.1
S.D.	0.867	16.0	11.1	0.387	8.8	9.2	4.5

Probe Frequency 8.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
1534	1.850	37.2	45.4	3.014	97.8	44.2	0.0
1700	2.914	44.0	22.4	1.343	28.2	10.6	5.0
1716	*****	12.5	11.2	1.356	59.0	0.0	13.3
1718	1.870	50.2	11.8	1.281	63.0	1.1	6.7
1759	5.993	56.1	31.3	2.652	67.6	33.6	0.8
Mean	3.157	40.0	24.4	1.929	63.1	17.9	5.2
S.D.	1.955	16.9	14.4	0.835	24.8	20.0	5.3

Probe Frequency 11.2 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
1534	8.681	102.5	49.8	2.431	125.1	24.9	3.3
1700	5.750	78.8	80.0	3.684	112.2	55.9	0.0
1716	*****	30.2	50.6	4.578	127.7	100.4	6.7
1718	3.405	88.0	45.3	2.025	82.1	40.8	6.7
1759	4.633	80.7	155.9	4.638	70.1	77.7	8.3
Mean	5.617	76.0	76.3	3.471	103.4	59.9	5.0
S.D.	2.256	27.3	46.5	1.205	26.0	29.9	3.3

155 dB 10X 1/M

INDIVIDUAL TUNING CURVE STATISTICS

Probe Frequency 0.5 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
1102	1.135	19.7	11.4	2.753	25.9	30.2	8.3
1271	1.340	18.9	3.9	1.229	32.0	16.5	5.0
1272	1.239	36.6	0.0	1.750	25.2	9.9	10.0
1280	2.058	49.5	22.7	1.120	30.5	18.6	-0.5
1293	2.051	25.8	19.0	1.284	24.5	6.2	24.7
Mean	1.565	30.1	11.4	1.627	27.6	16.3	9.5
S.D.	0.453	13.0	9.6	0.674	3.4	9.2	9.4

Probe Frequency 1.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
1102	1.959	43.1	25.3	2.011	38.8	20.8	8.3
1271	0.900	26.3	2.1	1.643	41.0	18.4	0.0
1272	0.657	14.4	7.2	1.520	26.4	12.8	28.3
1280	*****	22.7	7.2	2.557	55.1	26.9	0.8
1293	1.649	41.1	16.2	2.557	0.0	15.7	26.7
Mean	1.291	29.5	11.6	2.058	32.2	18.9	12.8
S.D.	0.613	12.3	9.2	0.490	20.7	5.4	13.8

Probe Frequency 2.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
1102	3.450	29.7	27.6	4.885	26.2	26.7	15.0
1271	2.886	38.0	31.7	6.246	57.0	27.3	-1.7
1272	1.298	176.7	6.9	2.564	31.7	23.8	21.7
1280	5.421	57.6	44.1	6.153	45.2	28.3	-6.5
1293	7.981	43.3	36.3	5.727	12.0	16.8	24.0
Mean	4.207	69.0	29.3	5.115	34.4	24.6	10.5
S.D.	2.574	61.0	13.9	1.524	17.4	4.7	13.8

155 dB 10X 1/M

INDIVIDUAL TUNING CURVE STATISTICS

Probe Frequency 4.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
1102	5.118	86.1	68.9	4.828	76.2	57.6	5.0
1271	1.291	27.1	0.0	2.133	64.0	11.0	17.9
1272	0.998	32.3	0.0	1.265	23.5	0.0	3.3
1280	2.612	99.0	33.1	3.532	80.7	55.4	5.2
1293	4.754	116.0	55.4	2.733	32.3	33.3	17.3
Mean	2.955	72.1	31.5	2.898	55.3	31.5	9.8
S.D.	1.912	40.2	31.4	1.361	26.0	25.8	7.2

Probe Frequency 8.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
1102	*****	86.7	*****	5.668	70.0	27.7	11.7
1271	1.271	43.2	0.0	1.889	59.3	5.8	15.4
1272	2.184	50.9	17.6	3.921	52.4	39.4	3.3
1280	1.759	80.3	6.4	1.851	78.0	0.0	-2.8
1293	2.938	86.9	21.3	3.522	53.8	10.1	-3.0
Mean	2.038	69.6	11.3	3.370	62.7	16.6	4.9
S.D.	0.706	20.9	9.8	1.589	11.0	16.4	8.4

Probe Frequency 11.2 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
1102	3.226	93.2	43.2	2.218	75.7	3.2	1.7
1271	10.504	95.9	35.5	*****	11.6	0.0	-1.7
1272	16.843	127.6	55.8	3.925	52.3	56.6	10.0
1280	9.012	100.5	60.4	*****	68.1	5.7	-5.0
1293	*****	82.6	*****	8.399	85.2	44.9	3.3
Mean	9.896	99.9	48.7	4.847	58.6	22.1	1.7
S.D.	5.595	16.8	11.4	3.192	28.9	26.6	5.7

155 dB 10X 1/10M

INDIVIDUAL TUNING CURVE STATISTICS

Probe Frequency 0.5 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	PTS
1925	3.327	31.7	37.4	1.659	32.9	18.6	-3.3
1931	1.189	24.6	25.2	1.659	28.9	31.4	-5.0
1948	1.407	36.5	6.2	0.979	30.6	6.4	3.3
1967	1.659	20.0	18.6	3.182	37.6	25.0	-12.0
1974	1.289	34.2	18.8	1.059	26.9	19.0	1.7
Mean	1.774	29.4	21.2	1.708	31.4	20.1	-3.1
S.D.	0.886	6.9	11.4	0.884	4.1	9.3	6.1

Probe Frequency 1.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	PTS
1925	1.266	62.5	5.6	1.125	59.3	5.0	6.7
1931	2.100	38.2	21.3	1.689	47.4	15.7	1.7
1948	2.557	47.8	4.5	2.557	62.8	21.3	5.0
1967	*****	16.2	5.6	1.548	62.5	16.2	-10.3
1974	1.094	56.1	5.0	1.230	50.6	11.2	6.7
Mean	1.754	44.2	8.4	1.630	56.5	13.9	1.9
S.D.	0.692	18.1	7.2	0.567	7.1	6.1	7.2

Probe Frequency 2.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	PTS
1925	7.269	58.6	44.3	1.139	31.6	0.0	11.7
1931	3.610	54.8	13.3	6.153	49.9	4.4	-1.7
1948	6.041	68.6	29.2	1.970	74.5	15.1	-1.7
1967	8.309	77.4	43.4	7.269	78.6	20.4	-3.7
1974	*****	*****	35.4	10.970	50.3	11.5	12.3
Mean	6.307	64.9	33.1	5.500	57.0	10.3	3.6
S.D.	2.023	10.2	12.7	4.030	19.4	8.2	8.2

155 dB 10X 1/10M

INDIVIDUAL TUNING CURVE STATISTICS

Probe Frequency 4.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
1925	2.531	110.5	22.1	3.654	49.3	44.2	-3.3
1931	4.406	78.3	44.5	2.972	80.8	33.2	-1.7
1948	5.059	100.2	44.5	3.489	106.9	44.3	-1.7
1967	1.896	81.7	10.9	3.255	98.5	33.2	-3.7
1974	2.352	77.8	22.1	3.255	102.7	33.2	1.7
Mean	3.249	89.7	28.8	3.325	87.6	37.6	-1.7
S.D.	1.393	14.8	15.0	0.260	23.6	6.0	2.1

Probe Frequency 8.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
1925	4.305	80.2	32.5	1.607	64.7	0.0	3.3
1931	0.840	42.8	0.0	*****	*****	*****	-1.0
1948	2.717	55.7	23.0	1.147	31.3	11.2	-1.7
1967	3.236	89.6	35.6	1.674	70.8	10.6	1.3
1974	*****	25.1	0.0	3.522	70.3	10.1	-1.2
Mean	2.774	58.7	18.2	1.987	59.3	8.0	0.1
S.D.	1.449	26.5	17.3	1.049	18.9	5.3	2.1

Probe Frequency 11.2 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
1925	3.567	71.4	17.4	0.862	56.2	0.0	-5.0
1931	3.748	106.9	47.6	*****	*****	*****	-0.4
1948	2.852	85.9	40.0	1.486	70.6	9.8	0.0
1967	*****	81.0	0.0	3.603	97.2	52.8	9.7
1974	3.144	86.4	30.2	2.730	98.9	9.8	-1.7
Mean	3.328	86.3	27.0	2.170	80.7	18.1	0.5
S.D.	0.405	13.0	18.9	1.231	20.9	23.6	5.5

155 dB 100X 10/M

INDIVIDUAL TUNING CURVE STATISTICS

Probe Frequency 0.5 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
1880	1.129	31.2	31.6	0.867	5.9	0.0	33.3
1922	1.486	23.1	25.2	1.607	26.1	31.6	-10.0
1927	1.089	33.3	25.2	0.382	13.4	19.2	16.7
1945	1.059	22.9	19.0	0.403	9.4	18.8	0.0
1949	1.987	35.0	37.8	1.253	10.1	12.6	36.7
1953	1.478	25.7	19.0	0.865	15.1	12.8	15.0
Mean	1.371	28.5	26.3	0.896	13.3	15.8	15.3
S.D.	0.358	5.3	7.3	0.478	7.0	10.4	18.2

Probe Frequency 1.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
1880	1.008	42.4	2.3	6.233	23.9	35.8	48.3
1922	2.241	48.2	33.0	1.551	41.1	16.8	3.3
1927	1.406	50.6	17.4	2.557	41.4	15.7	3.3
1945	1.837	38.2	32.5	1.213	39.9	28.0	1.7
1949	2.100	58.1	32.5	*****	0.0	0.0	43.3
1953	2.241	48.2	33.0	1.205	21.6	11.2	31.7
Mean	1.806	47.6	25.1	2.552	28.0	17.9	21.9
S.D.	0.503	6.9	12.8	2.131	16.3	12.6	21.7

Probe Frequency 2.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
1880	1.787	43.6	23.9	*****	0.0	0.0	41.7
1922	1.226	37.7	31.9	4.100	18.9	30.1	1.7
1927	0.870	43.8	0.0	5.249	51.2	29.2	3.3
1945	0.976	48.0	0.9	2.278	55.4	15.1	5.0
1949	2.173	51.3	54.9	2.278	5.6	16.0	40.0
1953	1.577	55.0	22.1	*****	0.0	0.0	35.0
Mean	1.435	46.5	22.3	3.476	21.8	15.1	21.1
S.D.	0.502	6.2	20.6	1.461	25.4	13.3	19.6

155 dB 100X 10/M

INDIVIDUAL TUNING CURVE STATISTICS

Probe Frequency 4.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	PTS
1880	4.754	84.0	33.3	*****	3.1	0.0	41.7
1922	5.059	70.4	77.6	6.768	50.5	66.6	-8.0
1927	3.489	94.3	44.3	*****	*****	22.1	-11.7
1945	3.255	102.6	44.2	2.966	78.7	33.0	-1.7
1949	4.100	92.1	44.4	4.754	64.2	33.3	23.3
1953	3.489	102.6	44.3	5.622	124.4	99.6	5.0
Mean	4.024	91.0	48.0	5.028	64.2	42.4	8.1
S.D.	0.745	12.3	15.1	1.603	44.0	35.3	20.6

Probe Frequency 8.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	PTS
1880	5.286	90.9	76.7	*****	*****	0.0	56.7
1922	5.192	101.9	66.1	3.500	67.1	33.6	8.3
1927	1.562	57.3	11.2	2.750	83.8	43.7	-8.3
1945	1.074	53.5	0.0	1.607	52.0	0.0	5.0
1949	4.305	59.1	32.5	1.494	51.4	22.4	13.3
1953	0.969	20.8	11.8	1.484	62.5	1.1	11.7
Mean	3.065	63.9	33.0	2.167	63.4	16.8	14.4
S.D.	2.079	29.0	31.7	0.915	13.3	19.2	22.1

Probe Frequency 11.2 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	PTS
1880	2.664	73.6	61.2	*****	0.0	0.0	66.7
1922	6.221	122.5	75.5	5.750	107.5	80.0	8.3
1927	5.750	74.0	19.6	1.743	59.9	0.0	3.3
1945	4.241	87.5	55.1	3.405	65.5	45.3	-5.0
1949	1.602	57.5	0.0	1.150	37.2	15.1	6.7
1953	11.496	77.3	80.0	3.453	102.3	75.5	15.0
Mean	5.329	82.1	48.6	3.100	62.1	36.0	15.8
S.D.	3.498	22.0	32.0	1.795	40.4	36.4	25.8

155 dB 100X 1/M

INDIVIDUAL TUNING CURVE STATISTICS

Probe Frequency 0.5 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
1746	1.232	29.3	18.8	0.865	19.7	12.8	13.3
1826	1.486	29.3	31.6	0.536	17.7	19.2	23.3
1854	1.118	30.2	19.0	0.700	21.3	6.6	-1.7
1866	0.938	29.4	19.0	0.885	21.3	25.2	-1.7
1868	1.288	29.7	19.0	1.106	22.1	6.4	10.0
1887	0.980	31.2	19.2	1.345	25.5	25.4	8.3
Mean	1.174	29.9	21.1	0.906	21.2	15.9	8.6
S.D.	0.205	0.8	5.1	0.288	2.6	8.6	9.5

Probe Frequency 1.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
1746	1.588	45.8	22.9	1.400	19.5	11.2	26.7
1826	2.081	49.1	21.8	1.167	0.0	7.3	23.3
1854	1.837	49.0	27.4	*****	*****	*****	3.3
1866	1.649	37.4	22.4	2.081	44.9	21.8	1.7
1868	1.837	46.9	27.4	0.572	6.7	16.2	18.3
1887	2.081	50.7	21.8	1.400	15.8	11.2	26.7
Mean	1.846	46.5	24.0	1.324	17.4	13.5	16.7
S.D.	0.208	4.8	2.7	0.542	17.2	5.6	11.4

Probe Frequency 2.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
1746	1.454	38.9	39.0	*****	0.0	1.8	25.0
1826	1.577	41.1	0.0	0.604	8.2	0.0	20.0
1854	1.577	54.9	7.1	*****	*****	*****	5.0
1866	2.874	49.3	23.0	2.278	58.4	15.1	-5.0
1868	2.874	29.0	23.0	4.100	44.3	14.2	16.7
1887	1.262	24.6	14.2	2.278	18.4	15.1	16.7
Mean	1.936	39.6	17.7	2.315	25.8	9.2	13.1
S.D.	0.735	11.6	13.8	1.428	24.7	7.6	11.0

155 dB 100X 1/M

INDIVIDUAL TUNING CURVE STATISTICS

Probe Frequency 4.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
1746	2.728	56.8	33.1	2.886	84.8	33.2	20.0
1826	3.654	60.2	44.2	2.378	53.1	10.9	11.7
1854	3.654	107.3	33.2	*****	*****	*****	8.3
1866	3.404	66.7	33.1	2.175	84.8	10.9	-2.5
1868	4.100	141.5	55.4	4.754	107.1	55.4	-4.2
1887	3.255	68.0	33.2	3.951	112.0	44.3	14.2
Mean	3.466	83.4	38.7	3.229	88.4	31.0	7.9
S.D.	0.461	33.8	9.3	1.095	23.4	19.9	9.5

Probe Frequency 8.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
1746	4.305	49.5	54.9	1.064	32.1	12.3	10.0
1826	2.005	78.8	33.6	1.436	57.4	21.8	10.0
1854	3.596	59.0	33.0	*****	*****	*****	-5.0
1866	1.356	61.1	1.1	1.784	75.0	11.8	-16.7
1868	9.630	84.3	64.3	7.520	73.0	54.3	6.7
1887	2.377	35.0	55.4	2.582	70.0	33.0	20.0
Mean	3.878	61.3	40.4	2.877	61.5	26.7	4.2
S.D.	3.016	18.3	23.0	2.655	17.8	17.7	13.0

Probe Frequency 11.2 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
1746	2.300	77.8	15.1	1.774	53.7	0.0	8.3
1826	1.182	28.4	0.0	3.833	73.8	30.2	15.0
1854	3.256	107.2	40.0	*****	*****	*****	6.7
1866	4.384	83.2	4.5	1.328	98.6	9.8	-6.7
1868	11.496	109.2	34.7	1.643	26.9	35.5	-8.3
1887	6.718	110.3	90.6	5.609	129.6	40.0	5.0
Mean	4.889	86.0	30.8	2.838	76.5	23.1	3.3
S.D.	3.751	31.5	33.3	1.838	39.6	17.3	9.1

155 dB 100X 1/10M

INDIVIDUAL TUNING CURVE STATISTICS

Probe Frequency 0.5 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
1914	1.486	26.3	31.6	1.486	13.4	12.6	16.7
1917	0.980	30.6	19.2	1.138	33.2	19.0	6.7
1970	1.129	28.8	18.8	1.011	21.0	19.0	6.7
1999	1.265	31.1	31.4	0.694	18.0	6.4	25.0
2066	0.578	24.3	25.2	1.038	28.3	31.6	-3.3
Mean	1.088	28.2	25.2	1.073	22.8	17.7	10.3
S.D.	0.340	2.9	6.2	0.284	8.0	9.4	10.8

Probe Frequency 1.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
1914	1.275	41.2	22.4	3.056	20.2	15.7	28.3
1917	1.589	37.3	11.2	1.589	48.4	11.8	0.0
1970	2.464	41.9	33.0	1.551	48.2	16.8	10.0
1999	2.217	52.4	36.9	1.013	24.6	16.2	21.7
2066	3.136	46.9	26.3	1.877	56.9	26.9	-3.3
Mean	2.136	43.9	26.0	1.817	39.7	17.5	11.3
S.D.	0.734	5.8	10.0	0.759	16.2	5.6	13.6

Probe Frequency 2.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
1914	2.278	44.6	15.1	4.100	0.0	6.2	25.0
1917	0.823	30.2	0.9	4.100	60.7	14.2	-3.3
1970	1.418	36.8	31.0	6.153	52.8	28.3	8.3
1999	5.249	55.2	37.2	0.904	19.1	0.0	38.3
2066	4.568	37.7	30.1	0.976	56.0	0.0	-3.3
Mean	2.867	40.9	22.9	3.247	37.7	9.7	13.0
S.D.	1.949	9.5	14.7	2.266	26.7	11.9	18.3

155 dB 100X 1/10M

INDIVIDUAL TUNING CURVE STATISTICS

Probe Frequency 4.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	PTS
1914	3.165	71.2	22.1	*****	0.0	0.0	21.7
1917	4.221	132.7	44.5	3.951	88.1	44.3	0.8
1970	4.754	108.0	44.4	2.728	63.4	33.1	-5.8
1999	5.059	49.0	55.5	*****	6.6	11.1	75.8
2066	3.706	119.8	66.4	2.728	116.9	44.2	-1.7
Mean	4.181	96.2	46.6	3.136	55.0	26.5	18.2
S.D.	0.768	34.9	16.4	0.706	50.9	20.1	33.9

Probe Frequency 8.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	PTS
1914	3.570	37.3	44.2	2.717	82.8	22.4	5.0
1917	1.484	104.7	10.6	1.799	53.9	23.5	0.0
1970	2.382	58.9	23.0	0.794	49.5	0.0	10.0
1999	7.821	105.1	65.5	*****	9.1	0.0	70.0
2066	6.089	79.6	43.1	2.346	75.5	33.6	1.7
Mean	4.269	77.1	37.3	1.914	54.2	15.9	17.3
S.D.	2.633	29.4	21.2	0.836	28.8	15.2	29.7

Probe Frequency 11.2 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	PTS
1914	1.463	48.5	0.0	0.881	59.8	15.1	18.3
1917	5.981	102.1	85.3	1.385	91.3	0.0	8.3
1970	1.095	26.5	0.0	0.937	57.1	9.8	11.7
1999	4.527	115.1	40.0	*****	8.7	0.0	71.7
2066	13.836	118.2	110.2	6.581	100.2	80.8	-3.3
Mean	5.380	82.1	47.1	2.446	63.4	21.1	21.3
S.D.	5.155	41.9	49.8	2.766	36.0	34.0	29.2

160 dB 1X

INDIVIDUAL TUNING CURVE STATISTICS

Probe Frequency 0.5 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	PTS
1843	1.189	24.6	31.6	1.038	31.0	6.0	-11.7
1972	1.120	24.9	37.8	0.768	23.4	24.8	-2.5
1973	1.038	27.1	12.4	1.486	29.7	31.6	-4.6
2013	0.865	24.6	12.6	0.819	25.8	12.6	-1.7
2035	0.973	24.9	18.8	0.808	27.9	12.4	3.3
2057	0.885	19.8	25.2	1.011	21.0	19.0	-1.7
Mean	1.012	24.3	23.1	0.988	26.5	17.7	-3.1
S.D.	0.129	2.4	10.3	0.268	3.8	9.3	4.9

Probe Frequency 1.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	PTS
1843	1.717	26.1	28.0	1.284	61.6	17.4	-10.0
1972	1.535	44.5	21.8	1.385	45.3	16.2	1.7
1973	1.837	40.0	21.3	2.100	54.5	21.3	0.0
2013	1.918	56.1	16.2	1.607	52.3	21.8	-1.7
2035	1.578	57.8	21.8	1.918	41.5	16.2	3.3
2057	2.557	34.5	21.3	1.551	33.2	16.8	-3.3
Mean	1.857	43.2	21.7	1.641	48.1	18.3	-1.6
S.D.	0.373	12.3	3.7	0.313	10.2	2.6	4.7

Probe Frequency 2.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	PTS
1843	3.858	74.2	21.2	1.324	61.4	15.1	-3.3
1972	7.269	60.0	20.4	2.699	54.7	13.3	3.3
1973	5.249	49.9	21.2	5.249	30.4	5.3	-3.7
2013	6.153	32.2	20.4	7.269	66.7	4.4	5.0
2035	5.249	48.6	21.2	4.568	33.8	6.2	0.0
2057	2.278	8.9	15.1	5.249	49.8	21.2	-1.7
Mean	5.010	45.6	19.9	4.393	49.5	10.9	-0.1
S.D.	1.750	22.7	2.4	2.101	14.7	6.7	3.6

160 dB 1X

INDIVIDUAL TUNING CURVE STATISTICS

Probe Frequency 4.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
1843	7.138	104.7	66.7	10.074	99.4	77.8	3.3
1972	3.951	98.9	44.3	2.890	104.6	44.3	-1.7
1973	3.056	96.2	33.1	3.489	102.7	44.3	1.7
2013	2.585	66.8	11.1	3.009	79.3	22.2	6.7
2035	3.489	107.7	44.3	2.821	91.1	33.2	4.6
2057	2.733	87.8	22.2	2.123	67.9	11.0	-5.0
Mean	3.825	93.7	36.9	4.068	90.8	38.8	1.6
S.D.	1.699	14.9	19.4	2.975	14.6	23.1	4.3

Probe Frequency 8.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
1843	3.124	66.2	55.4	1.472	38.8	21.8	-1.7
1972	3.001	63.7	43.7	2.376	69.4	33.0	13.3
1973	1.356	44.4	0.0	2.177	60.3	11.2	9.2
2013	1.064	34.2	0.0	2.058	81.0	21.8	5.0
2035	*****	25.1	31.9	2.914	70.4	21.8	6.7
2057	1.425	46.6	10.6	3.322	65.9	0.0	-8.3
Mean	1.994	46.7	23.6	2.387	64.3	18.3	4.0
S.D.	0.986	16.1	23.5	0.655	14.2	11.3	7.8

Probe Frequency 11.2 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
1843	4.241	104.8	55.1	3.771	104.8	80.8	0.0
1972	2.848	74.7	70.2	0.940	52.1	1.2	12.5
1973	3.857	44.2	49.8	1.533	101.2	0.0	8.7
2013	13.756	100.6	44.5	4.389	104.9	45.3	0.0
2035	4.011	94.0	45.3	11.497	109.8	64.9	3.3
2057	4.019	89.2	50.6	4.011	85.6	71.0	-5.0
Mean	5.455	84.6	52.6	4.357	93.1	43.9	3.3
S.D.	4.096	22.4	9.4	3.771	21.7	35.5	6.4

160 dB 10X 10/M

INDIVIDUAL TUNING CURVE STATISTICS

Probe Frequency 0.5 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
0515	0.885	23.2	18.8	0.801	28.1	12.8	-1.7
0517	2.080	42.4	25.2	1.306	25.7	12.6	-5.0
0518	1.288	24.9	19.0	1.465	25.0	6.4	5.0
0522	2.436	29.1	25.0	1.465	47.1	6.4	13.3
0523	1.486	26.9	25.2	1.249	42.0	6.4	16.7
Mean	1.635	29.3	22.6	1.257	33.6	8.9	5.7
S.D.	0.621	7.7	3.4	0.272	10.3	3.4	9.3

Probe Frequency 1.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
0515	2.476	46.2	26.3	1.906	67.1	26.9	1.7
0517	3.570	55.7	36.9	3.136	70.5	37.5	5.0
0518	2.081	45.3	21.8	1.546	39.5	33.0	1.7
0522	1.649	36.1	16.2	0.853	12.2	5.0	35.0
0523	3.570	39.4	31.3	*****	16.2	15.7	36.7
Mean	2.669	44.5	26.5	1.860	41.1	23.6	16.0
S.D.	0.873	7.5	8.1	0.956	27.4	13.2	18.2

Probe Frequency 2.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
0515	1.414	37.2	0.0	*****	*****	*****	1.7
0517	1.135	51.2	7.1	2.039	48.7	22.1	5.0
0518	4.015	41.8	20.4	4.100	51.6	70.0	1.7
0522	2.021	56.3	31.0	*****	19.3	0.0	23.3
0523	1.332	53.1	7.1	*****	0.0	0.0	35.0
Mean	1.983	47.9	13.1	3.070	29.9	23.0	13.3
S.D.	1.183	8.1	12.4	1.457	24.7	33.0	15.1

160 dB 10X 10/M

INDIVIDUAL TUNING CURVE STATISTICS

Probe Frequency 4.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
0515	2.733	62.4	33.3	4.100	94.3	55.4	11.7
0517	4.100	81.1	66.5	6.768	106.0	110.7	1.7
0518	5.059	90.2	55.5	2.422	56.2	55.4	8.3
0522	2.890	67.4	44.3	2.583	79.4	33.2	18.3
0523	3.532	67.5	55.4	2.819	63.2	33.4	23.3
Mean	3.663	73.7	51.0	3.739	79.8	57.7	12.7
S.D.	0.951	11.5	12.6	1.818	20.8	31.7	8.5

Probe Frequency 8.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
0515	3.159	80.9	10.1	2.857	70.6	32.5	6.7
0517	2.382	72.9	21.8	4.152	93.4	31.9	5.0
0518	2.929	73.3	31.9	2.465	73.7	32.5	5.0
0522	0.868	80.6	0.0	2.857	89.7	21.3	3.3
0523	5.993	75.9	31.3	3.522	71.0	0.0	25.0
Mean	3.066	76.7	19.0	3.171	79.7	23.6	9.0
S.D.	1.864	3.8	13.8	0.667	11.0	14.0	9.0

Probe Frequency 11.2 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
0515	3.835	83.9	55.1	*****	*****	*****	3.3
0517	3.083	98.0	65.7	3.413	132.6	80.8	3.3
0518	13.755	102.2	74.7	4.527	81.6	80.8	-1.7
0522	15.385	94.5	95.1	4.843	114.6	60.4	1.7
0523	2.356	100.1	24.9	*****	0.0	0.0	31.7
Mean	7.683	95.7	63.1	4.261	82.2	55.5	7.7
S.D.	6.335	7.2	25.9	0.751	58.7	38.2	13.6

160 dB 10X 1/M

INDIVIDUAL TUNING CURVE STATISTICS

Probe Frequency 0.5 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	PTS
1714	1.264	33.6	25.2	0.808	22.3	25.2	1.7
1764	0.890	31.8	12.6	1.478	29.5	19.0	15.0
1776	1.072	33.8	31.4	0.602	22.2	18.6	5.0
1778	0.660	20.1	0.0	0.885	24.4	18.8	8.3
1779	0.910	31.0	25.4	0.746	25.0	19.0	5.0
1785	1.120	15.8	25.0	0.829	30.2	12.4	11.7
Mean	0.986	27.7	19.9	0.892	25.6	18.8	7.8
S.D.	0.212	7.8	11.5	0.303	3.5	4.0	4.9

Probe Frequency 1.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	PTS
1714	2.557	57.4	32.5	1.482	57.8	16.2	-3.3
1764	1.717	40.7	28.0	1.121	19.9	11.2	30.0
1776	1.418	48.7	16.2	1.529	53.3	21.3	6.7
1778	1.649	46.1	16.2	1.336	36.6	17.4	1.7
1779	1.433	52.0	28.0	1.837	43.2	27.4	3.3
1785	1.918	46.1	16.2	1.275	36.6	22.4	5.0
Mean	1.782	48.5	22.8	1.430	41.2	19.3	7.2
S.D.	0.423	5.7	7.4	0.248	13.6	5.6	11.7

Probe Frequency 2.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	PTS
1714	2.077	61.4	15.1	3.026	49.5	14.2	-1.7
1764	1.487	42.5	7.1	*****	0.0	0.0	27.5
1776	6.881	52.7	67.3	2.593	64.4	14.2	3.3
1778	5.249	54.9	13.3	1.577	50.4	6.2	3.3
1779	1.228	51.3	8.0	5.016	69.4	38.1	0.0
1785	7.269	39.4	52.3	2.359	38.7	14.2	0.0
Mean	4.032	50.4	27.2	2.914	45.4	14.5	5.4
S.D.	2.766	8.1	25.9	1.287	24.8	12.9	11.0

160 dB 10X 1/M

INDIVIDUAL TUNING CURVE STATISTICS

Probe Frequency 4.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
1714	3.621	98.4	55.3	8.083	116.7	88.8	5.0
1764	3.489	91.9	44.3	3.951	77.4	44.3	6.7
1776	4.100	123.4	44.4	5.059	105.0	44.5	5.0
1778	2.733	91.8	22.1	3.404	98.9	33.1	1.7
1779	4.754	94.8	44.4	2.980	79.1	55.3	1.7
1785	3.056	106.8	33.1	5.155	100.2	43.8	0.0
Mean	3.625	101.2	40.6	4.772	96.2	51.6	3.3
S.D.	0.726	12.2	11.5	1.841	15.3	19.5	2.6

Probe Frequency 8.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
1714	1.484	66.7	0.6	2.652	74.0	33.6	8.3
1764	3.522	68.7	32.5	3.073	86.3	33.6	6.2
1776	4.152	68.5	31.9	2.002	80.1	23.0	3.3
1778	1.189	34.8	0.0	1.499	70.2	10.6	6.7
1779	2.382	82.0	21.8	2.582	59.8	33.0	-5.0
1785	3.522	87.1	32.5	3.045	70.8	21.8	0.0
Mean	2.708	68.0	19.9	2.476	73.5	25.9	3.3
S.D.	1.210	18.3	15.7	0.617	9.1	9.3	5.0

Probe Frequency 11.2 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
1714	4.247	90.5	60.4	3.446	96.4	40.0	5.0
1764	6.265	99.4	59.6	4.527	72.9	40.0	3.3
1776	5.750	87.3	80.0	3.541	125.9	65.7	1.7
1778	2.300	89.8	9.8	3.295	90.3	30.2	10.0
1779	4.527	98.4	40.0	2.638	88.6	30.2	-5.0
1785	2.875	60.4	30.2	4.241	123.3	55.1	8.3
Mean	4.327	87.6	46.7	3.615	99.6	43.5	3.9
S.D.	1.552	14.2	25.1	0.681	20.9	14.2	5.3

160 dB 10X 1/10M

INDIVIDUAL TUNING CURVE STATISTICS

Probe Frequency 0.5 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
0445	1.744	26.9	25.2	2.600	20.4	25.2	3.3
0492	1.553	20.0	25.4	1.117	43.4	25.4	-5.0
0503	1.713	23.2	19.0	1.086	17.5	6.4	-3.3
0506	1.232	29.2	25.2	1.010	27.1	0.0	8.3
0508	2.051	25.6	19.0	1.093	28.7	19.0	-3.3
Mean	1.658	25.0	22.7	1.381	27.4	15.2	0.0
S.D.	0.299	3.5	3.4	0.683	10.1	11.5	5.7

Probe Frequency 1.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
0445	1.719	34.9	20.7	1.274	34.1	20.7	11.7
0492	1.529	31.2	21.3	4.170	75.7	31.3	-1.7
0503	1.167	41.6	21.3	1.649	27.0	22.4	-1.7
0506	1.924	47.4	31.9	2.557	28.1	15.7	25.0
0508	2.100	58.3	38.0	3.905	40.9	36.4	0.0
Mean	1.688	42.7	26.6	2.711	41.2	25.3	6.7
S.D.	0.362	10.7	7.9	1.301	20.1	8.4	11.7

Probe Frequency 2.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
0445	4.100	34.6	38.1	3.610	49.5	13.3	10.0
0492	4.015	45.2	20.4	3.324	64.7	6.2	11.7
0503	2.772	61.6	22.1	3.610	50.3	29.2	6.7
0506	2.288	53.9	21.2	*****	0.0	6.2	30.0
0508	1.093	49.7	0.0	1.799	54.6	15.1	0.0
Mean	2.854	49.0	20.4	3.086	43.8	14.0	11.7
S.D.	1.258	10.1	13.5	0.868	25.2	9.4	11.2

160 dB 10X 1/10M

INDIVIDUAL TUNING CURVE STATISTICS

Probe Frequency 4.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
0445	6.093	94.6	88.7	3.297	84.8	66.5	3.3
0492	5.059	117.9	77.6	2.399	102.9	55.2	-3.3
0503	2.586	116.9	33.1	4.100	89.3	33.3	-1.7
0506	4.292	74.0	66.7	2.111	30.6	66.7	13.3
0508	4.221	90.7	44.5	3.069	90.7	66.3	0.0
Mean	4.450	98.8	62.1	2.995	79.7	57.6	2.3
S.D.	1.286	18.6	23.0	0.783	28.2	14.4	6.6

Probe Frequency 8.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
0445	1.425	61.4	12.3	4.305	82.8	21.3	3.3
0492	3.014	73.7	44.2	2.695	82.6	44.2	-3.3
0503	1.540	83.0	11.2	1.922	71.4	21.8	-3.3
0506	2.382	80.1	21.8	1.176	57.8	10.6	0.0
0508	6.089	125.3	20.7	5.286	57.1	31.9	-3.3
Mean	2.890	84.7	22.1	3.077	70.3	26.0	-1.3
S.D.	1.902	24.2	13.3	1.694	12.6	12.7	3.0

Probe Frequency 11.2 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
0445	2.272	79.4	25.7	2.493	72.8	55.9	1.7
0492	3.497	96.7	60.4	5.648	151.4	90.6	-3.3
0503	3.833	95.7	35.5	2.682	91.0	30.2	-5.0
0506	2.695	89.4	50.6	5.750	87.3	64.9	0.0
0508	6.562	93.6	54.3	3.043	40.5	60.4	-1.7
Mean	3.772	91.0	45.3	3.923	88.6	60.4	-1.7
S.D.	1.679	7.0	14.3	1.633	40.4	21.6	2.6

160 dB 100X 10/M

INDIVIDUAL TUNING CURVE STATISTICS

Probe Frequency 0.5 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
0521	1.486	26.7	25.2	1.218	5.7	6.6	25.0
0537	2.080	24.7	25.2	1.486	27.4	12.8	30.0
0542	*****	*****	*****	*****	44.0	6.2	41.7
0543	1.288	37.6	19.0	0.946	14.7	6.2	15.0
0544	1.659	22.9	31.4	0.946	9.8	6.2	25.0
Mean	1.628	28.0	25.2	1.149	20.3	7.6	27.3
S.D.	0.337	6.6	5.1	0.259	15.5	2.9	9.7

Probe Frequency 1.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
0521	2.042	37.4	31.9	2.476	32.5	15.1	36.7
0537	5.201	38.5	47.6	1.250	36.6	10.6	36.7
0542	*****	*****	*****	*****	5.4	*****	48.3
0543	3.570	58.6	42.5	3.570	52.2	31.3	1.7
0544	1.924	56.6	37.5	*****	0.0	17.4	40.0
Mean	3.184	47.8	39.9	2.432	25.3	18.6	32.7
S.D.	1.540	11.4	6.7	1.161	22.0	8.9	18.0

Probe Frequency 2.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
0521	3.610	53.0	29.2	4.100	13.3	6.2	28.3
0537	5.249	63.4	29.2	*****	0.0	0.0	48.3
0542	*****	*****	*****	*****	*****	*****	50.0
0543	2.593	43.1	22.1	2.772	63.2	14.2	-1.7
0544	2.359	35.5	30.1	*****	13.1	0.0	43.3
Mean	3.453	48.8	27.7	3.436	22.4	5.1	33.7
S.D.	1.315	12.1	3.7	0.939	27.9	6.7	21.5

160 dB 100X 10/M

INDIVIDUAL TUNING CURVE STATISTICS

Probe Frequency 4.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
0521	4.100	98.5	77.5	1.629	36.7	33.2	35.0
0537	6.093	75.0	99.7	2.512	64.1	55.3	18.3
0542	*****	*****	*****	0.827	19.9	0.0	46.7
0543	4.100	70.4	55.4	3.621	72.9	55.3	3.3
0544	2.581	76.5	77.4	*****	0.0	10.9	30.0
Mean	4.218	80.1	77.5	2.147	38.7	31.0	26.7
S.D.	1.440	12.5	18.1	1.199	30.3	25.3	16.5

Probe Frequency 8.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
0521	7.799	66.9	41.9	*****	13.1	0.0	40.0
0537	6.528	149.3	41.9	5.286	149.3	20.7	-0.8
0542	*****	*****	*****	*****	*****	0.0	45.0
0543	4.881	110.0	75.5	3.258	69.9	31.9	1.7
0544	4.164	124.3	42.5	4.058	92.5	8.9	18.3
Mean	5.843	112.7	50.5	4.201	81.2	12.3	20.8
S.D.	1.637	34.5	16.7	1.021	56.4	13.9	21.2

Probe Frequency 11.2 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
0521	8.399	121.2	70.2	5.750	60.4	19.6	26.7
0537	3.824	149.9	75.5	3.144	140.9	24.9	10.0
0542	*****	*****	*****	*****	0.0	*****	40.0
0543	1.840	71.1	20.4	1.929	73.2	15.1	1.7
0544	1.533	67.1	20.4	2.980	93.7	45.3	-1.7
Mean	3.899	102.4	46.6	3.451	73.6	26.2	15.3
S.D.	3.167	40.2	30.4	1.625	51.3	13.3	17.6

160 dB 100X 1/M

INDIVIDUAL TUNING CURVE STATISTICS

Probe Frequency 0.5 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
1698	2.193	23.9	31.6	0.805	17.7	12.2	8.3
1775	1.486	22.4	25.2	1.129	26.0	25.2	6.7
1782	2.316	19.2	31.6	0.980	22.7	19.2	6.7
1787	*****	*****	*****	0.820	25.0	25.5	18.3
1817	1.286	34.5	24.8	0.944	28.4	31.4	0.0
Mean	1.820	25.0	28.3	0.936	23.9	22.7	8.0
S.D.	0.511	6.6	3.8	0.132	4.1	7.3	6.6

Probe Frequency 1.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
1698	1.205	40.7	11.2	0.958	55.4	17.4	3.3
1775	1.837	37.4	27.4	2.100	47.7	32.5	3.3
1782	1.551	34.9	16.8	1.400	19.9	11.8	25.0
1787	1.877	65.0	26.9	1.385	41.1	16.2	16.3
1817	1.443	58.9	16.8	1.417	43.8	21.8	1.7
Mean	1.583	47.4	19.8	1.452	41.6	19.9	9.9
S.D.	0.280	13.6	7.1	0.410	13.3	7.9	10.3

Probe Frequency 2.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
1698	2.874	51.9	31.9	1.530	33.6	7.1	23.3
1775	4.568	56.7	22.1	1.642	51.9	8.0	3.3
1782	4.100	34.4	22.1	0.677	27.5	8.0	20.0
1787	2.593	48.6	14.2	3.097	76.3	61.1	13.2
1817	*****	16.1	*****	1.568	46.8	5.7	5.0
Mean	3.533	41.6	22.6	1.703	47.2	18.0	13.0
S.D.	0.951	16.5	7.3	0.873	19.0	24.1	8.8

160 dB 100X 1/M

INDIVIDUAL TUNING CURVE STATISTICS

Probe Frequency 4.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
1698	2.728	65.8	33.2	4.232	94.9	66.4	18.3
1775	3.951	97.1	44.3	4.754	77.6	44.4	11.7
1782	3.069	80.7	44.3	2.733	38.1	22.1	10.0
1787	6.768	72.4	66.6	4.754	127.9	44.4	13.7
1817	3.489	35.6	44.3	3.654	111.3	33.2	6.7
Mean	4.001	70.3	46.5	4.025	90.0	42.1	12.1
S.D.	1.613	22.7	12.2	0.853	34.5	16.4	4.3

Probe Frequency 8.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
1698	3.725	68.3	55.4	2.624	62.0	44.2	26.7
1775	2.382	78.2	23.0	2.132	63.7	22.4	-5.0
1782	3.827	58.8	66.6	4.152	56.9	54.3	5.0
1787	6.687	125.4	43.1	4.305	59.3	10.1	27.0
1817	3.735	96.5	76.1	1.227	63.7	0.0	8.3
Mean	4.071	85.5	52.8	2.888	61.1	26.2	12.4
S.D.	1.580	26.4	20.8	1.323	3.0	22.8	14.1

Probe Frequency 11.2 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
1698	2.134	91.5	10.6	3.833	55.9	30.2	31.7
1775	1.917	86.7	25.7	7.475	80.8	70.2	3.3
1782	2.440	88.6	5.3	3.089	45.6	15.1	13.3
1787	*****	11.2	45.3	5.936	116.4	105.7	26.7
1817	4.213	97.8	155.9	17.245	27.2	67.2	-1.7
Mean	2.676	75.2	48.5	7.515	65.2	57.7	14.7
S.D.	1.047	36.0	62.0	5.708	34.5	35.8	14.4

160 dB 100X 1/10M

INDIVIDUAL TUNING CURVE STATISTICS

Probe Frequency 0.5 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
0546	0.416	10.8	12.6	2.436	0.0	5.8	38.3
0547	0.811	15.5	19.0	*****	9.0	6.2	35.0
0548	1.289	36.1	18.8	1.486	47.2	18.8	3.3
0549	1.253	21.1	12.6	1.066	18.8	6.2	6.7
0550	1.156	22.1	12.6	0.660	19.9	6.6	10.4
Mean	0.985	21.1	15.1	1.412	19.0	8.7	18.7
S.D.	0.370	9.5	3.4	0.761	17.7	5.6	16.6

Probe Frequency 1.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
0546	1.719	42.4	26.3	1.013	17.4	16.2	40.0
0547	2.100	45.2	26.9	*****	*****	10.6	46.7
0548	2.171	55.7	26.3	2.557	48.7	26.9	16.7
0549	2.557	37.4	26.9	1.216	32.3	16.8	16.7
0550	2.738	58.3	48.1	1.620	36.6	33.0	25.0
Mean	2.257	47.8	30.9	1.602	33.7	20.7	29.0
S.D.	0.401	8.9	9.6	0.685	12.9	9.0	13.7

Probe Frequency 2.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
0546	3.199	38.8	6.2	*****	*****	0.0	40.0
0547	3.253	46.2	13.3	*****	0.0	*****	60.0
0548	2.772	52.5	6.2	2.039	44.9	14.2	6.7
0549	4.100	34.4	30.1	2.593	50.1	22.1	8.3
0550	1.378	35.2	7.1	2.359	35.5	14.2	21.7
Mean	2.941	41.4	12.6	2.330	32.6	12.6	27.3
S.D.	0.997	7.8	10.2	0.273	22.6	9.2	22.6

160 dB 100X 1/10M

INDIVIDUAL TUNING CURVE STATISTICS

Probe Frequency 4.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
0546	2.890	50.1	44.3	*****	14.6	0.0	45.0
0547	4.754	122.9	66.5	*****	*****	0.0	51.7
0548	3.343	98.1	66.4	4.524	108.9	66.6	15.0
0549	6.093	109.6	66.6	8.772	83.4	77.7	1.7
0550	4.121	98.9	55.3	2.583	76.1	44.2	0.0
Mean	4.240	95.9	59.8	5.293	70.7	37.7	22.7
S.D.	1.259	27.5	9.9	3.165	40.0	36.5	24.3

Probe Frequency 8.0 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
0546	1.233	68.2	11.2	*****	*****	*****	58.3
0547	1.965	79.6	11.2	*****	*****	*****	53.3
0548	6.528	77.7	53.1	5.286	67.7	20.7	21.7
0549	1.176	45.4	10.6	1.145	35.0	0.0	5.0
0550	3.094	107.6	21.3	3.094	69.2	21.3	3.3
Mean	2.799	76.3	21.5	3.175	57.3	14.0	28.3
S.D.	2.224	21.4	18.2	2.071	19.4	12.1	26.2

Probe Frequency 11.2 kHz

Animal	PREEXPOSURE			POSTEXPOSURE			PTS
	Q10dB	HF Slope	LF Slope	Q10dB	HF Slope	LF Slope	
0546	1.561	73.7	15.1	*****	*****	*****	58.3
0547	4.870	95.4	100.4	*****	*****	*****	56.7
0548	4.038	109.9	75.5	2.529	82.9	15.1	5.0
0549	2.366	61.3	10.6	11.496	115.5	4.5	-5.0
0550	4.247	107.8	80.8	2.545	72.8	50.6	1.7
Mean	3.416	89.6	56.5	5.523	90.4	23.4	23.3
S.D.	1.390	21.4	40.9	5.173	22.3	24.1	31.4