SAE ARP 866A vs. ISO 9613-1/ANSI S1.26-1995:

A Sensitivity Analysis Comparing Two Procedures for Adjusting As-Measured Spectra to Reference Conditions

Clay N. Reherman
Christopher J. Roof
Gregg G. Fleming

U.S. Department of Transportation
Research and Special Programs Administration
John A. Volpe National Transportation Systems Center
Environmental Measurement and Modeling Division, DTS-34
Kendall Square
Cambridge, MA 02142-1093

May 2002

U.S. Department of Transportation

Table of Contents

Executive Summary

The Society of Automotive Engineers' (SAE) Aerospace Recommended Practice (ARP) No. 866A (866A), and a procedure utilizing pure-tone absorption equations developed in support of the International Organization for Standardization's (ISO) 9613-1 and the American National Standards Institute's (ANSI) S1.26-1995, are compared and a sensitivity analysis undertaken. The ISO and ANSI equations are identical to each other. Thirteen takeoff and two approach spectra for aircraft were utilized in the analysis, as well as one takeoff, two approach, and three flyover spectra for helicopters. As-measured spectra were processed at 10 standard distances between 200 and 25,000 feet, and at five different temperature/ relative humidity (RH) combinations, to generate adjusted spectra and associated L_{ASmx} values. The focus of the study is a refined version of the ISO/ANSI adjustment procedure developed specifically for application to one-third octave-level data.

The generalized results of the study are summarized in Figure ES-1 for all aircraft spectra tested. Difference values were obtained by subtracting 866A results from ISO/ANSI results. For aircraft noise certification purposes, distances between 400 and 4,000 feet may be considered most relevant. Therefore, the average, range, and standard deviations for all spectral data and temperature/RH combinations at 400, 630, 1,000, 2,000, and 4,000 feet are presented.

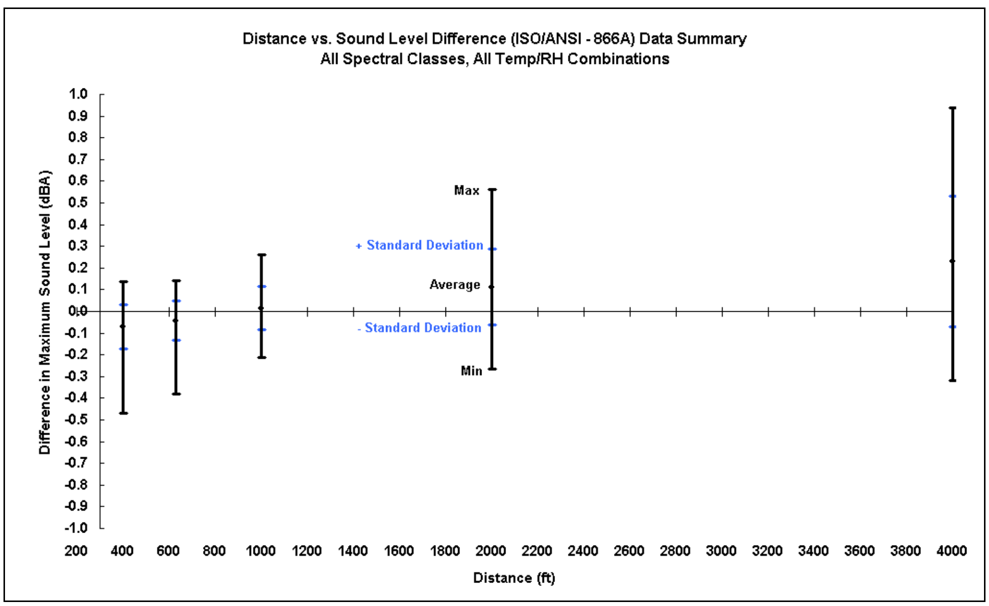


Figure ES-1. ISO/ANSI – 866A Difference Data Summary – All Aircraft

As seen in the figure, at 400 feet the maximum difference for all the data is 0.1 dBA, the minimum difference is –0.5 dBA, the average difference is –0.1 dBA, and the standard deviation is 0.1 dBA. At 630 feet, the maximum difference is 0.1 dBA, the minimum difference is –0.4 dBA, the average difference is 0.0 dBA, and the standard deviation is 0.1 dBA. At 1,000 feet, the maximum difference is 0.3 dBA, the minimum difference is -0.2 dBA, the average difference is 0.0 dBA, and the standard deviation is 0.1 dBA. At

2,000 feet, the maximum difference is 0.6 dBA, the minimum difference is -0.3 dBA, the average difference is 0.1 dBA, and the standard deviation is 0.2 dBA. At 4,000 feet, the maximum difference is 0.9 dBA, the minimum difference is -0.3 dBA, the average difference is 0.2 dBA, and the standard deviation is 0.3 dBA.

Figures ES-2 and ES-3 present results for this study specific to modern jets and a modern helicopter, respectively.

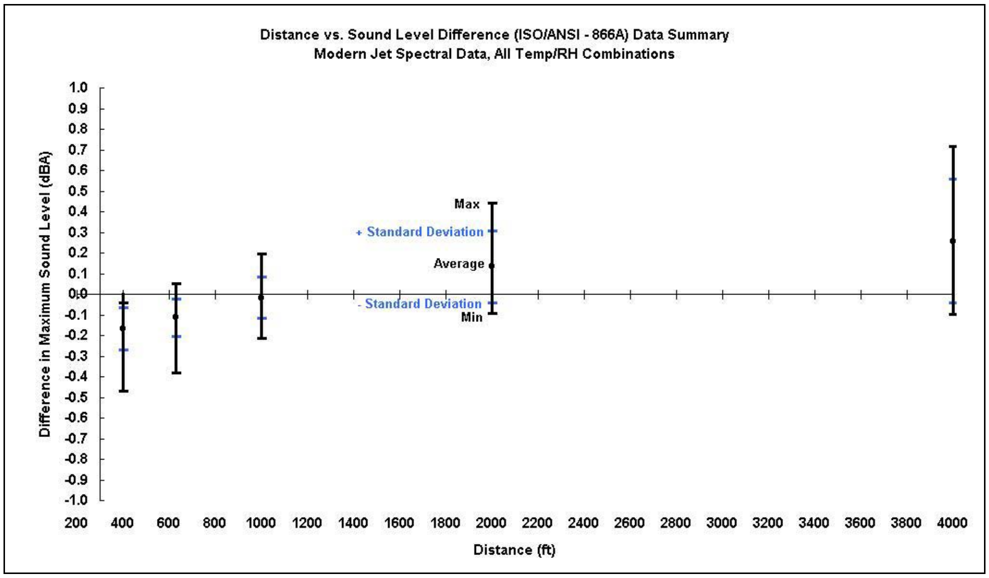


Figure ES-2. ISO/ANSI – 866A Difference Data Summary – Modern Jets

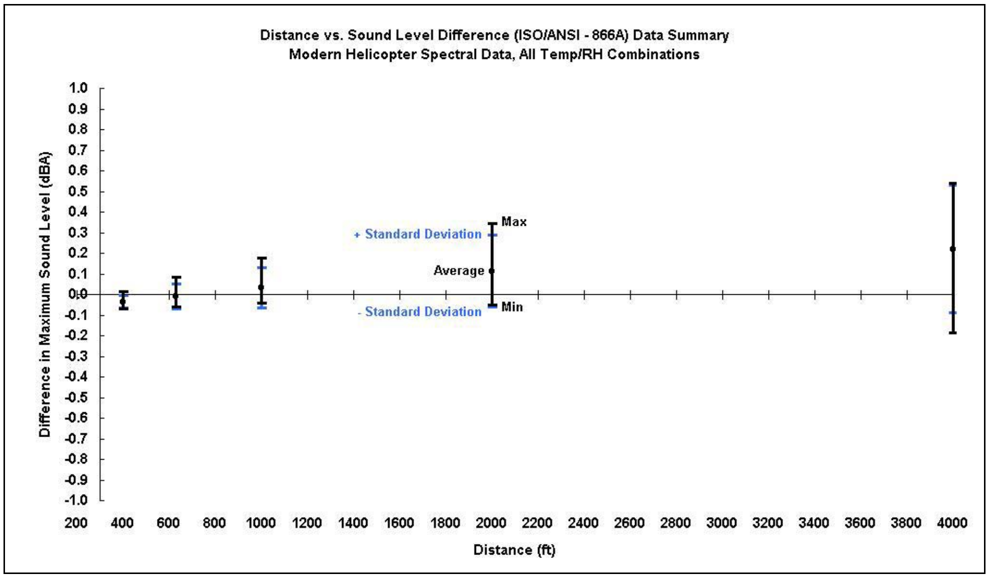


Figure ES-3. ISO/ANSI – 866A Difference Data Summary – Modern Helicopter

Representative plots of the L_{ASmx} data as well as A-weighted, spectra at time of L_{ASmx} are presented.

1.0 Introduction

Two procedures for adjusting as-measured test-day spectra to reference day conditions – the Society of Automotive Engineers' (SAE) Aerospace Recommended Practice (ARP) No. 866A (866A) and a procedure utilizing pure-tone absorption equations, developed in support of the International Organization for Standardization's (ISO) 9613-1 and the American National Standards Institute's (ANSI) S1.26-1995, and refined for application to one-third octave-band data – were evaluated and compared. The ISO and ANSI pure-tone absorption equations are identical to each other. The 866A procedure historically has been used for atmospheric absorption corrections for Federal Aviation Regulations (FAR) Part 36, Noise Standards: Aircraft Type and Airworthiness Certification and similar regulations of the International Civil Aviation Organization (ICAO). The ISO/ANSI procedure analyzed herein is under consideration for inclusion into harmonized regulations. This document presents a comparison of data corrected to several distances using the two different methodologies.

2.0 Analysis

Twenty-one sets of spectral data were utilized in the analysis, including 14 airplane and helicopter takeoffs, four approaches, and two level flyovers from the Federal Aviation Administration's (FAA) Integrated Noise Model (INM), and an MD900 level flyover from a 1996 joint government/industry noise measurement at Crow's Landing, California, sponsored by the National Rotorcraft Technology Center (NRTC).

Table 1 lists spectral class (SC) data for several aircraft chosen because they are considered to be representative of *modern* jet aircraft.

Table 1. Representative Modern Aircraft Spectral Classes

SC	Flight Type	Description	Aircraft ID
103	Departure	Two engine high bypass ratio turbofan aircraft	757PW / 757RR / 767300 / 767CF6 / 767JT9 / A300 / A310 / A320
105	Departure	Two engine high bypass ratio turbofan aircraft	MD9025 / MD9028 / 777200
203	Approach	Two engine high bypass ratio turbofan aircraft; two engine turbofan business aircraft	757PW / 757RR / 767300 / 767CF6 / 767JT9 / A300 / A310 / A320 / DC1010 / DC1030 / DC1040 / L1011 / L10115 / FAL20 / SABR80 / MU3001
205	Approach	Two engine high bypass ratio turbofan aircraft	MD9025 / MD9028 / 777200

Table 2 presents a list of the other jet aircraft (and representative SC's) utilized for this analysis.

Table 2. Representative Other Aircraft Spectral Classes

SC	Flight Type	Description	Aircraft ID
101	Departure	Two and Three engine low bypass ratio turbofan aircraft	727100 / 727200 / 727D15 / 727D17 / 727EM1 / 727EM2 / 727Q15 / 727Q7 / 727Q9 / 727QF / 737 / 737D17 / 737QN / DC9Q9 / DC910 / DC930 / DC950 / DC9Q7 / F10062 / F10065 / GIV / DC1010 / DC1030 / DC1040 / L1011 / L10115 / DC93HW / DC93LW
102	Departure	Two engine high bypass ratio turbofan aircraft	737300 / 7373B2 / 737400 / 737500
104	Departure	Two engine high bypass ratio turbofan aircraft	MD81 / MD82 / MD83 / F28MK2 / F28MK4 / GIIB / 737N17 / 737N19
106	Departure	Four engine turbofan aircraft and supersonic turbojet aircraft	DC870 / 707QN / DC8QN / CONCRD
107	Departure	Four engine turbofan aircraft	74710Q / 747200 / 74720A / 74420B / 747400 / 747SP / 747100 / 707120 / 707320 / 720B / DC850 / DC860 / 707 / 720 / DC820
108	Departure	Four engine turbofan aircraft	BAE146 / BAC111 / BAE300
109	Departure	Two engine turboprop; one and two engine piston aircraft	DHC6 / DHC6QP / SD330 / JPATS / GASEPF / GASEPV / BEC58P / COMSEP
110	Departure	Two engine turboprop; two and four engine piston aircraft	SF340 / HS748A / DC3 / DC6
111	Departure	Two engine turboprop aircraft	CNA441 / C12 / C23 / T44 / U21
112	Departure	Four engine turboprop aircraft	L188 / CVR580 / DHC7 / DHC8 / DHC830 / C-130E / C130 / C130AD / C130E / C130HP
113	Departure	Two engine turbojet and turbofan business aircraft	LEAR25 / LEAR35 / FAL20 / SABR80 / CNA500 / MU3001 / IA1125 / CIT3 / CL600 / CL601 / EMB145 / COMJET

Table 3 presents a list of the helicopters and their associated SC's, as utilized in this analysis.

Table 3. Helicopter Spectral Class Information

SC	Flight Type	Aircraft ID
116	Departure	SA355 / S65 / H500D
219	Approach	S76 / SA350 / SA341 / SA365
222	Approach	B206L
302	Flyover	S76 / SA341 / SA365
307	Flyover	B206L

See Appendix A for the normalized sound pressure levels of the 20 INM SC and also the MD900 helicopter used in the analysis.

For both the 866A and ISO/ANSI procedures, aircraft spectra were first corrected to the source (i.e., 0 feet) assuming test-day conditions of 77°F, 70% relative humidity (RH), and a test distance of 1,000 feet.[*] The aircraft spectra were then corrected from the source to 10 standard distances using the two procedures: 200, 400, 630, 1,000, 2,000, 4,000, 6,300, 10,000, 16,000 and 25,000 feet. The results for each procedure were then compared.

Five different temperature/RH combinations, 77°F/70% RH, 85°F/35% RH, 85°F/85% RH, 40°F/85% RH, and 40°F/55% RH, were used for corrections to the 10 standard distances. As illustrated in Figure 1, the temperature/RH combinations fall within the FAR 36 allowable test window, yet span a majority of the anticipated values for correction.

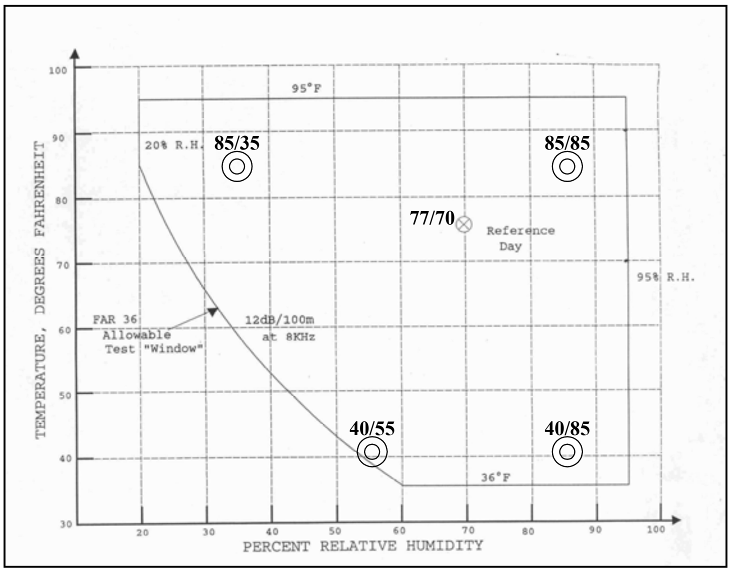


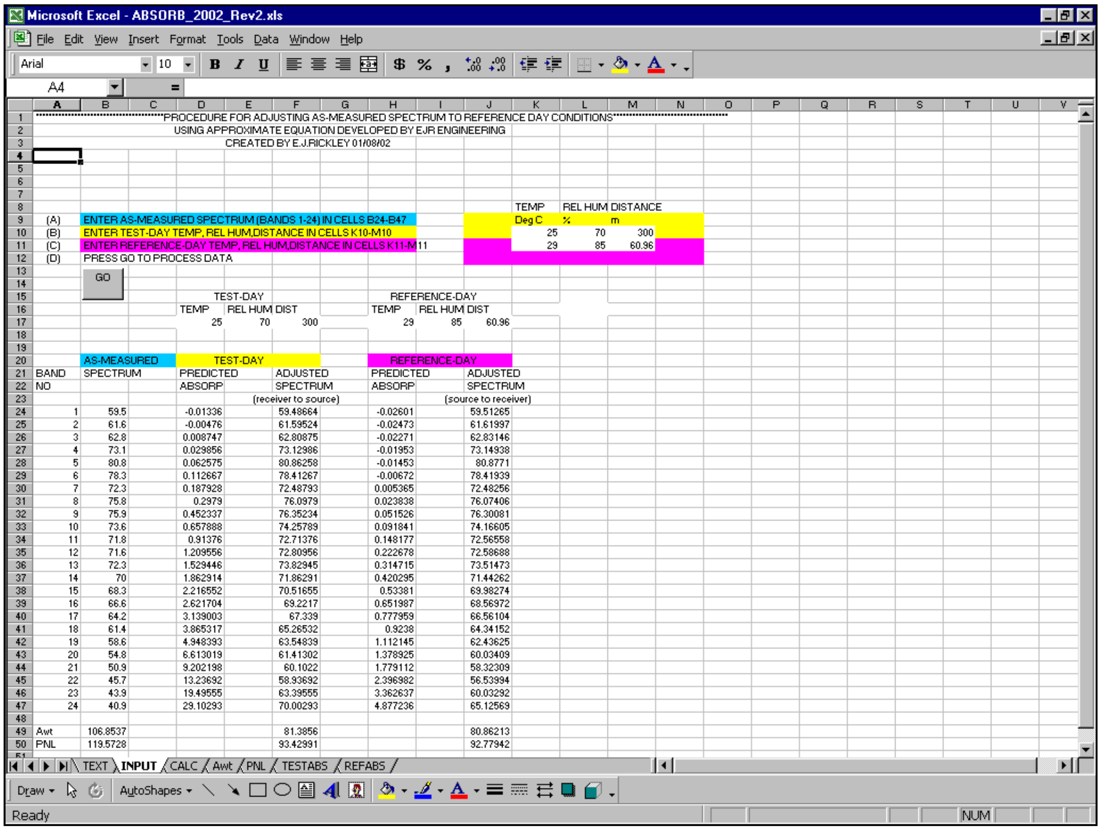
Figure 1. The FAR 36 Allowable Test Window

An internal Volpe computer program entitled LCorrect was used to implement the 866A procedure. This program accepts test-day temperature, humidity, and distance, reference temperature and humidity, and as-measured spectra as its inputs and calculates the spectrum at the time of A-weighted maximum sound level (L_{ASmx}) and the L_{ASmx} for each of the 10 standard distances. LCorrect accepts speed and sound exposure level (SEL) inputs as well, but no speed-based corrections were applied and SEL is not used for the calculations documented herein.

A macro-driven Microsoft Excel spreadsheet developed by EJR Engineering was utilized to implement the ISO/ANSI procedure. The spreadsheet accepts test-day temperature, humidity, and distance, and reference temperature, humidity, distance, and spectra as inputs. It utilizes macros to calculate the L_{ASmx} and the spectrum at time of L_{ASmx} for a

[*] Note that INM spectral class data are actually corrected to the SAE AIR 1845 Standard Atmosphere, not 77°F, 70% RH. The effects associated with this difference are consistent for the two procedures and therefore have no impact on the results.

user-specified distance. Calculations are implemented using an empirically-derived regression equation (see Appendix B for a detailed description). An example of the user-interface page for the spreadsheet is presented in Figure 2.



BAND NO	AS-MEASURED SPECTRUM	TEST-DAY PREDICTED ABSORP	TEST-DAY ADJUSTED SPECTRUM (receiver to source)	REFERENCE-DAY PREDICTED ABSORP	REFERENCE-DAY ADJUSTED SPECTRUM (source to receiver)
1	59.5	-0.01336	59.48664	-0.02601	59.51265
2	61.6	-0.00476	61.59524	-0.02473	61.61997
3	62.8	0.008747	62.80875	-0.02271	62.83146
4	73.1	0.029856	73.12986	-0.01953	73.14938
5	80.8	0.062575	80.86258	-0.01453	80.8771
6	78.3	0.112667	78.41267	-0.00672	78.41939
7	72.3	0.187928	72.48793	0.005365	72.48256
8	75.8	0.2979	76.0979	0.023838	76.07406
9	75.9	0.452337	76.35234	0.051526	76.30081
10	73.6	0.657888	74.25789	0.091841	74.16605
11	71.8	0.91376	72.71376	0.148177	72.56558
12	71.6	1.209556	72.80956	0.222678	72.58688
13	72.3	1.529446	73.82945	0.314715	73.51473
14	70	1.862914	71.86291	0.420295	71.44262
15	68.3	2.216552	70.51655	0.53381	69.98274
16	66.6	2.621704	69.2217	0.651987	68.56972
17	64.2	3.139003	67.339	0.777959	66.56104
18	61.4	3.865317	65.26532	0.9238	64.34152
19	58.6	4.948393	63.54839	1.112145	62.43625
20	54.8	6.613019	61.41302	1.378925	60.03409
21	50.9	9.202198	60.1022	1.779112	58.32309
22	45.7	13.23692	58.93692	2.396982	56.53994
23	43.9	19.49555	63.39555	3.362637	60.03292
24	40.9	29.10293	70.00293	4.877236	65.12569
Awt	106.8537		81.3856		80.86213
PNL	119.5728		93.42991		92.77942

Figure 2. The ISO/ANSI Spreadsheet

The ANSI/ISO procedure must be repeated separately for corrections to multiple distances.

2.1 866A vs. the ISO/ANSI Spreadsheet

An initial version of the ISO/ANSI spreadsheet was tested and the results compared to 866A. Some anomalous results were observed using the first version; consequently, a second, improved version was developed and tested. The results of these comparisons are presented below in Section 2.1.1 for Version 1 of the spreadsheet and Section 2.1.2 for Version 2.

2.1.1 Version 1, January 24, 2002

L_{ASmx} data were plotted as a function of distance for comparison. Figure 3 shows the results for SC 101, which consists of two- and three-engine low bypass ratio turbofan aircraft, including the 727-100 and 727-200, using 77°F/70% RH. The differences in dBA between the two procedures are shown using a secondary y-axis on the same plot.

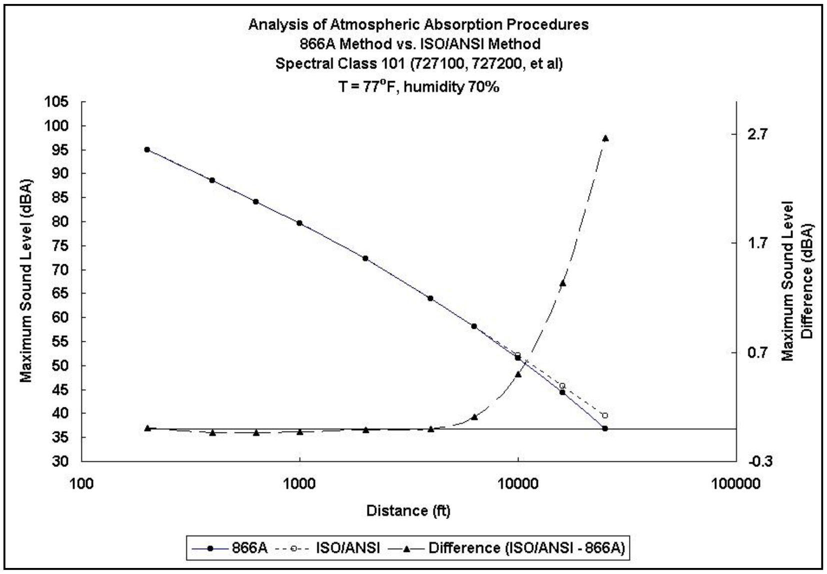


Figure 3. SC 101 L_{ASmx} Data vs. Distance

As seen in Figure 3, corrections to 77°F/70% RH, 866A and the first version of the ISO/ANSI spreadsheet generally yielded similar results for distances between 200 and 10,000 feet (within 1.0 dBA). One of the largest ISO/ANSI – 866A differences found at a shorter distance was 0.2 dBA found at 200 feet using SC 108 corrected to 77°F/70% RH. The results of this comparison are shown in Figure 4.

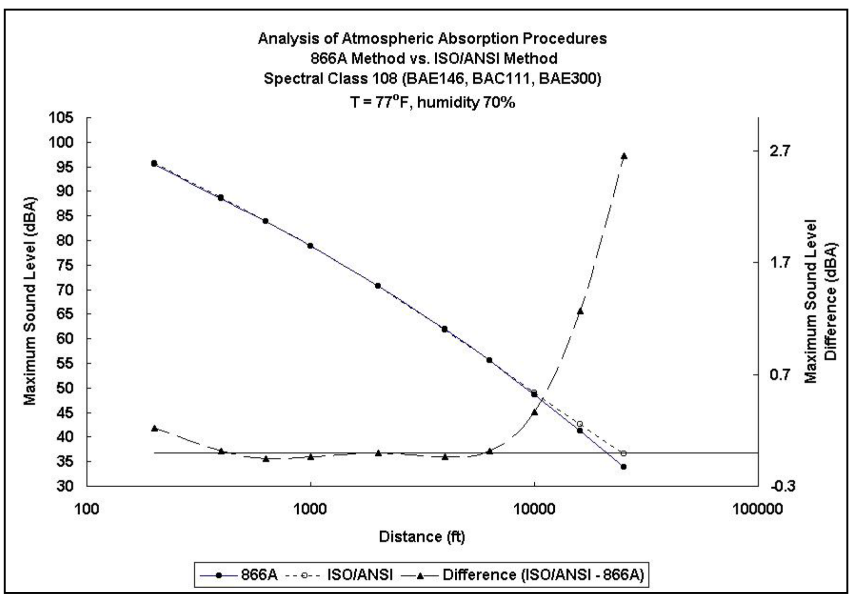


Figure 4. SC 108 L_{ASmx} Data vs. Distance

The difference was 2.7 dBA at 25,000 feet for SC 108. For distances between 16,000 and 25,000 feet, the ISO/ANSI procedure consistently produces larger values, up to 2.9 dBA larger than 866A at 25,000 feet.

In Figure 5, an examination of the A-weighted spectra generated for SC 108 at 200, 400, 630, and 1,000 feet reveals larger high-frequency energy for the ISO/ANSI procedure at 200 feet. In particular, the 6.5 dB difference in levels for 10,000 Hz one-third octave-band helps to explain the 0.2 dBA L_{ASmx} difference at 200 feet presented in Figure 4.

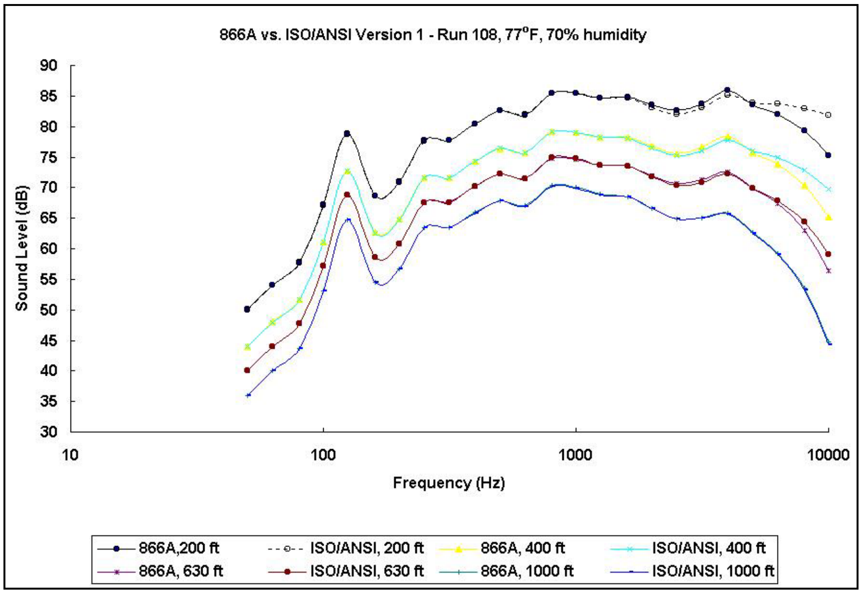


Figure 5. Spectral Data for SC 108 at Short Distances
Generated Using 866A and ISO/ANSI Version 1

Figure 6 presents the A-weighted spectra for SC 108 plotted at each of the 10 standard distances. As can be seen, the first version of the ISO/ANSI spreadsheet tends to break down at higher frequencies for distances greater than 6,300 feet.

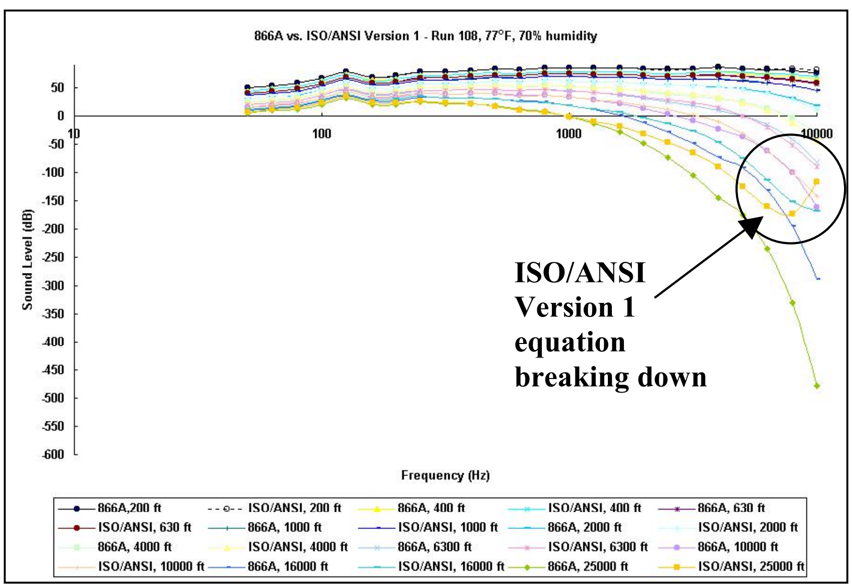


Figure 6. All Spectral Data for SC 108
Generated Using 866A and ISO/ANSI Version 1

Version 1 tests at 85°F/35% RH yield differences of up to 1.4 dBA for distances between 200 and 16,000 feet, and differences of up to 10.5 dBA at 25,000 feet. Tests at 85°F/85% RH yield differences of up to 1.1 dBA for distances between 200 and 6,300 feet, and differences of up to 4.9 dBA for distances between 10,000 and 25,000 feet.

Tests were not completed for 40°F/85% RH and 40°F/55% RH because Version 1 of the ISO/ANSI spreadsheet would not calculate a 25,000-foot result for temperatures less than 54°F.

2.1.2 Version 2, February 11, 2002

Version 1 of the ISO/ANSI procedure was refined by EJR Engineering based on the results presented above, and Version 2 of the spreadsheet was developed. Tables in Appendix C present all of the L_{ASmx} versus distance data generated using 866A and Version 2 of the ISO/ANSI spreadsheet.

L_{ASmx} comparisons using Version 2 of the spreadsheet for 77°F/70% RH and 85°F/85% RH were very close to the results using the first version. As seen in Figure 7, plots of the A-weighted spectra generated by Version 2 illustrate more consistent high-frequency stability at larger distances. These improvements in the spectral data result in changes in the L_{ASmx} values of less than 0.1 dBA, as compared to Version 1 of the ISO/ANSI spreadsheet.

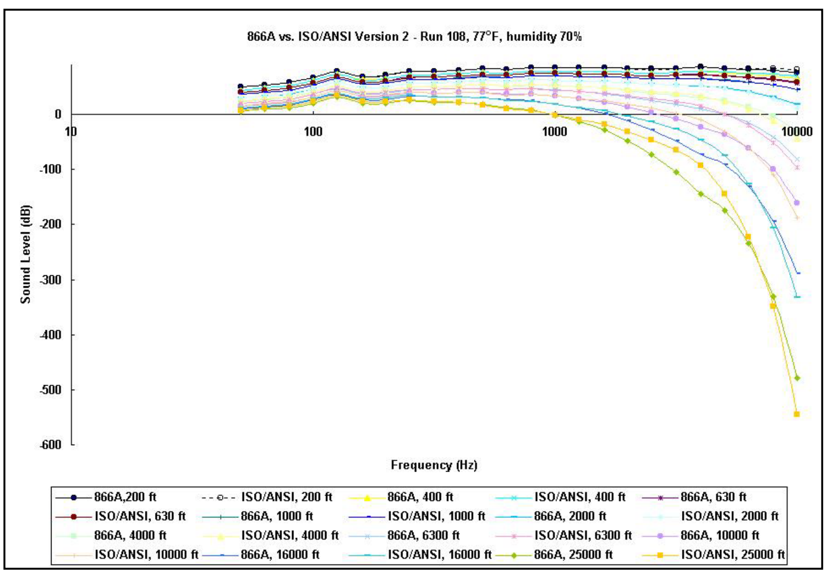


Figure 7. All Spectral Data for SC 108
Generated Using 866A and ISO/ANSI Version 2

For corrections to 85°F/35% RH, Version 2 of the ISO/ANSI spreadsheet yields results within 1.9 dBA of those calculated by 866A at 25,000 feet. For comparison, Figure 8 presents the results for the correction of SC 108 to 85°F/35% RH using the ISO/ANSI spreadsheet Version 1, whereas Figure 9 presents these same, improved results, calculated using ISO/ANSI Version 2.

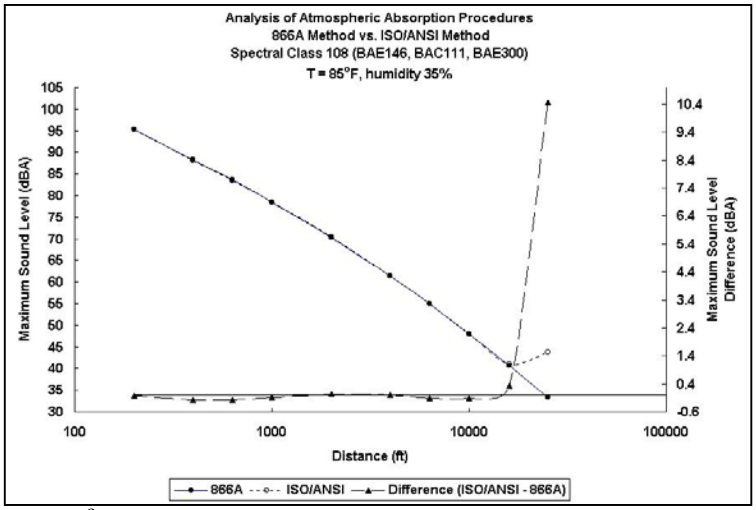


Figure 8. $85^{o}F/35\%$ L_{ASmx} Data Using 866A and ISO/ANSI, Version 1

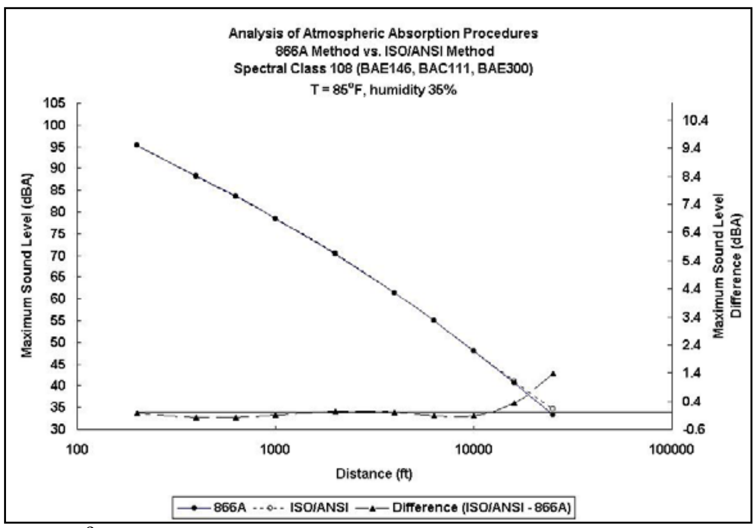


Figure 9. $85^{o}F/35\%$ L_{ASmx} Data Using 866A and ISO/ANSI, Version 2

The ISO/ANSI spreadsheet Version 1 did not calculate sound levels at 25,000 feet for temperatures less than $54^{o}F$, but Version 2 does calculate these values. Tests at $40^{o}F/85\%$ RH yield differences of up to 1.8 dBA. Tests at $40^{o}F/55\%$ RH yield differences of up to 1.6 dBA.

Hereafter, only results computed using the second version of the ISO/ANSI spreadsheet will be presented.

3.0 Results

Tables 4 through 8 summarize the comparison of 866A L_{ASmx} data with ISO/ANSI Version 2 L_{ASmx} data for the five different temperature/RH combinations. These tables take into account all 21 spectral studies and present the maximum, minimum, and average difference values found at each distance. Difference data represent ISO/ANSI L_{ASmx} values minus 866A L_{ASmx} values.

Table 4. L_{ASmx} Difference Data for 866A vs. ISO/ANSI Version 2 at 77°F/70% RH

Distance (ft.)	Difference Data: ISO/ANSI Version 2 L_{ASmx} - 866A L_{ASmx} (dBA)		
	Max Difference	**Min Difference**	**Average Difference**
200	0.2	-0.3	-0.1
400	0.0	-0.2	-0.1
630	0.0	-0.2	-0.1
1,000	0.0	0.0	0.0
2,000	0.1	-0.1	0.0
4,000	0.3	-0.2	0.0
6,300	0.5	-0.2	0.1
10,000	1.0	-0.1	0.4
16,000	1.8	0.7	1.2
25,000	2.9	2.2	2.5

Table 5. L_{ASmx} Difference Data for 866A vs. ISO/ANSI Version 2 at 85°F/35% RH

Distance (ft.)	Difference Data: ISO/ANSI Version 2 L_{ASmx} - 866A L_{ASmx} (dBA)		
	Max Difference	**Min Difference**	**Average Difference**
200	0.0	-0.4	-0.1
400	0.0	-0.4	-0.1
630	0.0	-0.3	-0.1
1,000	0.0	-0.2	-0.1
2,000	0.1	-0.2	0.0
4,000	0.1	-0.3	-0.1
6,300	0.3	-0.4	-0.2
10,000	0.6	-0.6	-0.3
16,000	1.1	-0.5	0.0
25,000	1.9	0.1	0.8

Table 6. L_{ASmx} Difference Data for 866A vs. ISO/ANSI Version 2 at 85^{o}F/85% RH

Distance (ft.)	Difference Data: ISO/ANSI Version 2 L_{ASmx} - 866A L_{ASmx} (dBA)		
	Max Difference	**Min Difference**	**Average Difference**
200	0.4	-0.3	0.0
400	0.1	-0.3	-0.1
630	0.1	-0.2	-0.1
1,000	0.1	-0.2	0.0
2,000	0.3	-0.3	0.0
4,000	0.6	-0.2	0.3
6,300	1.1	0.2	0.7
10,000	1.8	1.0	1.5
16,000	3.1	2.4	2.8
25,000	4.9	4.1	4.7

Table 7. L_{ASmx} Difference Data for 866A vs. ISO/ANSI Version 2 at 40^{o}F/85% RH

Distance (ft.)	Difference Data: ISO/ANSI Version 2 L_{ASmx} - 866A L_{ASmx} (dBA)		
	Max Difference	**Min Difference**	**Average Difference**
200	0.0	-0.5	-0.1
400	0.0	-0.5	-0.1
630	0.1	-0.4	0.0
1,000	0.2	-0.2	0.0
2,000	0.4	0.0	0.2
4,000	0.7	0.1	0.4
6,300	1.0	0.1	0.6
10,000	1.3	0.2	0.8
16,000	1.5	0.4	1.0
25,000	1.8	0.6	1.1

Table 8. L_{ASmx} Difference Data for 866A vs. ISO/ANSI Version 2 at 40°F/55% RH

Distance (ft.)	Difference Data: ISO/ANSI Version 2 L_{ASmx} - 866A L_{ASmx} (dBA)		
	Max Difference	Min Difference	Average Difference
200	0.0	-0.5	-0.1
400	0.1	-0.4	0.0
630	0.1	-0.2	0.0
1,000	0.3	0.0	0.1
2,000	0.6	0.0	0.3
4,000	0.9	0.1	0.5
6,300	1.1	0.1	0.7
10,000	1.3	0.1	0.8
16,000	1.6	0.2	0.9
25,000	1.6	0.2	1.0

4.0 Conclusions

Comparisons were made of 866A and ISO/ANSI L_{ASmx} data for a range of distances spanning 200 to 25,000 feet. For certification purposes, distances between 400 and 4,000 feet may be considered most relevant. At these distances, differences between 866A and ISO/ANSI L_{ASmx} data were practically negligible (less than 1 dBA). Difference value averages, ranges, and standard deviations for all SC and temperature/RH combinations at 400, 630, 1,000, 2,000, and 4,000 feet are presented in Figure 10.

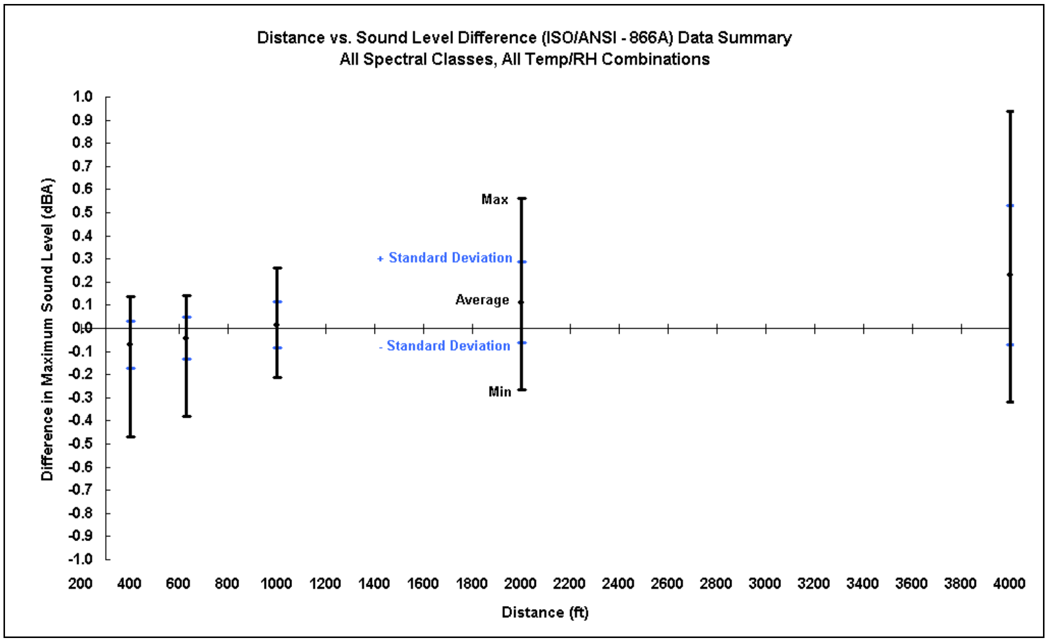


Figure 10. ISO/ANSI – 866A Difference Data Summary

As can be seen in Figure 10, the average, minimum and maximum differences for all data corrected to 400 feet are -0.1, -0.5 and 0.1 dBA, respectively. The standard deviation for the 400-foot data is 0.1 dBA. At 630 feet, the average, minimum and maximum differences are 0.0, -0.4 and 0.1 dBA, respectively. The standard deviation for the 630-foot data is 0.1 dBA. At 1,000 feet, the average, minimum and maximum differences are 0.0, -0.2 and 0.3 dBA, respectively. The standard deviation for the 100-foot data is 0.1 dBA. At 2,000 feet, the average, minimum and maximum differences are 0.1, -0.3 and 0.6 dBA, respectively. The 2,000-foot standard deviation is 0.2 dBA. At 4,000 feet, the average, minimum and maximum differences are 0.2, -0.3 and 0.9 dBA, respectively. The 4,000-foot standard deviation is 0.3 dBA.

Figures 11 and 12 present results for this study specific to modern jets and a modern helicopter, respectively.

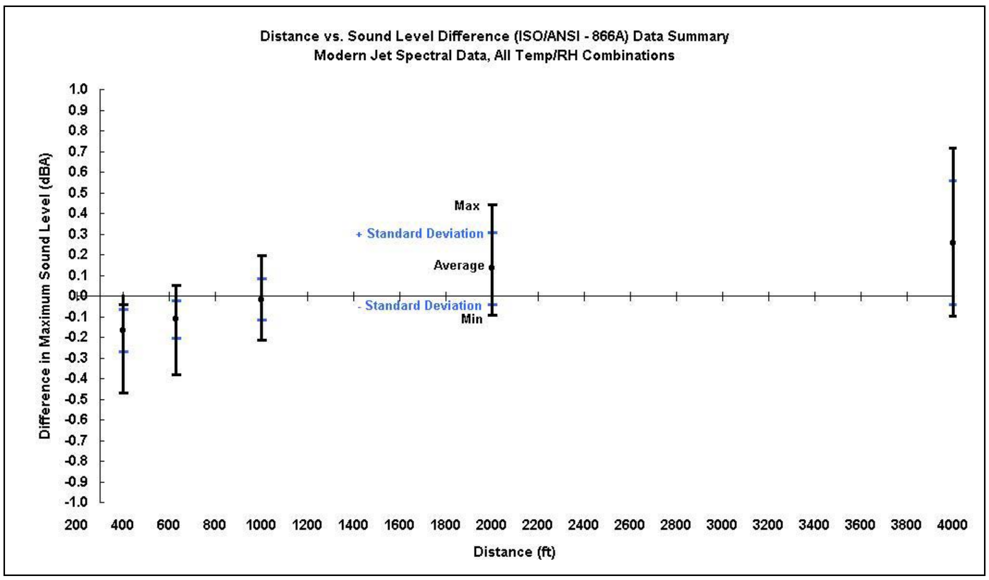


Figure 11. ISO/ANSI – 866A Difference Data Summary – Modern Jets

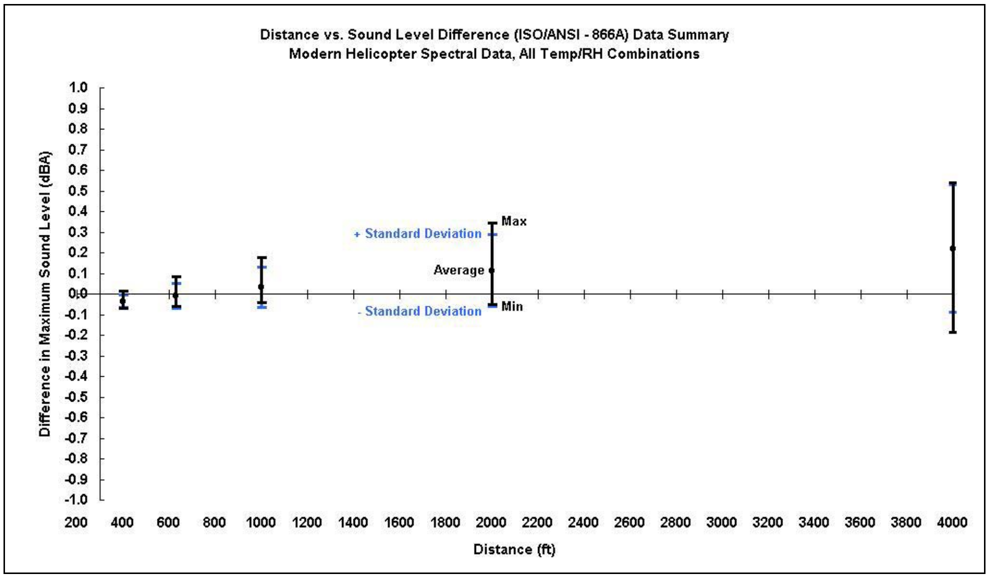


Figure 12. ISO/ANSI – 866A Difference Data Summary – Modern Helicopter

Appendix A

Spectral Class Data

The 20 sets of INM spectral class one-third octave-band data used in this study are presented below, along with the spectral data for the MD900. These data sets have all been normalized to 70.0 dB at 1,000 Hz, with relative differences in adjacent bands preserved.

A.1 Modern Aircraft

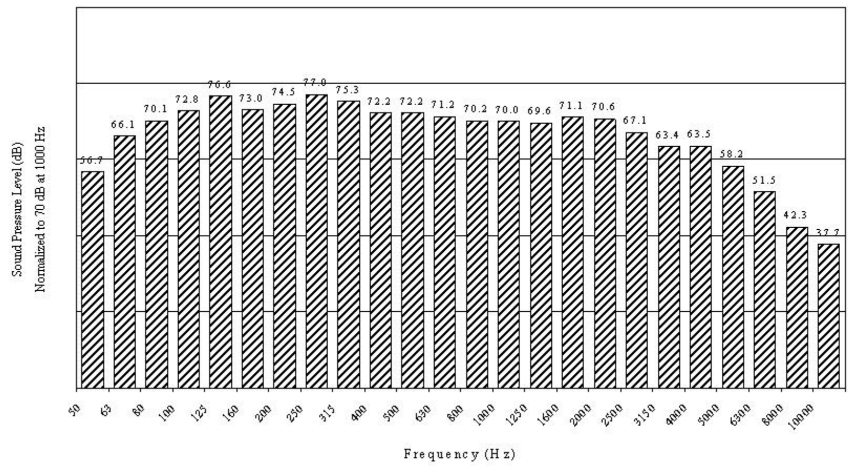


Figure A.1 Spectral Class 103 Sound Pressure Levels

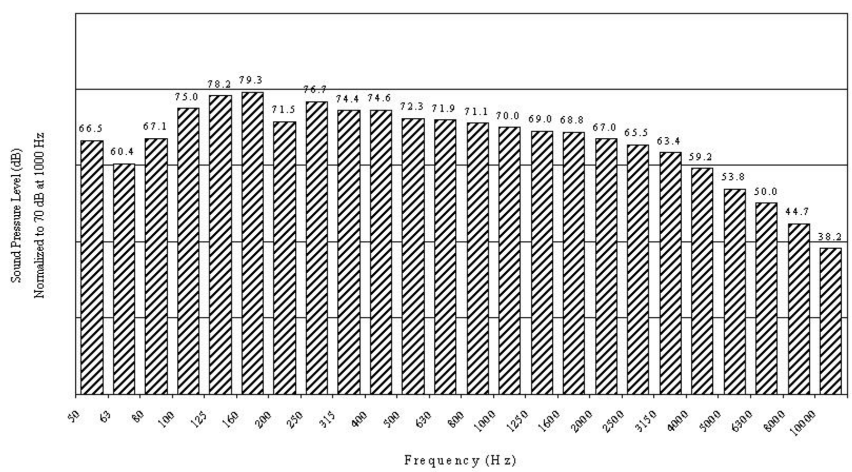


Figure A.2 Spectral Class 105 Sound Pressure Levels

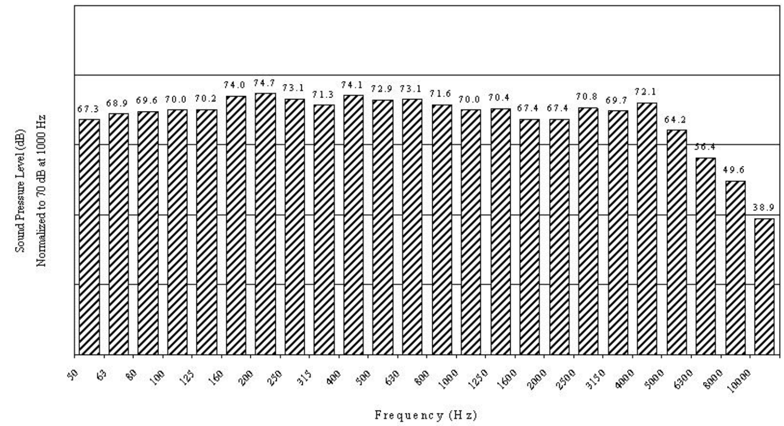


Figure A.3 Spectral Class 203 Sound Pressure Levels

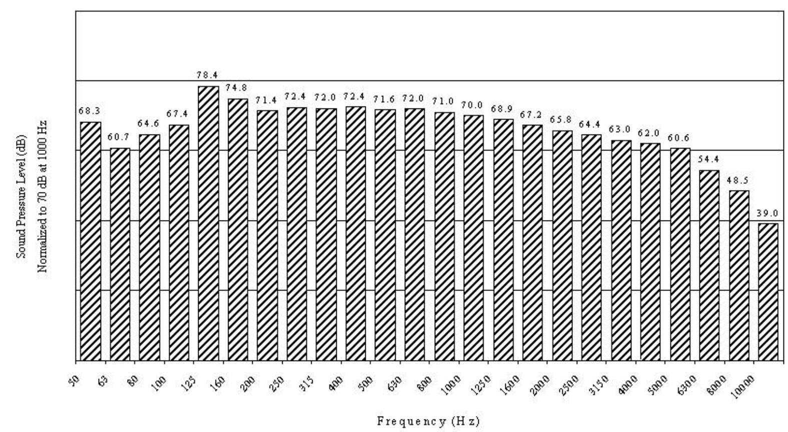


Figure A.4 Spectral Class 205 Sound Pressure Levels

A.2 Other Aircraft

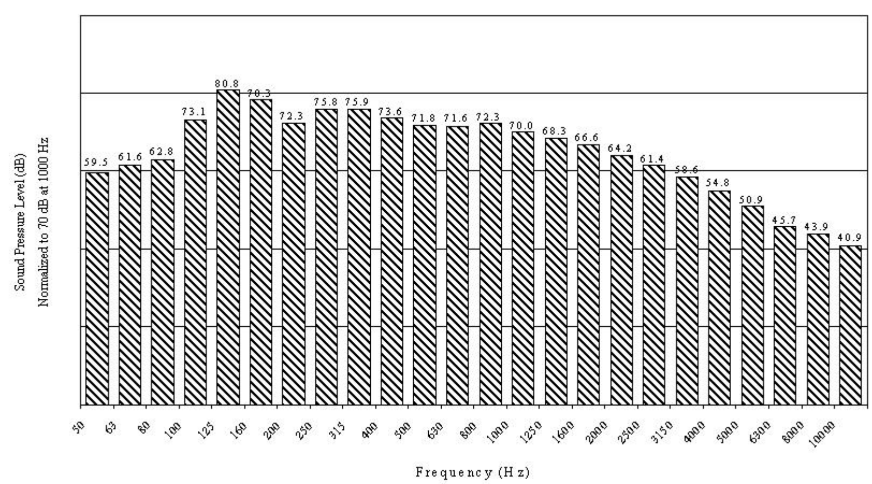


Figure A.5 Spectral Class 101 Sound Pressure Levels

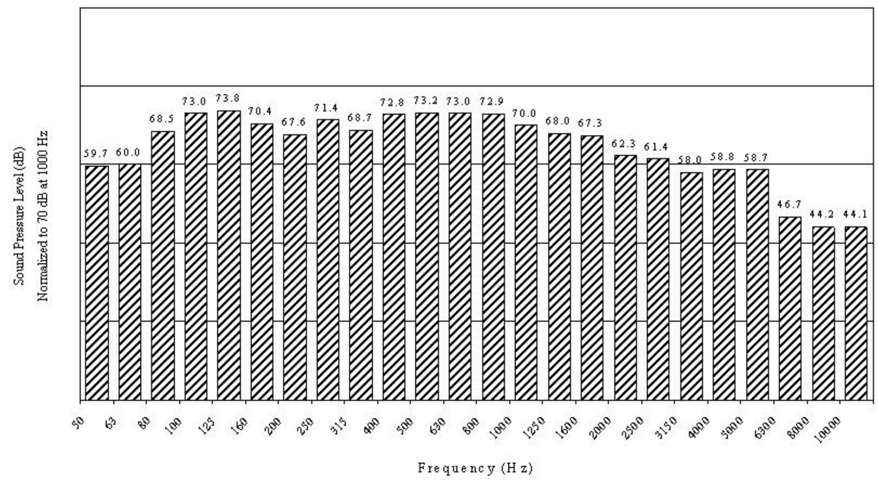


Figure A.6 Spectral Class 102 Sound Pressure Levels

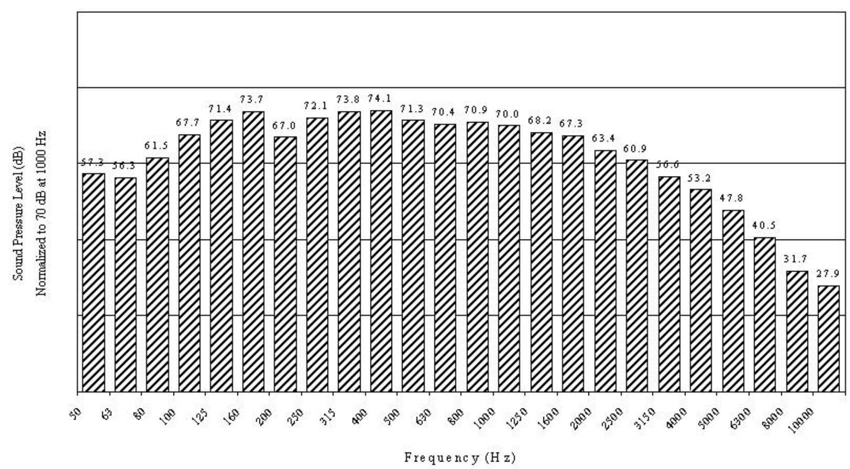


Figure A.7 Spectral Class 104 Sound Pressure Levels

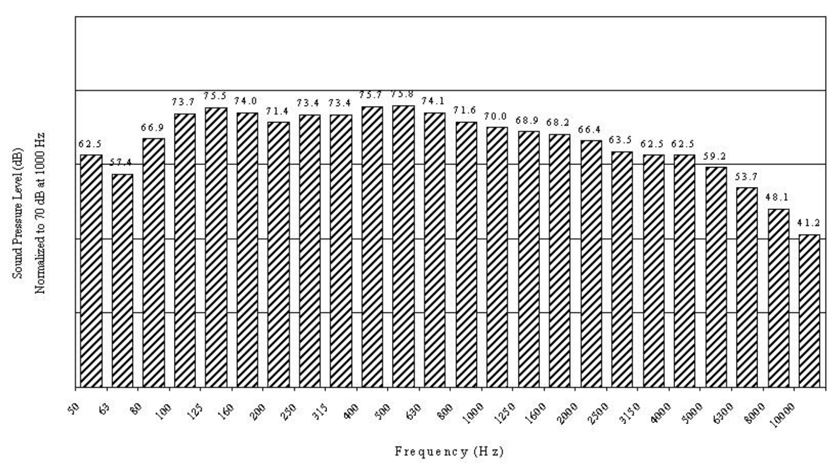


Figure A.8 Spectral Class 106 Sound Pressure Levels

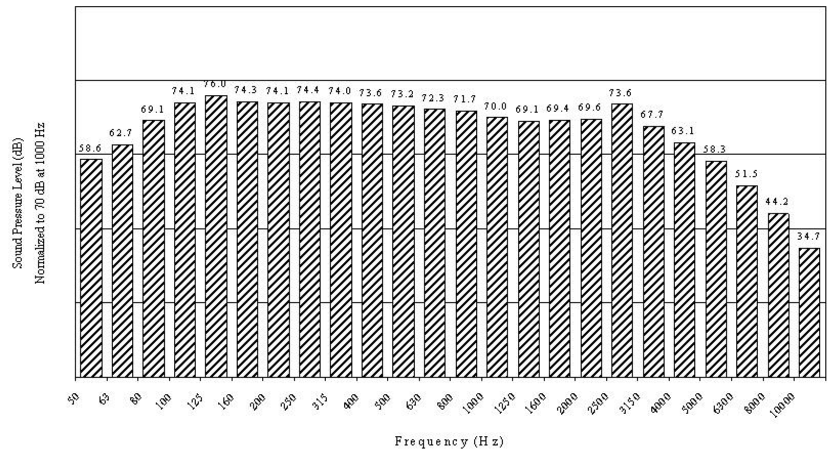


Figure A.9 Spectral Class 107 Sound Pressure Levels

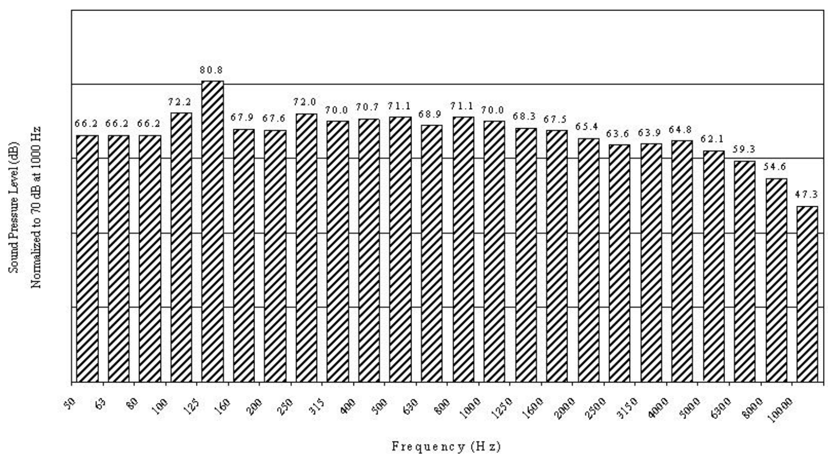


Figure A.10 Spectral Class 108 Sound Pressure Levels

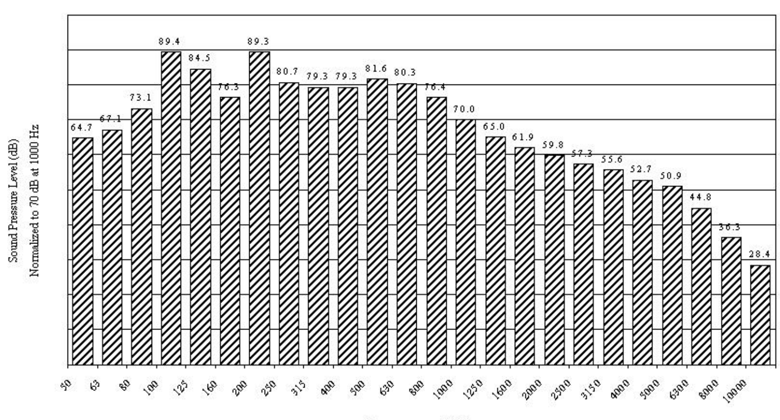


Figure A.11 Spectral Class 109 Sound Pressure Levels

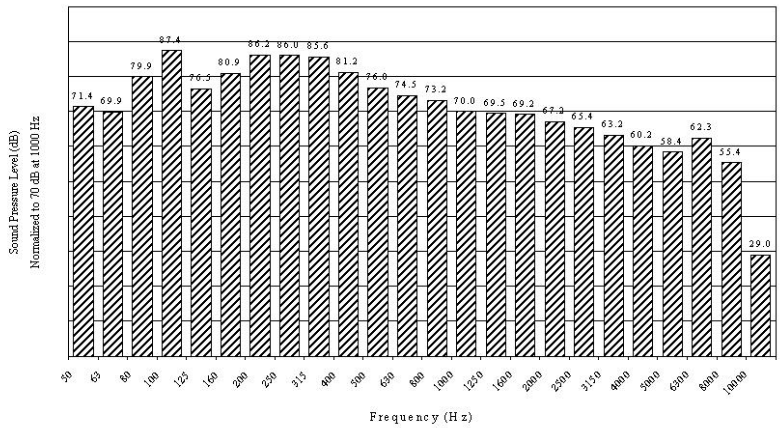


Figure A.12 Spectral Class 110 Sound Pressure Levels

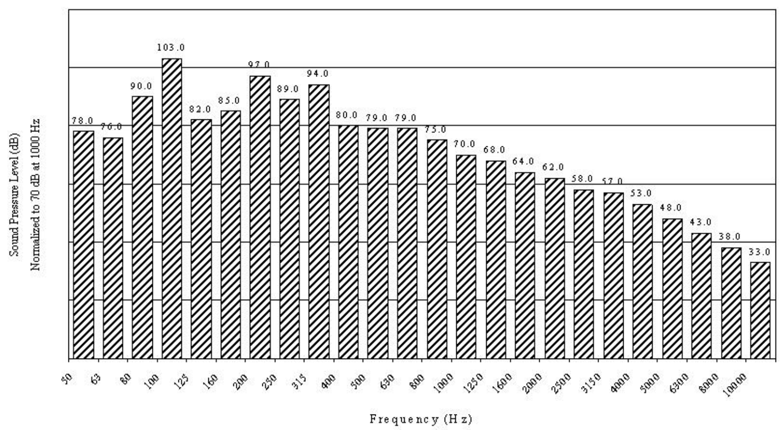


Figure A.13 Spectral Class 111 Sound Pressure Levels

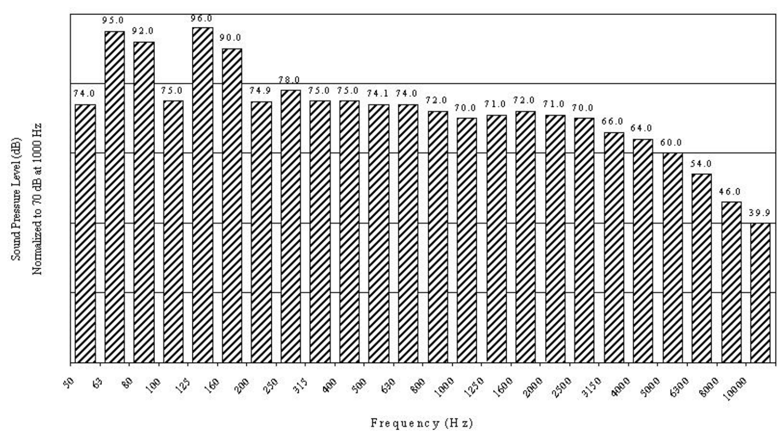


Figure A.14 Spectral Class 112 Sound Pressure Levels

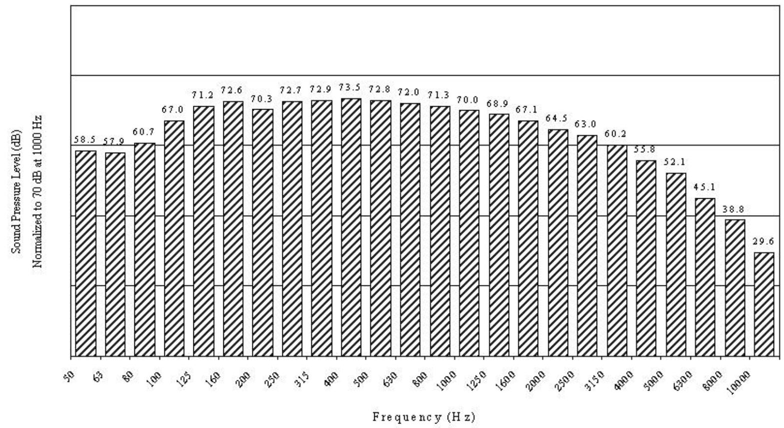


Figure A.15 Spectral Class 113 Sound Pressure Levels

A.3 Helicopters

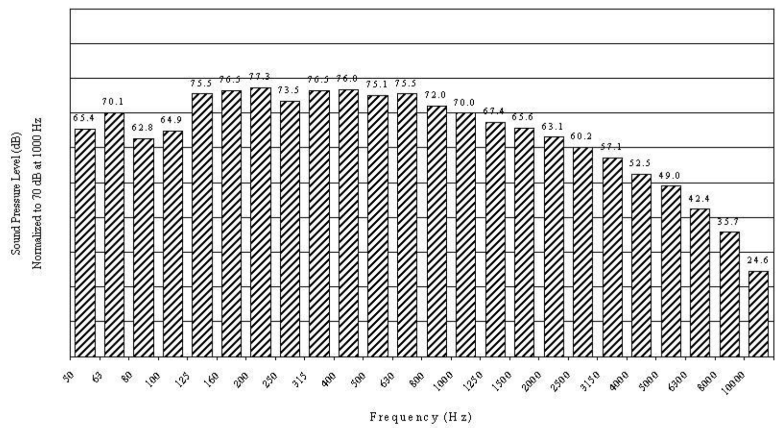


Figure A.16 Spectral Class 116 Sound Pressure Levels

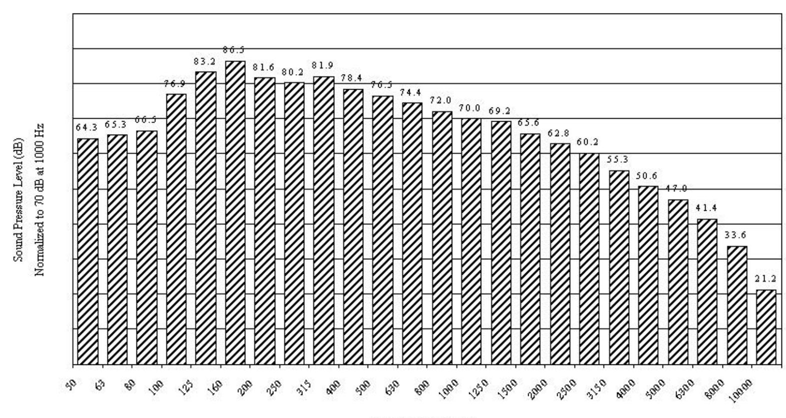


Figure A.17 Spectral Class 219 Sound Pressure Levels

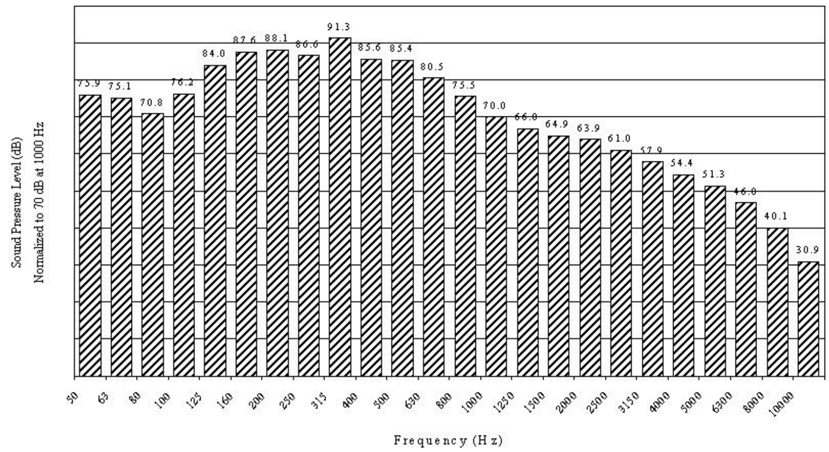


Figure A.18 Spectral Class 222 Sound Pressure Levels

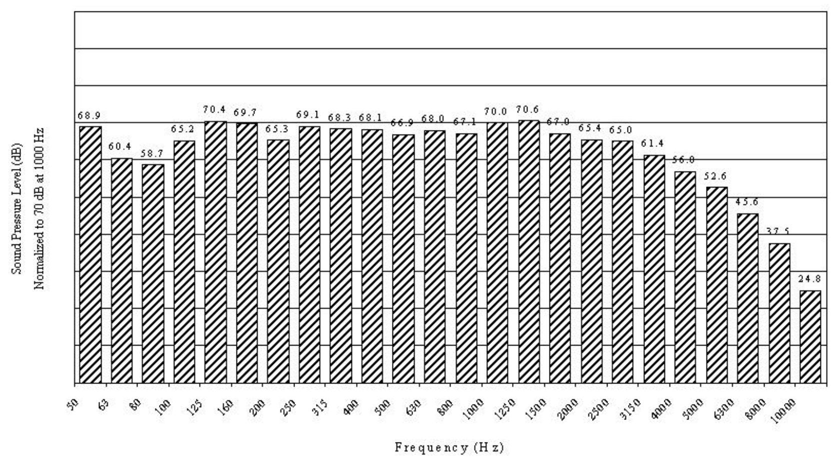


Figure A.19 Spectral Class 302 Sound Pressure Levels

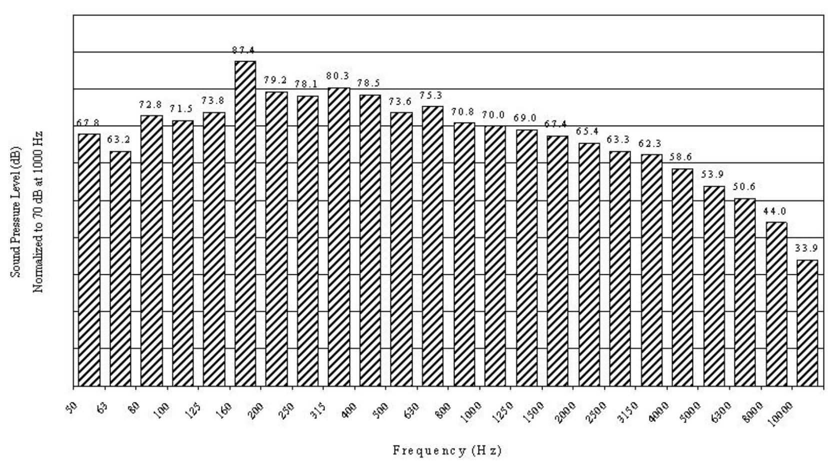


Figure A.20 Spectral Class 307 Sound Pressure Levels

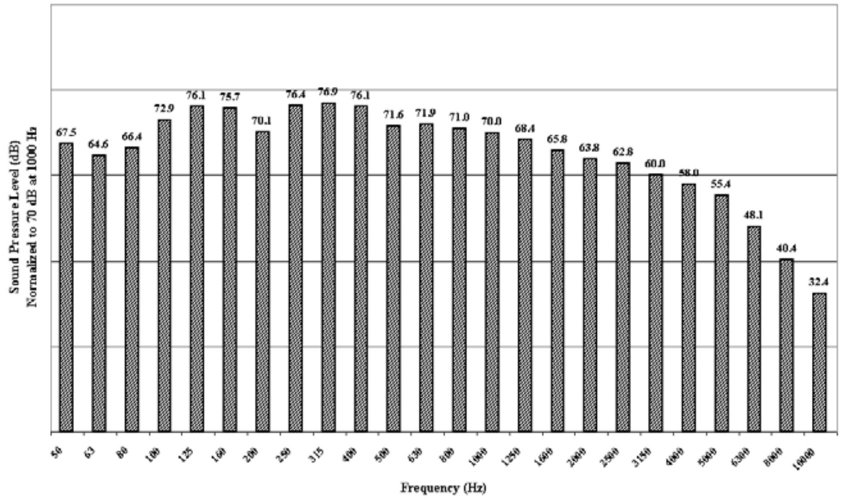


Figure A.21 MD900 Sound Pressure Levels

Appendix B

ISO/ANSI Pure-Tone Absorption Equation (Version 1 and Version 2)

The following memorandum briefly explains the first version of the ISO/ANSI pure-tone absorption equation. An addendum has been added which briefly explains the changes made to the first version of the equation which led to the second version.

B.1 Memorandum, January 31, 2002

SAE A-21 Project Working Team (PWT) on Atmospheric Absorption,

As most of you are aware the U.S. Department of Transportation, John A. Volpe National Transportation Systems Center, Acoustics Facility (Volpe Center), in support of the Federal Aviation Administration's (FAA) Office of Environment and Energy (AEE), have been working under the auspices of a Society of Automotive Engineers' (SAE) Project Working Team (PWT) to assist in the development of an update to SAE Aerospace Recommended Practice (ARP) 866A, *Standard Values of Atmospheric Absorption as a Function of Temperature and Humidity* [REF 1]. Other members of the PWT include Airbus Industries, Boeing Commercial Airplane Company, Dytec Engineering, Mestre Grieve and Associates, and Louis Sutherland.

The work focus for the PWT has been an evaluation of the equations included in two standards, ISO 9613-1, *Acoustics - Attenuation of sound during propagation outdoors - Part 1: Calculation of the absorption of sound by the atmosphere* [REF 2], and ANSI S1.26-1995, *Standard Values of Atmospheric Absorption as a Function of Temperature and Humidity* [REF 3]. The ISO and ANSI equations for computing sound attenuation rates as a function of propagation distance are algebraically identical to one another, and specify computation as a function of temperature, relative humidity, and atmospheric pressure for a **single, discrete frequency or pure-tone.**

To date, the PWT has sufficient data and has performed the necessary analyses to conclude that: (1) the pure-tone absorption equations developed in support of the ANSI and ISO standards are more accurate than the equations of SAE ARP 866A, and (2) adoption of the new equations would result in a change in noise certificated levels for aircraft certified under current FAA and International Civil Aviation Organization (ICAO) noise regulations. These conclusions are based on the results presented in References 4 and 5.

However, the noise certification regulations of both the FAA and ICAO, which mandate the use of SAE ARP 866A, require that noise data be analyzed in one-third-octave bands. Application of the pure-tone sound absorption equations to one-third octave-band data is the only remaining technical obstacle to the adoption of the ISO and ANSI pure-tone equations as a replacement to SAE ARP 866A.

The authors of the ISO and ANSI standards included methods for adapting the pure-tone algorithms for use in fractional-octave-band analysis, e.g., a one-third octave-band or full octave-band analysis. Annex D of both the ISO and ANSI standard present a relatively complex but technically sound method for adapting the pure-tone algorithms for use in fractional octave-band analysis -- the spectrum integrated or **exact method**. In addition, Annex E of the ANSI standard presents a more empirical method of adapting the pure-tone algorithms to one-third-octave bands -- the **approximate method**. For the purpose of aircraft noise certification, the exact method is considered too complex. The approximate method, although easy to implement, is cited in Annex E as accurate only for total path-length absorptions of less than 50 dB. Such a limitation is not adequate for aircraft noise certification, where the total path-length absorption can exceed several hundred decibels, depending on temperature, relative humidity, and source-to-receptor distance. It is particularly not appropriate fro the development of noise-power-distance (NPD) data.

This memorandum presents a brief overview of a newly-proposed approach for adapting the pure-tone algorithms in the ISO and ANSI standards to one-third octave-band data - the **proposed method**. The proposed method can be considered an extension to the approximate method included in Annex E of the ANSI standard. In that regard, the proposed method produces results, which are almost identical to the ANSI approximate method up to 50 dB path-length absorption (see error comparison below). However, where the approximate method breaks down after about 50 dB path-length absorption, the proposed method is considered reliable to 200 dB total path-length absorption. Consequently, the proposed method is considered appropriate for both the adjustment of aircraft noise certification data and for development of NPD data.

The proposed method was developed using an approach similar to that used in the error assessment of the ANSI approximate method [REF 6]. Specifically, the exact method presented in both the ISO and ANSI standards was considered the reference or “gold standard” by which the proposed method was judged. This is considered a reasonable approach since the exact method effectively derives pure-tone sound pressure levels (SPL) from one-third octave-band data. The pure-tone absorption equations are then applied to the derived SPL data. An inherent assumption in this process is that of the one-third octave-band filter shape. For the development of the proposed method a third-order Butterworth filter shape was assumed. This was the same assumption made by the authors of the ANSI approximate method, and it appears to be reasonable since most analyzer manufacturers base their filter design on the traditional third-order Butterworth.

In developing the proposed method a set of broadband (non-tonal) spectra were processed over the complete range of temperature and relative humidity conditions allowed under aircraft noise certification. Note that although the pure-tone ISO and ANSI equations include atmospheric pressure as a variable, previous studies have shown data to be negligibly effected by pressure [REF 5 & 6]. Hence for the purpose of the development of the proposed method, atmospheric pressure was set to a fixed, ISA, sea level value of 1013.25 mm Hg. Data were processed in two ways: (1) from the source to a fixed receiver distance (Case 1); and (2) from a fixed receiver distance to the source (Case 2). In each case the result was a set of points and associated curves relating attenuation by absorption, computed at mid-band for each one-third octave-band frequency and the exact band-level attenuation computed for that band. Figures 1 and 2 respectively show a set of curves for Case 1 and Case 2 computed at 25ºC and 70% relative humidity.

Using the computer program STATISTICA, a statistical analysis was then performed with a goal of developing an empirical equation to compute representative attenuation by absorption for a particular one-third-octave band. The general form of the equation for the ANSI approximate method was used as a starting point. The goal of the analysis was to extend the applicability of that equation to well beyond the recommended 50 dB path-length absorption, using the data derived from the exact method.

Initially two statistical equations were developed, one for Case 1 and a second for Case 2. Although the case dependency on the equations is apparent, the need for reciprocity dictated that a single equation be maintained. That is to say, if two separate equations were maintained data could not be corrected from a receiver to the source and back to the receiver, under the same temperature and humidity conditions such that the original starting data (at a receiver) could be replicated. Consequently, it was decided to maintain the Case 1 equation since it would result in smaller errors as compared with the Case 2 equation. The Case 1 equation was also more consistent with the ANSI approximate method up to 50 dB path-length absorption. As noted in Figures 1 and 2, the band-level attenuation versus the mid-band-level attenuation is data slope dependant; thus, the equations were developed with a slope term. The introduction of a slope term in the equation would however also preclude reciprocity since, for example, the data would be corrected from a receiver to the source assuming one slope and then corrected back to the receiver assuming a different slope. Consequently, the final version of the proposed equation assumes a fixed slope of 3 dB per one-third-octave band. This was found to be a good compromise with the test data and considered to be fairly representative for most broadband aircraft spectra.

The equation for the proposed method for predicting attenuation by atmospheric absorption is as follows:

Predicted Attenuation = (A + B*Mid)*(1+C*(D - E*Mid))^F (1)

where Mid = Band-Level Attenuation at the exact mid-band frequency and A= -0.02397; B= 0.867941757; C= 0.111761; D= 0.95824; E= 0.008191; F= 1.6.

Based on a comparison with data corrected using the exact method, the errors associated with the proposed method and the errors associated with the ANSI approximate method are as follows:

Attenuation Range (dB)	Error Proposed Method (dB)	Error ANSI Approximate Method (dB)
0 – 10	0.5, 0	0.3, -0.3
10 – 50	2.5, -0.1	0.6, -5

50 – 100	2.5, -4	-5, -10
100 – 150	2.0, -11	-10,-25
150 – 200	-2.0, -20	-25,-50

As you can see there is a substantial improvement in accuracy and in the useful range to be realized with the proposed method. I have included with this memorandum an MS Excel spreadsheet, which can be used to assess the proposed method using example spectral data. The spreadsheet is self-explanatory and is setup to mimic a simplified procedure under current FAA and ICAO noise regulations. The Volpe Center is currently using this spreadsheet to exhaustively test the proposed method. I am requesting the addressees of this memorandum to also exercise the method with your own data and provide feedback to me by March 29, 2002.

Sincerely Yours,

Gregg G. Fleming

cc: J. Brooks, SAE, A-21 Chair
M. Marsan, FAA/AEE
J. Gulding, FAA/AEE

B.1.1 References

[1] Society of Automotive Engineers, Committee A-21, Aircraft Noise, Standard Values of Atmospheric Absorption as a Function of Temperature and Humidity, Aerospace Recommended Practice No. 866A, Warrendale, PA: Society of Automotive Engineers, Inc., March 1975.

[2] International Organization for Standardization, Committee ISO/TC 43, Acoustics, Sub-Committee SC 1, Noise, Acoustics - Attenuation of sound during propagation outdoors - Part 1: Calculation of the absorption of sound by the atmosphere, ISO 9613-1, Geneva, Switzerland: International Organization for Standardization, 1993.

[3] American National Standards Institute, Committee S1, Acoustics, Method for Calculation of the Absorption of Sound by the Atmosphere, ANSI S1.26-1995, New York, NY: American National Standards Institute, September 1995.

[4] Rickley, E.J., and Fleming, G.G., Computing the Absorption of Sound by the Atmosphere and its Applicability to Aircraft Noise Certification, Cambridge, MA: Volpe Center, August 1998.

[5] Lempereur, Pierre, Presentation to SAE A-21: Modeling of Sound Attenuation By Atmosphere, Application to Aircraft Noise Certification, Toulouse, France: Aerospatiale, October 1998.

[6] Joppa, P.D., et.al., *Representative frequency approach to the effect of bandpass filters on evaluation of sound attenuation by the atmosphere*, Noise Control Engineering Journal 44(6) 1996 Nov-Dec.

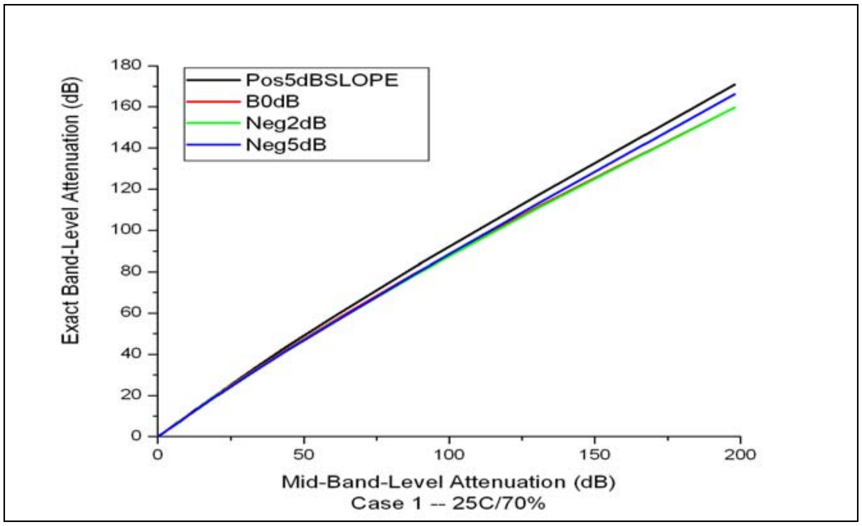


Figure B.1 – Case 1 -- 25ºC/70%RH Exact Band-Level vs. Mid-Band-Level Attenuation Data Slopes +5, 0, -2, and -5 dB

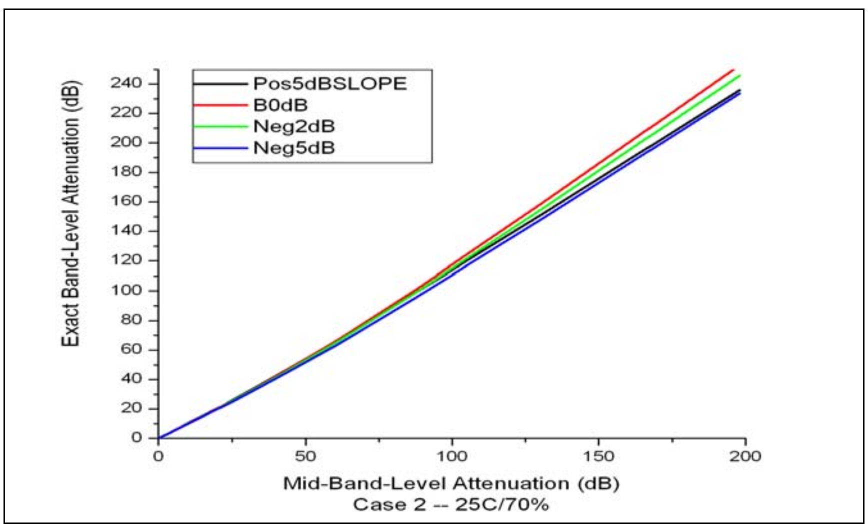


Figure B.2 – Case 2 -- 25ºC/70%RH Exact Band-Level vs. Mid-Band-Level Attenuation Data Slopes +5, 0, -2, and -5 dB

B.2 Addendum, March 15, 2002

The refined equation in the second version of the proposed method for predicting attenuation by atmospheric absorption is the same as in the memorandum above in cases where Band-Level Attenuation at the exact mid-band frequency, or Mid, is less than 150 dB:

Predicted Attenuation = (A + B*Mid)*(1+C*(D - E*Mid))^F (1) where A, B, C, D, E, and F retain the same values as above, A= -0.02397; B= 0.867941757; C= 0.111761; D= 0.95824; E= 0.008191, and F= 1.6.

However, in cases where Mid ≥ 150, the equation changes to:

Predicted Attenuation = ((A+B*150)*(1+C*(D-E*150))^F)*0.95*Mid/150 (2)

where A, B, C, D, E, and F retain the same values.

Appendix C

L_{ASmx} Difference Data Tables

Appendix C presents 105 tables containing the L_{ASmx} vs. distance data generated with 866A and Version 2 of the ISO/ANSI spreadsheet, using the 21 as-measured spectra and the five different temperature/RH combinations.

C.1 As-Measured Spectra Adjusted to 77^{o}F/70% RH

Table C-1. Spectral Class 101 at 77^{o}F/70% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	94.9	94.9	0.0
400	88.5	88.5	0.0
630	84.1	84.1	0.0
1000	79.6	79.5	0.0
2000	72.2	72.2	0.0
4000	64.0	64.0	0.0
6300	58.1	58.2	0.1
10000	51.6	52.1	0.5
16000	44.3	45.7	1.3
25000	36.8	39.4	2.7

Table C-2. Spectral Class 102 at 77^{o}F/70% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	94.7	94.8	0.1
400	88.2	88.2	0.0
630	83.8	83.81	0.0
1000	79.1	79.1	0.0
2000	71.5	71.5	-0.1
4000	62.9	62.7	-0.2
6300	56.4	56.2	-0.2
10000	49.0	48.9	-0.1
16000	40.5	41.2	0.7
25000	31.9	34.0	2.2

Table C-3. Spectral Class 103 at 77^{o}F/70% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	96.7	96.5	-0.2
400	90.1	89.9	-0.1
630	85.5	85.4	-0.1
1000	80.6	80.6	0.0
2000	72.6	72.7	0.1
4000	63.7	63.8	0.1
6300	57.5	57.7	0.1
10000	50.8	51.3	0.5
16000	43.3	44.6	1.2
25000	35.4	37.9	2.5

Table C-4. Spectral Class 104 at 77^{o}F/70% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	93.9	93.9	0.0
400	87.5	87.5	0.0
630	83.2	83.1	0.0
1000	78.5	78.5	0.0
2000	71.0	71.0	0.0
4000	62.5	62.4	-0.1
6300	56.2	56.2	0.0
10000	49.2	49.4	0.2
16000	41.2	42.0	0.9
25000	32.5	34.7	2.2

Table C-5. Spectral Class 105 at 77^{o}F/70% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	95.8	95.7	-0.1
400	89.3	89.2	-0.1
630	84.8	84.8	-0.1
1000	80.1	80.1	0.0
2000	72.5	72.5	0.0
4000	64.1	64.1	0.0
6300	58.1	58.2	0.1
10000	51.5	52.0	0.5
16000	44.2	45.5	1.3
25000	36.5	39.2	2.6

Table C-6. Spectral Class 106 at 77^{o}F/70% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	96.2	96.2	0.0
400	89.7	89.6	0.0
630	85.2	85.2	0.0
1000	80.5	80.5	0.0
2000	72.9	72.9	0.0
4000	64.5	64.4	-0.1
6300	58.3	58.2	-0.1
10000	51.2	51.3	0.1
16000	43.1	43.8	0.8
25000	34.4	36.6	2.2

Table C-7. Spectral Class 107 at 77^{o}F/70% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	97.9	97.6	-0.3
400	91.2	91.0	-0.2
630	86.5	86.4	-0.1
1000	81.4	81.4	0.0
2000	73.1	73.2	0.1
4000	63.9	64.0	0.1
6300	57.5	57.5	0.0
10000	50.6	50.9	0.3
16000	42.9	43.9	1.1
25000	34.8	37.2	2.5

Table C-8. Spectral Class 108 at 77^{o}F/70% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	95.4	95.7	0.2
400	88.6	88.6	0.0
630	83.9	83.8	-0.1
1000	78.8	78.8	0.0
2000	70.7	70.7	0.0
4000	61.9	61.9	0.0
6300	55.6	55.6	0.0
10000	48.7	49.0	0.4
16000	41.3	42.5	1.3
25000	34.0	36.6	2.7

Table C-9. Spectral Class 109 at 77^oF/70% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	100.1	100.1	0.0
400	93.9	93.9	0.0
630	89.7	89.7	0.0
1000	85.4	85.4	0.0
2000	78.5	78.5	0.0
4000	71.0	71.0	0.0
6300	65.5	65.7	0.2
10000	59.4	60.0	0.6
16000	52.4	53.9	1.5
25000	45.1	47.9	2.8

Table C-10. Spectral Class 110 at 77^oF/70% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	100.3	100.3	0.0
400	93.9	93.9	0.0
630	89.7	89.6	0.0
1000	85.2	85.2	0.0
2000	78.3	78.3	0.0
4000	70.9	71.0	0.2
6300	65.5	65.9	0.3
10000	59.5	60.2	0.7
16000	52.6	54.0	1.4
25000	44.9	47.4	2.6

Table C-11. Spectral Class 111 at 77^oF/70% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	106.2	106.1	-0.1
400	100.1	100.0	0.0
630	96.0	95.9	0.0
1000	91.8	91.8	0.0
2000	85.3	85.4	0.1
4000	78.4	78.6	0.3
6300	73.4	73.9	0.5
10000	68.0	68.9	0.9
16000	61.7	63.3	1.6
25000	55.0	57.7	2.7

Table C-12. Spectral Class 112 at 77°F/70% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	100.2	100.1	-0.1
400	93.8	93.7	-0.1
630	89.5	89.4	-0.1
1000	85.0	85.0	0.0
2000	77.9	78.0	0.1
4000	70.7	71.0	0.3
6300	65.8	66.3	0.5
10000	60.6	61.6	1.0
16000	55.0	56.8	1.8
25000	49.0	51.9	2.9

Table C-13. Spectral Class 113 at 77°F/70% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	94.6	94.5	-0.1
400	88.2	88.1	0.0
630	83.8	83.7	0.0
1000	79.1	79.0	0.0
2000	71.5	71.4	0.0
4000	62.9	62.8	-0.1
6300	56.6	56.5	-0.1
10000	49.4	49.5	0.1
16000	41.2	42.1	0.8
25000	32.5	34.7	2.2

Table C-14. Spectral Class 116 at 77°F/70% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	95.6	95.6	0.0
400	89.3	89.3	0.0
630	85.1	85.0	0.0
1000	80.6	80.5	0.0
2000	73.3	73.3	0.0
4000	65.3	65.2	-0.1
6300	59.3	59.3	0.0
10000	52.5	52.7	0.2
16000	44.6	45.6	1.0
25000	36.2	38.6	2.4

Table C-15. Spectral Class 203 at 77^{o}F/70% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	98.7	98.4	-0.3
400	91.8	91.5	-0.2
630	86.9	86.7	-0.2
1000	81.5	81.5	0.0
2000	72.8	72.9	0.1
4000	63.6	63.6	0.0
6300	57.2	57.1	-0.1
10000	50.0	50.2	0.2
16000	42.0	43.0	1.0
25000	33.6	36.0	2.4

Table C-16. Spectral Class 205 at 77^{o}F/70% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	95.3	95.2	0.0
400	88.7	88.6	-0.1
630	84.1	84.0	-0.1
1000	79.2	79.2	0.0
2000	71.4	71.4	0.0
4000	62.7	62.7	-0.1
6300	56.5	56.4	0.0
10000	49.5	49.8	0.3
16000	41.9	43.0	1.2
25000	34.0	36.6	2.6

Table C-17. Spectral Class 219 at 77^{o}F/70% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	97.6	97.6	0.0
400	91.4	91.3	0.0
630	87.2	87.1	0.0
1000	82.8	82.8	0.0
2000	75.9	75.9	0.0
4000	68.4	68.5	0.1
6300	63.0	63.2	0.3
10000	56.9	57.6	0.7
16000	50.1	51.5	1.5
25000	42.6	45.4	2.8

Table C-18. Spectral Class 222 at 77°F/70% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	103.9	103.9	0.0
400	97.8	97.7	0.0
630	93.6	93.6	0.0
1000	89.3	89.3	0.0
2000	82.6	82.6	0.0
4000	75.2	75.3	0.1
6300	69.8	70.0	0.2
10000	63.6	64.1	0.5
16000	56.2	57.4	1.2
25000	48.0	50.3	2.3

Table C-19. Spectral Class 302 at 77°F/70% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	93.6	93.5	-0.1
400	87.1	86.9	-0.1
630	82.5	82.4	-0.1
1000	77.6	77.6	0.0
2000	69.4	69.4	0.0
4000	60.0	60.0	0.0
6300	53.0	52.9	-0.1
10000	45.3	45.5	0.2
16000	37.1	38.1	1.0
25000	28.9	31.3	2.4

Table C-20. Spectral Class 307 at 77°F/70% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	97.4	97.3	-0.1
400	91.0	91.0	0.0
630	86.8	86.7	0.0
1000	82.3	82.2	0.0
2000	75.2	75.2	0.0
4000	67.5	67.6	0.1
6300	62.0	62.3	0.3
10000	56.0	56.7	0.7
16000	49.1	50.6	1.5
25000	41.7	44.5	2.9

Table C-21. MD900 Spectral Data at 77°F/70% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	81.3	81.2	-0.1
400	74.9	74.8	0.0
630	70.5	70.5	0.0
1000	65.9	65.9	0.0
2000	58.5	58.5	0.0
4000	50.3	50.3	0.0
6300	44.4	44.5	0.1
10000	37.7	38.1	0.4
16000	30.1	31.2	1.1
25000	21.9	24.2	2.3

C.2 As-Measured Spectra Adjusted to 85°F/35% RH

Table C-22. Spectral Class 101 at 85°F/35% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	94.8	94.8	0.0
400	88.4	88.4	0.0
630	84.0	84.0	0.0
1000	79.4	79.4	0.0
2000	72.0	71.9	0.0
4000	63.7	63.5	-0.1
6300	57.7	57.4	-0.2
10000	51.0	50.8	-0.2
16000	43.7	43.8	0.2
25000	36.0	37.0	1.0

Table C-23. Spectral Class 102 at 85°F/35% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	94.7	94.6	0.0
400	88.1	88.1	0.0
630	83.7	83.6	0.0
1000	78.9	78.9	0.0
2000	71.3	71.2	0.0
4000	62.5	62.3	-0.2
6300	55.9	55.5	-0.4
10000	48.3	47.7	-0.6
16000	39.7	39.3	-0.4
25000	30.9	31.5	0.7

Table C-24. Spectral Class 103 at 85^{o}F/35% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	96.6	96.4	-0.2
400	90.0	89.8	-0.2
630	85.3	85.2	-0.1
1000	80.4	80.3	0.0
2000	72.3	72.3	0.1
4000	63.3	63.3	0.0
6300	57.1	56.9	-0.2
10000	50.2	49.9	-0.3
16000	42.6	42.5	-0.1
25000	34.5	35.0	0.6

Table C-25. Spectral Class 104 at 85^{o}F/35% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	93.9	93.9	0.0
400	87.5	87.4	0.0
630	83.1	83.1	0.0
1000	78.4	78.4	0.0
2000	70.8	70.8	0.0
4000	62.1	62.0	-0.1
6300	55.7	55.4	-0.3
10000	48.5	48.0	-0.5
16000	40.3	39.8	-0.5
25000	31.5	31.7	0.2

Table C-26. Spectral Class 105 at 85^{o}F/35% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	95.7	95.6	-0.1
400	89.2	89.1	-0.1
630	84.7	84.6	-0.1
1000	79.9	79.9	0.0
2000	72.2	72.2	0.0
4000	63.7	63.6	-0.1
6300	57.6	57.4	-0.2
10000	51.0	50.7	-0.2
16000	43.5	43.6	0.1
25000	35.7	36.6	1.0

Table C-27. Spectral Class 106 at 85°F/35% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	96.1	96.1	-0.1
400	89.6	89.5	-0.1
630	85.1	85.0	-0.1
1000	80.3	80.3	0.0
2000	72.6	72.6	0.0
4000	64.1	63.9	-0.2
6300	57.8	57.3	-0.4
10000	50.5	49.9	-0.6
16000	42.2	41.7	-0.5
25000	33.4	33.9	0.5

Table C-28. Spectral Class 107 at 85°F/35% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	97.8	97.5	-0.3
400	91.1	90.8	-0.3
630	86.3	86.1	-0.2
1000	81.2	81.1	-0.1
2000	72.7	72.7	0.0
4000	63.4	63.4	-0.1
6300	57.0	56.7	-0.3
10000	50.0	49.6	-0.4
16000	42.1	41.9	-0.2
25000	33.9	34.6	0.7

Table C-29. Spectral Class 108 at 85°F/35% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	95.3	95.2	0.0
400	88.4	88.2	-0.2
630	83.6	83.4	-0.2
1000	78.5	78.4	-0.1
2000	70.4	70.4	0.0
4000	61.5	61.5	0.0
6300	55.1	54.9	-0.1
10000	48.1	48.0	-0.1
16000	40.7	41.0	0.3
25000	33.2	34.6	1.4

Table C-30. Spectral Class 109 at 85°F/35% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	100.1	100.1	0.0
400	93.8	93.8	0.0
630	89.7	89.6	0.0
1000	85.3	85.2	-0.1
2000	78.4	78.3	-0.1
4000	70.7	70.5	-0.2
6300	65.2	64.9	-0.2
10000	58.9	58.8	-0.1
16000	51.8	52.1	0.3
25000	44.4	45.5	1.1

Table C-31. Spectral Class 110 at 85°F/35% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	100.2	100.2	0.0
400	93.9	93.8	-0.1
630	89.6	89.5	-0.1
1000	85.1	85.0	-0.1
2000	78.2	78.0	-0.1
4000	70.6	70.4	-0.2
6300	65.2	64.9	-0.3
10000	59.1	58.8	-0.3
16000	51.9	51.8	-0.1
25000	44.0	44.5	0.5

Table C-32. Spectral Class 111 at 85°F/35% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	106.2	106.1	-0.1
400	100.0	99.9	-0.1
630	96.0	95.9	-0.1
1000	91.7	91.6	-0.1
2000	85.2	85.1	-0.1
4000	78.2	78.1	-0.1
6300	73.2	73.2	0.0
10000	67.6	67.7	0.1
16000	61.2	61.8	0.5
25000	54.3	55.7	1.4

Table C-33. Spectral Class 112 at 85^{o}F/35% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	100.2	100.0	-0.2
400	93.8	93.6	-0.1
630	89.4	89.3	-0.1
1000	84.9	84.8	-0.1
2000	77.8	77.8	0.0
4000	70.5	70.6	0.1
6300	65.6	65.9	0.3
10000	60.4	60.9	0.6
16000	54.6	55.7	1.1
25000	48.5	50.4	1.9

Table C-34. Spectral Class 113 at 85^{o}F/35% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	94.6	94.5	-0.1
400	88.1	88.0	-0.1
630	83.6	83.6	0.0
1000	78.9	78.9	0.0
2000	71.2	71.2	0.0
4000	62.5	62.4	-0.1
6300	56.1	55.7	-0.4
10000	48.7	48.2	-0.6
16000	40.4	39.9	-0.5
25000	31.5	31.7	0.2

Table C-35. Spectral Class 116 at 85^{o}F/35% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	95.6	95.6	0.0
400	89.3	89.3	0.0
630	85.0	85.0	0.0
1000	80.4	80.4	0.0
2000	73.1	73.0	-0.1
4000	64.9	64.7	-0.2
6300	58.9	58.4	-0.4
10000	51.9	51.3	-0.5
16000	43.8	43.5	-0.4
25000	35.2	35.6	0.4

Table C-36. Spectral Class 203 at 85^{o}F/35% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	98.6	98.1	-0.4
400	91.5	91.1	-0.4
630	86.5	86.2	-0.3
1000	81.1	80.9	-0.2
2000	72.4	72.3	0.0
4000	63.1	63.0	-0.1
6300	56.6	56.3	-0.3
10000	49.4	48.9	-0.5
16000	41.2	40.9	-0.3
25000	32.6	33.1	0.5

Table C-37. Spectral Class 205 at 85^{o}F/35% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	95.2	95.1	-0.1
400	88.5	88.4	-0.1
630	83.9	83.8	-0.1
1000	79.0	79.0	-0.1
2000	71.1	71.1	0.0
4000	62.3	62.3	-0.1
6300	56.0	55.7	-0.2
10000	48.9	48.6	-0.3
16000	41.2	41.2	0.1
25000	33.2	34.2	1.0

Table C-38. Spectral Class 219 at 85^{o}F/35% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	97.6	97.5	0.0
400	91.3	91.3	0.0
630	87.1	87.1	-0.1
1000	82.7	82.6	-0.1
2000	75.7	75.6	-0.1
4000	68.1	68.0	-0.2
6300	62.6	62.4	-0.2
10000	56.5	56.3	-0.1
16000	49.4	49.7	0.2
25000	41.8	42.9	1.0

Table C-39. Spectral Class 222 at 85°F/35% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	103.9	103.9	0.0
400	97.7	97.7	-0.1
630	93.6	93.5	-0.1
1000	89.3	89.2	-0.1
2000	82.5	82.3	-0.2
4000	75.0	74.7	-0.3
6300	69.5	69.0	-0.4
10000	63.1	62.6	-0.5
16000	55.5	55.1	-0.4
25000	46.9	47.0	0.1

Table C-40. Spectral Class 302 at 85°F/35% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	93.6	93.4	-0.1
400	87.0	86.8	-0.1
630	82.4	82.3	-0.1
1000	77.4	77.4	0.0
2000	69.1	69.2	0.1
4000	59.5	59.6	0.1
6300	52.4	52.3	0.0
10000	44.6	44.4	-0.3
16000	36.3	36.2	-0.2
25000	27.9	28.6	0.6

Table C-41. Spectral Class 307 at 85°F/35% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	97.3	97.2	-0.1
400	91.0	90.9	-0.1
630	86.7	86.6	-0.1
1000	82.2	82.1	-0.1
2000	75.0	74.9	-0.1
4000	67.3	67.1	-0.1
6300	61.7	61.5	-0.2
10000	55.5	55.4	-0.1
16000	48.5	48.8	0.3
25000	40.9	42.0	1.1

Table C-42. MD900 Spectral Data at 85^{o}F/35% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	81.2	81.1	-0.1
400	74.8	74.7	-0.1
630	70.4	70.3	-0.1
1000	65.7	65.7	0.0
2000	58.3	58.2	-0.1
4000	50.0	49.8	-0.2
6300	44.0	43.6	-0.4
10000	37.2	36.7	-0.5
16000	29.4	29.0	-0.3
25000	20.9	21.3	0.4

C.3 As-Measured Spectra Adjusted to 85^{o}F/85% RH

Table C-43. Spectral Class 101 at 85^{o}F/85% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	94.8	94.8	0.0
400	88.4	88.4	0.0
630	84.1	84.0	-0.1
1000	79.4	79.4	-0.1
2000	72.0	72.0	0.0
4000	63.7	63.9	0.2
6300	57.7	58.3	0.7
10000	51.0	52.5	1.5
16000	43.7	46.5	2.8
25000	36.0	40.6	4.6

Table C-44. Spectral Class 102 at 85^{o}F/85% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	94.7	94.8	0.1
400	88.2	88.2	0.0
630	83.7	83.7	0.0
1000	79.0	78.9	0.0
2000	71.3	71.2	-0.1
4000	62.5	62.5	0.0
6300	55.9	56.2	0.3
10000	48.3	49.3	1.0
16000	39.7	42.1	2.4
25000	30.9	35.3	4.4

Table C-45. Spectral Class 103 at 85°F/85% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	96.6	96.4	-0.2
400	90.0	89.8	-0.2
630	85.4	85.2	-0.2
1000	80.4	80.3	-0.2
2000	72.3	72.2	-0.1
4000	63.3	63.5	0.2
6300	57.1	57.7	0.7
10000	50.2	51.8	1.6
16000	42.6	45.6	2.9
25000	34.5	39.3	4.8

Table C-46. Spectral Class 104 at 85°F/85% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	93.9	93.8	-0.1
400	87.5	87.4	-0.1
630	83.1	83.0	-0.1
1000	78.4	78.3	-0.1
2000	70.8	70.7	-0.1
4000	62.1	62.3	0.1
6300	55.7	56.3	0.6
10000	48.5	49.9	1.4
16000	40.3	43.1	2.8
25000	31.5	36.2	4.7

Table C-47. Spectral Class 105 at 85°F/85% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	95.7	95.6	-0.1
400	89.2	89.1	-0.1
630	84.7	84.6	-0.1
1000	79.9	79.9	-0.1
2000	72.2	72.2	0.0
4000	63.7	64.0	0.2
6300	57.6	58.3	0.7
10000	51.0	52.5	1.5
16000	43.5	46.4	2.9
25000	35.7	40.4	4.7

Table C-48. Spectral Class 106 at 85^oF/85% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	96.2	96.2	0.0
400	89.6	89.6	0.0
630	85.1	85.1	0.0
1000	80.3	80.3	0.0
2000	72.7	72.7	0.0
4000	64.1	64.3	0.2
6300	57.8	58.3	0.5
10000	50.5	51.8	1.3
16000	42.2	44.8	2.6
25000	33.4	38.0	4.5

Table C-49. Spectral Class 107 at 85^oF/85% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	97.8	97.5	-0.3
400	91.1	90.8	-0.3
630	86.4	86.1	-0.2
1000	81.2	81.0	-0.2
2000	72.7	72.7	-0.1
4000	63.5	63.6	0.2
6300	57.0	57.6	0.6
10000	50.0	51.4	1.4
16000	42.1	44.9	2.8
25000	33.9	38.5	4.7

Table C-50. Spectral Class 108 at 85^oF/85% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	95.4	95.7	0.4
400	88.5	88.6	0.1
630	83.7	83.8	0.0
1000	78.6	78.6	0.0
2000	70.4	70.4	-0.1
4000	61.5	61.5	0.0
6300	55.1	55.5	0.5
10000	48.1	49.4	1.3
16000	40.7	43.3	2.6
25000	33.2	37.6	4.3

Table C-51. Spectral Class 109 at 85°F/85% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	100.1	100.1	0.0
400	93.8	93.9	0.0
630	89.7	89.7	0.0
1000	85.3	85.4	0.1
2000	78.4	78.5	0.2
4000	70.7	71.2	0.4
6300	65.2	66.0	0.8
10000	58.9	60.5	1.6
16000	51.8	54.7	2.9
25000	44.4	49.0	4.7

Table C-52. Spectral Class 110 at 85°F/85% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	100.2	100.3	0.1
400	93.9	93.9	0.0
630	89.6	89.6	0.0
1000	85.1	85.2	0.1
2000	78.2	78.4	0.2
4000	70.6	71.2	0.6
6300	65.2	66.3	1.0
10000	59.1	60.9	1.8
16000	51.9	55.0	3.1
25000	44.0	48.8	4.9

Table C-53. Spectral Class 111 at 85°F/85% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	106.2	106.1	0.0
400	100.0	100.0	0.0
630	96.0	96.0	0.0
1000	91.7	91.8	0.1
2000	85.2	85.5	0.3
4000	78.2	78.8	0.6
6300	73.2	74.3	1.1
10000	67.6	69.4	1.8
16000	61.2	64.1	2.9
25000	54.3	58.7	4.4

Table C-54. Spectral Class 112 at 85°F/85% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	100.2	100.0	-0.1
400	93.8	93.6	-0.1
630	89.4	89.3	-0.1
1000	84.9	84.8	0.0
2000	77.8	77.9	0.1
4000	70.5	71.0	0.5
6300	65.6	66.5	0.9
10000	60.4	61.9	1.6
16000	54.6	57.2	2.6
25000	48.5	52.5	4.1

Table C-55. Spectral Class 113 at 85°F/85% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	94.6	94.5	-0.1
400	88.1	88.0	-0.1
630	83.7	83.6	-0.1
1000	78.9	78.8	-0.1
2000	71.2	71.2	-0.1
4000	62.5	62.6	0.1
6300	56.1	56.5	0.5
10000	48.7	50.0	1.3
16000	40.4	43.1	2.7
25000	31.5	36.2	4.7

Table C-56. Spectral Class 116 at 85°F/85% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	95.6	95.6	0.0
400	89.3	89.3	0.0
630	85.0	85.0	0.0
1000	80.4	80.4	0.0
2000	73.1	73.2	0.1
4000	64.9	65.2	0.3
6300	58.9	59.5	0.7
10000	51.9	53.3	1.4
16000	43.8	46.6	2.8
25000	35.2	40.0	4.8

Table C-57. Spectral Class 203 at 85^{o}F/85% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	98.7	98.4	-0.3
400	91.7	91.4	-0.2
630	86.7	86.5	-0.1
1000	81.2	81.2	-0.1
2000	72.4	72.5	0.0
4000	63.2	63.3	0.1
6300	56.6	57.1	0.5
10000	49.4	50.7	1.3
16000	41.2	43.9	2.7
25000	32.6	37.4	4.7

Table C-58. Spectral Class 205 at 85^{o}F/85% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	95.2	95.2	0.0
400	88.6	88.5	0.0
630	84.0	83.9	-0.1
1000	79.1	79.0	-0.1
2000	71.1	71.1	-0.1
4000	62.3	62.4	0.1
6300	56.0	56.5	0.5
10000	48.9	50.2	1.3
16000	41.2	43.9	2.7
25000	33.2	37.8	4.6

Table C-59. Spectral Class 219 at 85^{o}F/85% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	97.6	97.5	0.0
400	91.3	91.3	0.0
630	87.1	87.1	0.0
1000	82.7	82.7	0.0
2000	75.7	75.9	0.2
4000	68.1	68.6	0.5
6300	62.6	63.6	0.9
10000	56.5	58.2	1.7
16000	49.4	52.4	3.0
25000	41.8	46.6	4.8

Table C-60. Spectral Class 222 at 85°F/85% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	103.9	103.9	0.0
400	97.7	97.8	0.0
630	93.6	93.6	0.1
1000	89.3	89.4	0.1
2000	82.5	82.7	0.3
4000	75.0	75.6	0.6
6300	69.5	70.5	1.0
10000	63.1	64.8	1.8
16000	55.5	58.5	3.0
25000	46.9	51.9	4.9

Table C-61. Spectral Class 302 at 85°F/85% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	93.6	93.4	-0.2
400	87.0	86.8	-0.2
630	82.4	82.2	-0.2
1000	77.4	77.2	-0.2
2000	69.1	68.8	-0.3
4000	59.5	59.3	-0.2
6300	52.4	52.5	0.2
10000	44.6	45.8	1.2
16000	36.3	39.0	2.7
25000	27.9	32.6	4.7

Table C-62. Spectral Class 307 at 85°F/85% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	97.3	97.3	-0.1
400	91.0	90.9	0.0
630	86.7	86.7	0.0
1000	82.2	82.2	0.0
2000	75.0	75.1	0.1
4000	67.3	67.7	0.5
6300	61.7	62.6	0.9
10000	55.5	57.2	1.7
16000	48.5	51.5	3.0
25000	40.9	45.7	4.8

Table C-63. MD900 Spectral Data at 85°F/85% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	81.2	81.2	0.0
400	74.8	74.7	0.0
630	70.4	70.4	0.0
1000	65.8	65.7	0.0
2000	58.3	58.3	0.0
4000	50.0	50.3	0.3
6300	44.0	44.7	0.7
10000	37.2	38.7	1.6
16000	29.4	32.3	2.9
25000	20.9	25.7	4.8

C.4 As-Measured Spectra Adjusted to 40°F/85% RH

Table C-64. Spectral Class 101 at 40°F/85% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	94.9	94.9	0.0
400	88.6	88.6	0.0
630	84.3	84.4	0.0
1000	79.8	80.0	0.1
2000	72.8	73.1	0.3
4000	65.1	65.6	0.5
6300	59.7	60.3	0.6
10000	53.6	54.4	0.8
16000	47.0	47.9	0.9
25000	40.1	41.1	1.0

Table C-65. Spectral Class 102 at 40°F/85% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	94.7	94.7	0.0
400	88.3	88.3	0.0
630	84.0	84.0	0.1
1000	79.4	79.6	0.2
2000	72.2	72.6	0.4
4000	64.3	64.9	0.6
6300	58.4	59.3	0.9
10000	51.8	53.0	1.2
16000	44.2	45.7	1.5
25000	36.1	37.9	1.8

Table C-66. Spectral Class 103 at 40^{o}F/85% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	96.7	96.4	-0.2
400	90.1	89.9	-0.2
630	85.6	85.5	-0.1
1000	80.8	80.8	0.0
2000	73.2	73.4	0.2
4000	64.9	65.4	0.5
6300	59.2	59.8	0.7
10000	53.0	53.8	0.8
16000	46.2	47.1	0.9
25000	39.0	40.1	1.0

Table C-67. Spectral Class 104 at 40^{o}F/85% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	94.0	94.0	0.0
400	87.7	87.7	0.0
630	83.4	83.4	0.1
1000	78.9	79.0	0.1
2000	71.7	72.0	0.3
4000	63.8	64.3	0.6
6300	58.1	58.8	0.8
10000	51.7	52.7	1.0
16000	44.5	45.7	1.2
25000	36.8	38.2	1.4

Table C-68. Spectral Class 105 at 40^{o}F/85% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	95.8	95.7	-0.1
400	89.3	89.2	-0.1
630	85.0	84.9	0.0
1000	80.3	80.4	0.1
2000	73.1	73.3	0.2
4000	65.2	65.7	0.5
6300	59.6	60.3	0.6
10000	53.6	54.4	0.8
16000	46.9	47.8	0.9
25000	39.9	41.0	1.0

Table C-69. Spectral Class 106 at 40^{o}F/85% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	96.2	96.1	-0.1
400	89.7	89.6	-0.1
630	85.3	85.3	0.0
1000	80.7	80.8	0.1
2000	73.5	73.8	0.3
4000	65.7	66.2	0.5
6300	60.1	60.8	0.7
10000	53.8	54.7	1.0
16000	46.5	47.8	1.3
25000	38.7	40.2	1.6

Table C-70. Spectral Class 107 at 40^{o}F/85% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	97.9	97.5	-0.3
400	91.2	90.9	-0.3
630	86.5	86.3	-0.2
1000	81.5	81.4	-0.1
2000	73.5	73.7	0.2
4000	65.0	65.6	0.5
6300	59.2	60.0	0.7
10000	52.9	53.9	0.9
16000	45.9	47.0	1.1
25000	38.5	39.8	1.2

Table C-71. Spectral Class 108 at 40^{o}F/85% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	95.3	95.1	-0.1
400	88.4	88.2	-0.2
630	83.8	83.6	-0.1
1000	78.9	78.9	0.0
2000	71.3	71.6	0.3
4000	63.2	63.8	0.6
6300	57.3	58.1	0.8
10000	51.0	52.0	1.0
16000	44.0	45.1	1.1
25000	37.0	38.2	1.2

Table C-72. Spectral Class 109 at 40°F/85% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	100.1	100.2	0.0
400	94.0	94.0	0.0
630	89.9	89.9	0.1
1000	85.6	85.7	0.1
2000	79.0	79.2	0.2
4000	71.9	72.3	0.3
6300	66.9	67.3	0.5
10000	61.2	61.8	0.6
16000	54.9	55.6	0.8
25000	48.2	49.1	0.9

Table C-73. Spectral Class 110 at 40°F/85% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	100.3	100.2	-0.1
400	93.9	93.9	-0.1
630	89.8	89.7	0.0
1000	85.4	85.4	0.0
2000	78.7	78.8	0.1
4000	71.7	71.9	0.2
6300	66.7	67.0	0.3
10000	61.3	61.7	0.4
16000	55.1	55.6	0.6
25000	48.3	49.1	0.8

Table C-74. Spectral Class 111 at 40°F/85% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	106.2	106.1	-0.1
400	100.1	100.1	-0.1
630	96.1	96.0	-0.1
1000	91.9	91.9	0.0
2000	85.6	85.6	0.0
4000	78.9	79.0	0.1
6300	74.3	74.4	0.1
10000	69.2	69.5	0.2
16000	63.6	64.0	0.4
25000	57.6	58.2	0.7

Table C-75. Spectral Class 112 at 40^{o}F/85% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	100.2	100.0	-0.2
400	93.9	93.7	-0.2
630	89.6	89.5	-0.1
1000	85.1	85.1	0.0
2000	78.3	78.3	0.1
4000	71.2	71.4	0.2
6300	66.5	66.7	0.2
10000	61.6	61.9	0.3
16000	56.3	56.7	0.4
25000	50.9	51.5	0.6

Table C-76. Spectral Class 113 at 40^{o}F/85% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	94.6	94.6	-0.1
400	88.3	88.2	0.0
630	83.9	84.0	0.0
1000	79.4	79.5	0.1
2000	72.1	72.5	0.3
4000	64.2	64.8	0.6
6300	58.4	59.2	0.8
10000	52.0	53.0	1.0
16000	44.7	46.0	1.3
25000	36.8	38.3	1.5

Table C-77. Spectral Class 116 at 40^{o}F/85% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	95.7	95.7	0.0
400	89.4	89.5	0.0
630	85.3	85.3	0.1
1000	80.9	81.0	0.1
2000	74.0	74.2	0.3
4000	66.4	66.9	0.5
6300	61.0	61.6	0.6
10000	54.9	55.7	0.9
16000	47.9	49.0	1.1
25000	40.3	41.6	1.3

Table C-78. Spectral Class 203 at 40^{o}F/85% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	98.5	98.1	-0.5
400	91.5	91.0	-0.5
630	86.6	86.2	-0.4
1000	81.3	81.1	-0.2
2000	73.2	73.4	0.2
4000	64.8	65.4	0.6
6300	59.0	59.8	0.8
10000	52.6	53.6	1.0
16000	45.3	46.5	1.2
25000	37.6	39.0	1.4

Table C-79. Spectral Class 205 at 40^{o}F/85% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	95.2	95.1	-0.1
400	88.6	88.5	-0.1
630	84.2	84.1	-0.1
1000	79.4	79.5	0.1
2000	72.0	72.3	0.3
4000	64.0	64.6	0.6
6300	58.3	59.0	0.8
10000	51.9	52.9	1.0
16000	44.8	46.0	1.2
25000	37.6	38.8	1.3

Table C-80. Spectral Class 219 at 40^{o}F/85% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	97.6	97.6	0.0
400	91.5	91.5	0.0
630	87.3	87.4	0.0
1000	83.0	83.1	0.1
2000	76.4	76.5	0.2
4000	69.2	69.5	0.3
6300	64.2	64.6	0.4
10000	58.7	59.1	0.5
16000	52.4	53.1	0.6
25000	45.8	46.6	0.8

Table C-81. Spectral Class 222 at 40°F/85% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	104.0	104.0	0.0
400	97.8	97.8	0.0
630	93.8	93.8	0.0
1000	89.6	89.6	0.0
2000	83.0	83.1	0.1
4000	76.1	76.3	0.2
6300	71.1	71.4	0.3
10000	65.5	66.0	0.5
16000	59.1	59.8	0.7
25000	51.9	52.9	1.0

Table C-82. Spectral Class 302 at 40°F/85% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	93.7	93.5	-0.1
400	87.1	87.0	-0.1
630	82.7	82.6	0.0
1000	77.9	78.0	0.1
2000	70.2	70.5	0.3
4000	61.5	62.2	0.7
6300	55.1	56.1	1.0
10000	48.1	49.4	1.3
16000	40.5	41.8	1.4
25000	32.7	34.2	1.4

Table C-83. Spectral Class 307 at 40°F/85% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	97.4	97.3	-0.1
400	91.1	91.1	0.0
630	86.9	86.9	0.0
1000	82.5	82.5	0.1
2000	75.7	75.8	0.2
4000	68.4	68.7	0.3
6300	63.3	63.7	0.4
10000	57.7	58.2	0.5
16000	51.5	52.1	0.7
25000	44.9	45.7	0.8

Table C-84. MD900 Spectral Data at 40°F/85% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	81.3	81.2	-0.1
400	74.9	74.9	0.0
630	70.6	70.6	0.0
1000	66.1	66.2	0.1
2000	59.1	59.3	0.3
4000	51.5	51.9	0.5
6300	46.0	46.6	0.6
10000	40.0	40.7	0.8
16000	33.1	34.1	1.0
25000	25.8	27.0	1.2

C.5 As-Measured Spectra Adjusted to 40°F/55% RH

Table C-85. Spectral Class 101 at 40°F/55% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	94.8	94.7	0.0
400	88.3	88.4	0.0
630	84.0	84.1	0.1
1000	79.4	79.6	0.2
2000	72.2	72.6	0.4
4000	64.4	65.0	0.6
6300	58.9	59.6	0.7
10000	53.0	53.8	0.8
16000	46.5	47.3	0.8
25000	39.8	40.6	0.8

Table C-86. Spectral Class 102 at 40°F/55% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	94.5	94.5	0.0
400	88.0	88.0	0.1
630	83.6	83.7	0.1
1000	78.9	79.2	0.3
2000	71.5	72.0	0.5
4000	63.3	64.1	0.8
6300	57.3	58.4	1.1
10000	50.7	52.0	1.3
16000	43.1	44.7	1.6
25000	35.3	36.9	1.6

Table C-87. Spectral Class 103 at 40^{o}F/55% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	96.4	96.2	-0.2
400	89.6	89.5	-0.1
630	84.9	84.9	0.0
1000	80.0	80.1	0.1
2000	72.1	72.5	0.4
4000	63.9	64.5	0.6
6300	58.3	59.0	0.7
10000	52.3	53.1	0.8
16000	45.7	46.6	0.9
25000	38.7	39.7	0.9

Table C-88. Spectral Class 104 at 40^{o}F/55% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	93.9	93.8	0.0
400	87.4	87.5	0.1
630	83.0	83.1	0.1
1000	78.4	78.6	0.2
2000	71.0	71.4	0.4
4000	62.9	63.6	0.7
6300	57.1	58.0	0.9
10000	50.8	51.8	1.0
16000	43.8	45.0	1.2
25000	36.3	37.6	1.4

Table C-89. Spectral Class 105 at 40^{o}F/55% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	95.6	95.5	-0.1
400	89.0	88.9	0.0
630	84.5	84.5	0.0
1000	79.7	79.9	0.2
2000	72.3	72.7	0.4
4000	64.4	65.0	0.6
6300	58.9	59.6	0.7
10000	53.0	53.7	0.8
16000	46.4	47.3	0.8
25000	39.6	40.5	0.9

Table C-90. Spectral Class 106 at 40^{o}F/55% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	96.0	95.9	-0.1
400	89.4	89.3	0.0
630	84.9	85.0	0.1
1000	80.2	80.4	0.2
2000	72.9	73.3	0.4
4000	64.9	65.6	0.7
6300	59.3	60.1	0.9
10000	52.9	54.0	1.1
16000	45.7	47.1	1.4
25000	38.0	39.5	1.5

Table C-91. Spectral Class 107 at 40^{o}F/55% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	97.5	97.2	-0.3
400	90.5	90.3	-0.2
630	85.7	85.5	-0.1
1000	80.4	80.5	0.1
2000	72.3	72.7	0.4
4000	64.0	64.7	0.7
6300	58.3	59.1	0.8
10000	52.1	53.1	1.0
16000	45.3	46.3	1.1
25000	38.1	39.2	1.1

Table C-92. Spectral Class 108 at 40^{o}F/55% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	94.8	94.7	-0.2
400	87.8	87.7	-0.1
630	83.1	83.0	0.0
1000	78.1	78.3	0.2
2000	70.4	70.9	0.5
4000	62.1	62.8	0.7
6300	56.3	57.2	0.9
10000	50.0	51.0	1.0
16000	43.4	44.3	1.0
25000	36.7	37.5	0.9

Table C-93. Spectral Class 109 at 40^{o}F/55% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	100.1	100.1	0.0
400	93.9	94.0	0.1
630	89.8	89.9	0.1
1000	85.5	85.6	0.1
2000	78.8	79.1	0.2
4000	71.6	72.0	0.4
6300	66.5	67.0	0.5
10000	60.8	61.4	0.6
16000	54.5	55.2	0.7
25000	48.0	48.7	0.7

Table C-94. Spectral Class 110 at 40^{o}F/55% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	100.1	100.1	-0.1
400	93.8	93.7	0.0
630	89.6	89.5	0.0
1000	85.2	85.2	0.0
2000	78.5	78.6	0.1
4000	71.4	71.7	0.2
6300	66.5	66.8	0.3
10000	61.1	61.5	0.4
16000	54.9	55.5	0.6
25000	48.2	48.9	0.7

Table C-95. Spectral Class 111 at 40^{o}F/55% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	106.2	106.1	-0.1
400	100.1	100.0	-0.1
630	96.1	96.0	-0.1
1000	91.9	91.9	0.0
2000	85.5	85.5	0.0
4000	78.9	78.9	0.1
6300	74.2	74.3	0.1
10000	69.2	69.4	0.2
16000	63.5	63.8	0.3
25000	57.5	58.0	0.5

Table C-96. Spectral Class 112 at 40^{o}F/55% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	100.0	99.9	-0.2
400	93.6	93.4	-0.1
630	89.2	89.1	-0.1
1000	84.7	84.7	0.0
2000	77.9	78.0	0.1
4000	71.0	71.1	0.1
6300	66.3	66.5	0.1
10000	61.5	61.6	0.1
16000	56.2	56.4	0.2
25000	50.9	51.1	0.2

Table C-97. Spectral Class 113 at 40^{o}F/55% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	94.5	94.4	0.0
400	88.0	88.0	0.0
630	83.5	83.6	0.1
1000	78.8	79.1	0.2
2000	71.4	71.8	0.4
4000	63.3	64.0	0.7
6300	57.5	58.4	0.9
10000	51.1	52.2	1.1
16000	43.9	45.2	1.3
25000	36.2	37.7	1.4

Table C-98. Spectral Class 116 at 40^{o}F/55% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	95.6	95.6	0.0
400	89.3	89.4	0.1
630	85.0	85.1	0.1
1000	80.6	80.8	0.2
2000	73.5	73.9	0.4
4000	65.9	66.4	0.6
6300	60.3	61.1	0.8
10000	54.2	55.1	1.0
16000	47.2	48.4	1.2
25000	39.8	41.1	1.3

Table C-99. Spectral Class 203 at 40^{o}F/55% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	98.0	97.5	-0.5
400	90.6	90.2	-0.4
630	85.5	85.2	-0.2
1000	80.1	80.1	0.0
2000	72.1	72.5	0.4
4000	63.8	64.5	0.7
6300	58.0	58.9	0.9
10000	51.6	52.7	1.1
16000	44.5	45.8	1.2
25000	37.1	38.4	1.3

Table C-100. Spectral Class 205 at 40^{o}F/55% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	94.9	94.8	-0.1
400	88.2	88.1	-0.1
630	83.6	83.6	0.0
1000	78.8	79.0	0.2
2000	71.2	71.6	0.4
4000	63.1	63.8	0.7
6300	57.3	58.2	0.9
10000	51.0	52.0	1.0
16000	44.2	45.2	1.1
25000	37.1	38.2	1.0

Table C-101. Spectral Class 219 at 40^{o}F/55% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	97.6	97.6	0.0
400	91.4	91.4	0.0
630	87.2	87.2	0.1
1000	82.9	82.9	0.1
2000	76.1	76.3	0.2
4000	68.9	69.2	0.3
6300	63.9	64.3	0.4
10000	58.4	58.8	0.5
16000	52.2	52.8	0.6
25000	45.7	46.3	0.7

Table C-102. Spectral Class 222 at 40^{o}F/55% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	104.0	103.9	0.0
400	97.8	97.8	0.0
630	93.7	93.7	0.0
1000	89.5	89.6	0.1
2000	82.9	83.1	0.1
4000	75.9	76.2	0.3
6300	70.9	71.3	0.4
10000	65.3	65.8	0.6
16000	58.8	59.6	0.8
25000	51.7	52.7	1.0

Table C-103. Spectral Class 302 at 40^{o}F/55% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	93.4	93.3	-0.1
400	86.7	86.6	0.0
630	82.0	82.1	0.1
1000	77.0	77.2	0.2
2000	68.9	69.5	0.6
4000	59.9	60.8	0.9
6300	53.5	54.6	1.1
10000	46.7	48.0	1.2
16000	39.5	40.8	1.2
25000	32.2	33.4	1.2

Table C-104. Spectral Class 307 at 40^{o}F/55% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	97.3	97.2	-0.1
400	90.9	90.9	0.0
630	86.6	86.7	0.0
1000	82.2	82.3	0.1
2000	75.3	75.5	0.2
4000	68.0	68.4	0.3
6300	62.9	63.3	0.4
10000	57.4	57.9	0.5
16000	51.2	51.8	0.6
25000	44.7	45.4	0.7

Table C-105. MD900 Spectral Data at 40°F/55% RH

Distance (ft.)	866A (dBA)	ISO/ANSI (dBA)	Difference (ISO/ANSI - 866A) (dBA)
200	81.1	81.1	0.0
400	74.7	74.7	0.0
630	70.3	70.4	0.1
1000	65.7	65.9	0.2
2000	58.5	58.9	0.3
4000	50.8	51.3	0.5
6300	45.4	46.0	0.7
10000	39.4	40.2	0.8
16000	32.7	33.6	1.0
25000	25.5	26.6	1.1