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Volume 1

COMMUNITY NOISE EXPOSURE RESULTING FROM AIRCRAFT OPERATIONS

Volume I. Acoustic Data on Military Aircraft

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NOVEMBER 1977

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AEROSPACE MEDICAL RESEARCH LABORATORY
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This report has been reviewed by the Information Office (OI) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nations.

This technical report has been reviewed and is approved for publication.

FOR THE COMMANDER

WILLIAM J. GANNON
Associate Director
Biodynamics and Bioengineering Division
Aerospace Medical Research Laboratory

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This report is one of a series describing the research program undertaken by the Aerospace Medical Research Laboratory to develop the procedures (NOISEMAP) and data base (NOISEFILE) for predicting community noise exposure resulting from military aircraft operations. It presents the results of field test measurements to define the single event noise produced on the ground by military fixed wing aircraft during controlled level flyovers and ground

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runups. For flight conditions, data are presented in terms of various acoustic measures over the range 200-25,000 feet minimum slant distance to the aircraft. For ground runups, data are presented as a function of angle and distance to the aircraft. All of the data are normalized to standard acoustic reference conditions of 59°F temperature and 70% relative humidity. This particular volume (Vol. 1) discusses the scope, limitations, and definitions needed to understand and use the subsequent volumes containing the NOISEFILE data for military aircraft. It includes guidance for making airspeed and engine power setting adjustments to the flight noise data for other than reference conditions. Work sheets and several examples are also provided in this volume for computing the cumulative noise exposure at a specified location on the ground from multiple flight operations or ground runups. The data volumes are: Vol. 2 - Bomber/Cargo; Vol. 3 - Attack/Fighter; Vol. 4 - Trainer/Fighter; Vol. 5 - Propeller; and Vol. 6 - Navy Aircraft.

SUMMARY

This six-volume report presents the single event noise levels produced on the ground by military fixed wing aircraft during level flyover and ground runup operations. The results of an extensive set of controlled field test measurements on 44 aircraft types comprise the basis for the NOISEFILE which is used with the NOISEMAP computer program for producing contours of equal noise exposure about airbases. This report provides the acoustic data and instructions/work sheets to allow hand computation of the total noise exposure at a given point on the ground for any specified set of ground runup and flight (takeoff, landing, traffic pattern, etc.) operations. Such hand computations can readily be used for making preliminary environmental noise impact assessments of existing or contemplated airfield or low-level training route operations, siting of new facilities, or identifying ground runup suppressor requirements.

Noise data estimated from measured noise characteristics on similar aircraft/engine configurations are included to supplement the measured data file and thereby provide a more complete noise data bank for modern military aircraft.

Volume 1 discusses the scope, definitions, and limitations of the subsequent noise data volumes as well as work sheets and several examples for making hand computations of aircraft noise exposure. The noise data volumes are categorized according to:

Vol. 2: Air Force Bomber/Cargo Aircraft Noise Data

Vol. 3: Air Force Attack/Fighter Aircraft Noise Data

Vol. 4: Air Force Trainer/Fighter Aircraft Noise Data

Vol. 5: Air Force Propeller Aircraft Noise Data

Vol. 6: Navy Aircraft Noise Data

PREFACE

The authors gratefully acknowledge the many helpful technical discussions and critical reviews of the data acquisition and reduction procedures by Bolt Beranek and Newman, Inc.; development of the OMEGA software programs by Mr. Henry Mohlman and maintenance of the data files by Mr. Dave Eilerman both of the University of Dayton Research Institute; the instrumentation development/noise measurement efforts of Harald K. Hille, and Capt N. A. Farinacci of the Biodynamic Environment Branch, as well as L. Keith Kettler of the University of Dayton Research Institute; the noise measurement/data reduction efforts by Robert A. Lee; and typing of this report by Mrs. Peggy S. Massie.

This report is one of a series describing the contractual and in-house research program undertaken by the Aerospace Medical Research Laboratory, Biodynamic Environment Branch, under Project/Task 723104, "Measurement and Prediction of Noise Environments of Air Force Operations", to develop the procedures and acoustic data base required for predicting community noise exposure resulting from aircraft operations. The companion reports are listed as references 1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, and 16. The Air Force Weapons Laboratory provided funding to partially support this development program.

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INTRODUCTION

Aircraft flight and ground runup operations at military airbases produce noise in surrounding communities that may interfere with some land uses or activity. The Air Force has for some time been generating maps of equal noise exposure contours about installations for use in environmental impact assessments and as an aid in minimizing community noise exposure and helping avoid restriction on essential mission operations. These maps are the output of NOISEMAP (ref. 1,2, 3,4,5,6,15) a fully computerized procedure that accounts for the single event noise characteristics of military aircraft (NOISEFILE) as well as the operational conditions (number and type of events, engine power settings, runway utilization, temporal distribution, etc.) at the airbase. The Aerospace Medical Research Laboratory has the responsibility for developing and continually updating this predictive methodology and data base. NOISEMAP is installed at the Air Force Civil Engineering Center (AFCEC/DEE) which is responsible for performing all Air Force applications of NOISEMAP to aircraft environmental noise problems. The validity and subsequently the usefulness of these environmental assessment or planning efforts is obviously a function of the uncertainties associated with NOISEFILE, as well as the assumptions in NOISEMAP itself. For this reason a major effort is being spent on developing NOISEFILE where possible by systematically measuring and analyzing the noise characteristics of military aircraft under controlled test conditions (ref. 7).

To account for individual and community response to aircraft noise, many measures of single event noisiness and cumulative exposure indices of annoyance for multiple events have been developed and are in use throughout the world today. The single event measures address the sound pressure level, frequency content, and/or duration of the event while the cumulative exposure indices consider the physical and attitudinal factors affecting the summation of the separate noise events. At present, the automatic optional output cumulative exposure capabilities of NOISEMAP and the corresponding NOISEFILE single event measures are:

NOISEMAP Index	NOISEFILE Measure Flight	NOISEFILE Measure Runup
DNL (Day-Night Average Sound Level)	SEL	AL
DNLT (DNL with tone corrected noise level)	SELT	ALT
DNLW (DNL with +10 dB runup noise penalty)	SEL	AL
DNLTW (DNL with both tone and runup penalties)	SELT	ALT
CNEL (Community Noise Equivalent Level-Calif.)	SEL	AL
NEF (Noise Exposure Forecast with runup penalty)	EPNL	PNLT

NOISEMAP can also be used to compute contours of WECPNL (Weighted Equivalent Continuous Perceived Noise Level advocated by the International Civil Aviation Organization) for flight operations by using EPNL and manually adding approximately +48 to the plotted values to account for differences in normalization constants between NEF and WECPNL.

Consistent with the recommendation of the Environmental Protection Agency, and an inter-agency agreement with that organization, all Air Force environmental noise assessments and land use planning studies are now done in terms of DNL. Because of this, the remainder of this discussion will be in terms of DNL and/or SEL, where appropriate, even though NOISEFILE contains single event noise data in the other measures needed for computing the other cumulative exposure indices.

Using NOISEMAP at the Air Force Civil Engineering Center, airbase noise exposure contour maps can be produced for any combination of temperature and relative humidity conditions. This capability provides the NOISEMAP user with the flexibility to develop contour maps custom fitted for his unique airbase temperature and humidity conditions or evaluate the seasonal effects on the shape and location of the contours. Inquiries for non-reference temperature and relative humidity NOISEFILE (single event) data or NOISEFILE in magnetic tape form should be directed to the Aerospace Medical Research Laboratory, Biodynamic Environment Branch, Wright-Patterson AFB OH 45433.

This report does not include data on helicopters, suppressors, blast deflectors, etc. When available and as required for Air Force noise assessment purposes, data on these other types of noise sources will be added to NOISEFILE as part of the continuing update effort by the Aerospace Medical Research Laboratory.

The reader is referred to the GLOSSARY for definitions of acoustical quantities and terminology used in this report.

TEST PROCEDURES

The basic procedures outlined in AMRL-TR-73-107 (ref. 7) are used to acquire the flight and ground runup noise characteristics of military aircraft. As discussed in Appendix A of that report, level flyovers are used to acquire the flight noise data as opposed to making measurements at a number of positions during actual flight (takeoff, landing, traffic pattern, etc.) operations. Using level flyovers, the number of microphone positions are decreased by a factor of three or four and the number of test flight hours are decreased by a factor of two, but with no decrease in the accuracy of the acoustical data.

For both the flight and ground runup measurements, only high quality NAGRA tape recorders and Bruel and Kjaer condenser type microphones, windscreens and accessories are used to record the noise data in analog form on magnetic tape for subsequent analysis in the laboratory in terms of one-third octave band sound pressure level information.

Cockpit instrument readings of engine/performance parameters are made during the tests to permit normalization of the acoustic data collected on measurements repeated to increase the sample size for a given test condition.

Noise measurements are conducted only under the following permissible meteorological conditions: (1) No rain or other precipitation; (2) Relative humidity not higher than 90% or lower than 30%; (3) Ambient temperatures 10 meters above the ground not more than 86°F or lower than 41°F; and (4) Airbase reported winds not above 10 knots (6 knots for ground runup measurements) and crosswind component not above 5 knots at 10 meters above ground.

All noise measurements are conducted over relatively flat terrain having no excessive sound absorption characteristics such as might be caused by thick, matted or tall grass, shrubs, or wooded areas.

LEVEL FLYOVERS

Level flyovers at various engine power settings (takeoff, landing, traffic pattern, etc.) are made using the four-microphone array shown in Figure 1. This microphone layout allows four noise time histories to be recorded during each flyover event. This usually means only two flyovers are needed at each engine power setting to obtain a sample size sufficient for a 90% confidence interval of 1 to 2 dB in the average SEL value. Each microphone site is located such that no obstructions are present that would significantly affect the sound field within a conical space defined by a half angle of 75° with a line perpendicular to the microphone site. All microphones are positioned 4 feet above the ground and oriented such that grazing incidence is maintained throughout the flyover. Photo-theodolite or radar tracking is used in conjunction with a recorded timing signal to correlate the noise measurements with the instantaneous spatial position of the aircraft during the flyovers.

GROUND RUNUPS

Farfield ground runup noise measurements are performed at 10 degree increments at a fixed radial distance of 75-200 meters from an aircraft as depicted in Figure 2. The microphone is oriented for zero degrees (perpendicular) incidence. Due to the geometry involved between a fixed noise source and microphone, not all of the acoustic energy travels in a straight line to the microphone, but some energy is reflected off the intervening ground surface. This well known and documented ground reflection effect results in energy reinforcements and, cancellations at frequencies defined by the geometry. These effects typically appear as +1 to -3 dB deviations in the frequency spectrum of the sound pressure level. To minimize this ground reflection effect phenomenon, the microphone is vertically swept from 2 to 10 feet above the ground while continuously recording the noise for approximately 6 seconds. This changing of the source to microphone geometry changes the frequencies at which the ground reflection effects occur. The data sample is power averaged during data reduction/analysis to obtain a sound pressure level spectrum for which the ground reflection effects have been smoothed over. This experimental technique was implemented after the start of the NOISEFILE measurements. As such, the noise data for the following aircraft were acquired at a fixed microphone height of 5-1/2 feet and no attempt was made to smooth over any ground reflection effects: B-57, C-5A, C-123K, C-130, F-4, F-100, F-105, F-111A, OV-10, and T-33.

Typically, measurements are performed at four or five engine power conditions ranging from idle to maximum. Note that all of the ground runup values reported in the data volumes have been normalized to *single* engine operation, even though the field measurements may have been made using more than one engine.

DATA ANALYSIS

Once having the data recorded on magnetic tape, the first steps in our data reduction/analysis process are correction for the frequency response functions of the microphone and record/reproduce instrumentation and conversion to root-mean-square, one-third octave band sound pressure levels punched on cards in digital form. This makes it relatively easy to then use specially designed software programs to perform the multitude of computations for normalizing the data from field test conditions to reference conditions and expressing the data in terms of the desired various single event noise measures. While digitizing the data is simple in concept, it does require sophisticated instrumentation (a real time frequency spectrum analyzer) coupled with a moderate digital storing/processing capability and a high speed card punch. Care must be exercised in selecting the equipment and setting up this capability to insure that the analysis equipment system requirements specified in Federal Aviation Regulations Part 36, "Noise Standards for Aircraft Type Certification", (ref. 10) can be met. Of special concern is the ability to analyze the flyover data time histories in discrete time slices such that no more than 5 milliseconds of data are excluded from contiguous samples. At our own facility, a General Radio Real-Time Spectrum Analyzer is directly interfaced with a Control Data Corporation Model 1700 batch terminal which includes a Model 415 high speed card punch as a peripheral device.

The procedures and algorithms specified in AMRL-TR-73-107 (ref. 7), with the exceptions as noted in the following discussions, are implemented in the OMEGA series of acoustic data reduction programs. (These OMEGA programs with complete documentation are available from the Aerospace Medical Research Laboratory, Biodynamic Environment Branch, Wright-Patterson AFB OH 45433). These data reduction tools were used exclusively in preparing the military aircraft noise data characteristics presented in the subsequent volumes of this report.

For identification purposes a code number has been assigned that is unique for each aircraft type. To readily differentiate in NOISEFILE the "estimated" from the directly measured noise data, aircraft code numbers 500-599 have been assigned to the "estimated" data. Based on the established principle that doubling the acoustic power is equivalent to adding +3 dB, adjustments for different numbers of engines or thrust can be easily calculated. To account for differences in the number of engines, $10 \log_{10} N_i/N_o$ is used where N_i is the number of engines on the aircraft to be "estimated" and N_o is the number of engines on the measured aircraft. In a similar fashion, thrust differences for the same type engine are calculated using $10 \log_{10} F_i/F_o$ where again the i and o subscripts refer to the "estimated" and measured aircraft respectively. For example, the C-140 (aircraft code 508) noise data are estimated from the T-39 measured data by $10 \log_{10}$ (number of C-140 engines/number of T-39 engines) = $10 \log_{10} 4/2$ = +3 dB to compensate for the C-140 aircraft having twice the number of engines of the same type as the T-39 aircraft and thereby theoretically radiating twice the acoustic energy. The F-5A (aircraft code 509) is an example of accounting for thrust differences due to engine model changes in the same basic aircraft. The F-5A in afterburner generates 4080 lb. of thrust compared to the 5000 lb of thrust developed by the F-5E aircraft for which measured noise data are available. The F-5A thrust correction is $10 \log_{10}$ 4080/5000 = -0.88 dB applied to the F-5E noise data.

While the measured flight noise data are acquired under varying field test meteorological and operational conditions, all of the measured and estimated noise levels in this report have been normalized to standard reference acoustic day values of 59°F temperature and 70% relative humidity. As discussed in AMRL-TR-73-107, ref. 7, this normalization is accomplished by correcting the one-third octave band spectrum at the time of maximum perceived noisiness (PNLM) for the differences in the atmospheric absorption coefficients between the field test and reference temperature and relative humidity values over the field test and reference sound propagation path lengths. In a similar fashion the ground runup data are also normalized to 59°F and 70% relative humidity. The time integrated single event noise measures (SEL, SELT, and EPNL) for the flight data are also normalized to a reference airspeed to account for the effect of airspeed on the duration of the event. This normalizing airspeed adjustment, in dB, is obtained by $10 \log_{10}$ (field test airspeed/reference airspeed). As stated in the Hand Computation of Noise Exposure section of this report, note that when making an airspeed adjustment *from* reference *to* a different airspeed, the computation is done by $10 \log_{10}$ (reference airspeed/desired test airspeed)!

BACKGROUND NOISE

Both the flyover and ground runup field measured data have been corrected for the influence of background/electronic noise whenever the data and background one-third octave SPL values differ by 6 to 16 dB. When the difference is more than 16 dB, then the measured SPL has not been influenced by the ambient noise by more than 0.1 dB and is therefore ignored. For those cases where the difference is 6 dB or less, the measured SPL is rejected and then synthesized based on: (1) For those spectra where *all* higher frequency SPL's have been rejected, the synthesized spectra decreases by at least 6 dB per one-third octave band or by the slope defined by the previous two non-rejected bands if that slope is greater than 6 dB per one-third octave; (2) For those spectra where *all* lower frequency SPL values have been rejected, the synthesized spectra is assumed to have the same value as the lowest frequency, non-rejected data SPL; and (3) For those spectra where the rejected bands are flanked by non-rejected bands, the synthesized spectra is a linear interpolation between the adjacent non-rejected bands.

EXCESS ATTENUATION

Noise levels measured when both the aircraft and observer are on the ground, such as during takeoff roll or ground runup or at very small aircraft to observer angles (normally 4 degrees or less), are attenuated by ground induced effects. This attenuation is in addition to the normal air-to-ground propagation losses from atmospheric absorption and simple geometric dispersion (inverse square law). Reference 8 gives the results of experimental studies of noise propagating along the earth's surface. Figure 3 (from ref. 7) shows the average values of this excess attenuation as a function of frequency and distance from the source. Consequently, the ground runup and ground-to-ground flyover data presented herein are the average levels expected for sound propagating downwind or on still days. Since the upwind excess attenuation would generally be greater, these NOISEFILE levels are somewhat higher than the levels expected under upwind propagation conditions. As discussed in ref. 7, an additional 5 dB of attenuation are applied to the ground-to-ground flyover data to approximate the 4 to 8 dB of additional excess attenuation evident in measurements of sideline noise. This additional excess attenuation is believed to be primarily due to intervening obstacles such as buildings, terrain, or trees and shrubs.

LEVEL FLYOVERS

The following steps describe the methodology used to obtain the single event noise level versus slant distance functions presented in the data volumes: (1) for each level flyover, after correcting for the individual microphone and record/reproduce instrumentation frequency response, the SPL time history is digitized using our General Radio-Control Data Corporation interface system; (2) the OMEGA 5.4 program operates on this time history to compute the SPL spectrum and SEL at the time of maximum perceived noisiness (PNLM) and normalized to a reference slant distance, airspeed, temperature, and relative humidity; (3) the OMEGA 6.6 program arithmetically averages the directivity angles and the normalized SPL spectra and SEL values for all microphone/level flyovers at the same engine power setting; and (4) these *averaged* SPL spectrum, directivity angles and SEL values are then used by the OMEGA 6.6 program to calculate the desired noise level versus distance functions for air-to-ground propagation conditions and ground-to-ground propagation conditions including the additional 5 dB excess attenuation discussed above.

An exception to the algorithms identified in AMRL-TR-73-107 (ref. 7) for computing the averaged noise level versus distance functions at reference conditions is that these data have not been adjusted for acoustical characteristic impedance differences between the field test and standard reference conditions. This adjustment would typically be: (1) -0.1 to -0.2 dB for the following aircraft measured or estimated from data measured at Wright-Patterson AFB: A-3, A-37, B-52, B-57, FB-111, C-5, C-7, C-9, C-97, C-118, C-119, C-121, C-123, C-130, C-131, C-135, C-140, C-141, F-4, F-100, F-101, F-102, F-104, F-105, F-106, F-111, OV-10, T-29, T-33, T-37, T-38, T-39, T-43, U-2 and U-4B; (2) -0.2 to -0.4 dB for the following aircraft measured or estimated from data measured at Edwards AFB: A-10, B-1, F-5, F-15, F-16, and SR-71; and (3) 0 dB for the following aircraft measured at San Clemente ALF: A-4, A-5, A-6, A-7, AV-8A, F-14, P-3, S-3A, and T-2C.

To minimize the size/cost of this report, only certain OMEGA 6.6 printout pages are provided in the data volumes. To facilitate comparing the noisiness of different aircraft, the graphs of noise level versus distance shown in the data volumes are sized to fit the standard 3 cycle by 10 divisions per inch semi-logarithmic paper. Also note that the Δ7, Δ8, and Δ9 terms tabulated in the full OMEGA 6.6 printouts do not correspond to the same quantities specified in AMRL-TR-73-107. These quantities are defined in the GLOSSARY even though they do not appear on the particular OMEGA 6.6 printout pages presented in the data volumes of this report.

In accordance with Appendix C of AMRL-TR-73-107 (ref. 7) integration periods less than 0.5 seconds are used whenever the flyover noise levels do not remain within 10 dB of the maximum value for at least 5 seconds. For events lasting 2 to 5 seconds, an integration period of 0.25 seconds is appropriate. For events lasting less than 2 seconds, an integration period of 0.125 seconds is used to insure an adequate number of samples is obtained to define the noise time history.

GROUND RUNUPS

In analyzing the ground runup data the OMEGA software does include normalizing the field measured data for the acoustical characteristic impedance. Note that the ground runup data always accounts for the excess attenuation due to ground-to-ground propagation conditions, but that there is not sufficient evidence available at this time to warrant including the additional excess attenuation term used with the level flyover data under ground-to-ground propagation conditions.

A minor clarification of the AMRL-TR-73-107 methodology is that the field measured data are not always acquired at a radius of 250 feet, but that occasionally the data are collected at further distances to insure the measurements are in the far field. For example, the C-5A noise measurements were made 655 feet (200 meters) from the aircraft.

As previously mentioned, note that the runup noise levels in the data volumes are always *single* engine operation.

ESTIMATED ACCURACY

The values presented in the data volumes represent the *expected average levels* assuming meteorological conditions that, on the long term, approximate the standard conditions of 59°F temperature and 70% relative humidity. They are only the expected average levels because the extrapolation procedures used to derive the noise versus distance functions employ analytical models based on *average* values of atmospheric absorption and excess attenuation. As such, one cannot go out on any one day and measure either flyover or ground runup noise and expect to get the same levels presented in the data volumes. Variability of such individual samples about the expected average values in the data volumes will be high, with typical standard deviations of 6 to 12 dB or more. However, the average of repetitive measurements of like samples (i.e., same type source, same type operating condition, same measurement location) over weeks or months should tend to approximate these expected average values when corrected for nonstandard meteorological and operational conditions.

For example, measurements have been made under the flight track during uncontrolled takeoff and landing operations by C-5 and C-141 aircraft. Using three microphones during each event, the *average* SEL values for a slant distance of 1,000 feet were normalized for airspeed, engine power setting, and weather conditions and then compared with the NOISEFILE values. The results differed from NOISEFILE by: (1) C-5 takeoff power SEL for 7 events (19 time histories) = -0.1 dB; (2) C-5 approach power SEL for 13 events (35 time histories) = 0.7 dB; (3) C-141 takeoff power SEL for 10 events (30 time histories) = 0.3 dB; and (4) C-141 approach power SEL for 20 events (52 time histories) = 2.0 dB. Similar measurements for C-9, C-130, and KC-135A aircraft takeoffs and landings showed *average* SEL values within 1 to -2 dB of the corresponding NOISEFILE values.

Due to strict adherence to standard operating procedures during acquisition and analysis of the measured single event noise data used in the data volumes, the flight noise values for air-to-ground propagation conditions are believed accurate within a standard deviation of plus or minus one to two dB for slant distances on the order of 10,000 feet. For larger slant distances the uncertainties in the flight noise data could be plus or minus 5 dB or more because of non-homogeneous propagation paths, etc.

The ground runup noise data and flight noise data under ground-to-ground propagation conditions are believed to be accurate within plus or minus 5 dB for distances up to 10,000 feet. The uncertainties associated with ground-to-ground propagation decrease the ability for accurately predicting noise levels at slant distances greater than 10,000 feet such that the levels should only be considered good to within plus or minus 10 to 15 dB.

On the other hand, cumulative noise exposure from a number of events seems to be predictable within about half the uncertainties in the single event noise data. Therefore DNL computations for combined flight and ground runup activity for slant distances up to 10,000 can be made with uncertainties on the order of plus or minus one to two dB.

When DNL values are less than 50, or whenever the total number of daily events is 10 or less, or whenever the SEL or AL is 45 dB or less for the noise source controlling the DNL, additional uncertainties are introduced which make the applicability or interpretation of DNL questionable. If any of these conditions exist, DNL by itself is probably not adequate to properly assess the environmental noise.

HAND COMPUTATION OF NOISE EXPOSURE

For many preliminary compatible land use planning or environmental noise impact assessment analyses, it is sufficient to compute the DNL at a specific location on the ground produced by a given set of aircraft flight or ground runup operations. Many such computations can be performed by hand using the reference noise data and making adjustments for the particular aircraft operational conditions being considered. Sophisticated computer programs like NOISEMAP are required only when the number of such point calculations becomes impractical, for example when computing contour lines of equal noise exposure about entire airbases, or when the noise exposure predictions must be computed more accurately than the simplifying assumptions inherent in the hand calculations will allow. Reference 2 discusses the more complex features of NOISEMAP, such as accounting for the effect of turns on DNL computations, that are ignored when making hand calculations. Since the expected uncertainties of NOISEMAP type computations are ± 1 dB to ± 2 dB for most situations, an additional 1 to 2 dB of uncertainty will probably be introduced when making hand calculations because of simplifying assumptions.

One such simplifying assumption involves the method used in making engine power setting ($\Delta''6$) adjustments to the reference flight noise data. Appendix A lists the $\Delta''6$ adjustment rates that can be used when making hand calculations. The spectral characteristics of the noise and, accordingly, any engine power setting adjustment varies with distance to the aircraft. Appendix A assumes these $\Delta''6$ adjustments are constant for all distances. This simplification means that for distances up to 4,000 feet, these $\Delta''6$ adjustment rates can make the resultant hand calculated values differ from NOISEMAP predictions by about 1 dB. For distances of 4,000 to 10,000 feet, this simplification can mean an uncertainty of 2 to 4 dB. For distances greater than 10,000 feet, uncertainties of 5 to 10 dB are possible. Using the adjustment rates specified in Appendix A with SELT or EPNL values introduces an additional uncertainty of 1 to 2 dB.

When performing any DNL hand calculations, *special attention* should be given to the following:

FLIGHT OPERATIONS

a. The angle of elevation is defined by the ground plane and the line of sight from the observer to the aircraft at the point of closest approach (minimum slant distance) for a straight line flight path segment.

b. Determine if air-to-ground or ground-to-ground propagation is involved. For aircraft to observer angles of 7° or greater, use air-to-ground noise levels listed on page I of the OMEGA 6.6 printout. For angles 4° or less, use the noise levels listed on page M of the OMEGA 6.6 printout. For angles between 7° and 4°, linearly interpolate the noise levels at the appropriate slant distance listed on pages I and M of the OMEGA 6.6 printout.

c. Airspeed adjustment, $\Delta'6 = 10 \log_{10} \frac{\text{reference airspeed}}{\text{test airspeed (knots)}}$.

d. Engine power setting adjustment, $\Delta''6 = \Delta''6$ adjustment rate multiplied by (test condition engine power setting - reference engine power setting). Specific values are listed in Appendix A.

GROUND RUNUP OPERATIONS

a. Angle of interest is measured by assuming the nose of the aircraft is at an angle of 0 degrees.

b. For multiple engine ground runups at the same power setting, add 10 $\log_{10}$ E to the noise levels listed in the OMEGA 8.2 printout, where E is the desired number of engines. That is, for C-141 ground runups using all four engines, add 10 $\log_{10} 4 = 6$ dB to the OMEGA 8.2

c. For engine power settings other than reference values, use linear interpolation at the proper angle and distance from the aircraft between bracketing reference power settings.

Summing dB values is done by:

$$10 \log \left(\sum^{i} \text{antilog} \frac{L_i}{10} \right)$$

Should logarithmic tables or a calculator not be available, the nomograph shown in Figure 4 can be used. For example, to sum two noise levels $L_1 = 95$ dB and $L_2 = 90$ dB:

$L_1 - L_2 = 95 - 90 = 5$ dB

$L_{Total} = L_1 +$ upper scale value $= 95 + 1.2 = 96.2$ dB

The following examples are presented to show how the sample worksheets on pages 19-23 can be used for hand calculating the DNL from flight or ground runup operations:

FLIGHT NOISE EXPOSURE - HAND CALCULATION EXAMPLES

Case 1 = Single Flight Operation With No Adjustments (p. 19)

Assumed Operations: Air-to-ground propagation, 10 daytime C-135A dry takeoffs at 96% RPM, airspeed of 200 knots, and slant distance of 1600 feet.

Reference Conditions: Ref. airspeed = 200 knots, ref. engine setting is 96% RPM, SEL_o = 113.8 dB at 1600 feet slant distance.

Answer: DNL = 74.4 dB

Discussion: Since air-to-ground propagation is assumed for these C-135A flights, the basic SEL_o value of 113.8 dB is found on page I2 of the OMEGA 6.6 printout for C-135A takeoff power. Since the assumed airspeed and engine power setting values are equal to the reference values, there are no Δ'6 or Δ"6 adjustments and the SEL is simply 113.8 dB. The DNL of 74.4 dB is computed by: DNL = SEL + 10 log N(number of day-night operations) - 49.4 = 113.8 + 10.0 - 49.4 = 74.4 dB.

Case 2 = Multiple Flight Operations With Day-Night, Airspeed, and Engine Power Setting Adjustments (p. 20)

Assumed Operations: Air-to-ground propagation, 8 daytime and 2 nighttime C-135A dry takeoffs at 96% RPM, 4 daytime dry takeoffs at 94% RPM, daytime airspeeds at 200 knots, nighttime airspeeds at 220 knots, slant distance for all flights is 2000 feet.

Reference Conditions: Ref. airspeed = 200 knots, ref. engine setting for takeoff dry power is 96% RPM (Δ"6 rate = 2.02 dB/1% RPM), SEL_o = 112.1 dB at 2000 feet slant distance.

Answer: DNL = 77.1 dB

Discussion: Separate DNL_i values need to be calculated for the day and night operations at 96% RPM and the operations at 94% RPM since different SEL values are obtained when the airspeed and engine setting adjustments are made to the SEL_o value found on page I2 of the OMEGA 6.6 printout. The DNL value for all of the operations can be calculated using $10 \log_{10} \Sigma(DNL_i/10)$ or estimated using the nomograph on Figure 4.

Case 3 = Flight Operations With Day-Night, Airspeed, Engine Power Setting, and Propagation - Noise Level Adjustments (p. 21)

Assumed Operations: Aircraft to observer location angle is 5°, airspeed is 185 knots for 22 daytime and 3 nighttime B-52G dry takeoffs at 95% RPM, slant distance for all flights is 4000 feet.

Reference Conditions: Ref. airspeed is 170 knots, ref. engine setting is 94% RPM (Δ"6 rate = 1.6 db/1% RPM).

Answer: 74.2 dB

Discussion: Since this problem assumes the noise is propagated at an angle of 5°, the transition region between air-to-ground and ground-to-ground propagation is involved. This means we must linearly interpolate between the SEL_o for air-to-ground propagation and the SEL_o for ground-to-ground propagation. Using the ground-to-ground boundary angle of 4° and the air-to-ground boundary angle of 7°, we see that for this case the assumed propagation angle of 5° falls 1/3 of the way from the ground-to-ground boundary to the air-to-ground boundary. Numerically the SEL_o for 5° at 4000 feet slant distance is found by:

109.3 dB is the SEL_o for air-to-ground propagation at 4000 ft as specified on page I1 of the OMEGA 6.6 printout.

103.1 dB is the SEL_o for ground-to-ground propagation at 4000 ft as specified on page M1 of the OMEGA 6.6 printout.

6.2 dB is the difference in noise levels between the air-to-ground and ground-to-ground propagation conditions.

2.1 dB (6.2 dB x 1/3 interpolation value) to be added to the ground-to-ground SEL_O.

105.2 dB (103.1 + 2.1) is the SEL_O for B-52G dry takeoff at 4000 feet slant distance for a 5° angle of propagation.

Once having this final SEL_O value, we can then make the airspeed and engine power setting adjustments needed to complete the DNL calculation.

GROUND RUNUP NOISE EXPOSURE EXAMPLES

Case 4 = Single Aircraft Ground Runup With No Adjustments (p. 22)

Assumed Operations: Angle of propagation is 130°, C-135A single engine maximum power for 30 sec. during each of 4 daytime runups at a distance of 1000 feet.

Reference Conditions: AL = 106.5 dB for 130° at 1000 feet as listed on page F4 of the OMEGA 8.2 printout.

Answer: DNL = 77.9 dB

Discussion: Since there are no adjustments in this example for number of engines or engine power setting, the AL of 106.5 dB is read directly off page F4 of the OMEGA 8.2 printout at 130° and 1000 feet. The DNL of 77.9 is computed by DNL = AL + 10 $\log_{10}$ N(number of day-night operations) + 10 $\log_{10}$ D(duration of runup in seconds) - 49.4 = 106.5 + 6 + 14.8 - 49.4 = 77.9 dB.

Case 5 = Multiple Ground Runups With Adjustments for Engine Power Setting and Number of Engines (p. 23)

Assumed Operations: Angle of propagation is 140°, C-135A four engines for 20 sec. at 88% RPM during each of 5 daytime and 2 nighttime runups at a distance of 1000 feet.

Reference Conditions: AL of 72.5 dB from page F2 of OMEGA 8.2 for single engine runup at 140° and 1000 feet for 80% RPM. AL of 95.8 dB from page F3 of OMEGA 8.2 for single engine runup at 140° and 1000 feet for 90% RPM.

Answer: 74.7 dB

Discussion: In this example we need to linearly interpolate between the AL_o values for 80% and 90% RPM to obtain the AL_o at 88% RPM for 140° and 1000 feet. The difference in the AL_o values at 90% RPM and 80% RPM is 23.3 dB (95.8 - 72.5 dB). Multiplying by the interpolation factor of 0.8 gives a $\Delta''6$ of 18.6 dB. This $\Delta''6$ must be added to the AL_o of 72.5 dB for the 80% RPM condition to get the AL_o for 88% RPM.

Case #1 Single Flight Operation With No Adjustments

TOTAL DNL FOR AIRCRAFT FLYOVER OPERATIONS*

	Test Parameters			Number of Operations								
Aircraft	Power Setting	Slant Distance	Air-Speed	Day (N_D)	Night (N_N)	Δ'6**	Δ"6***	SEL_O****	SEL = SEL_O + Δ'6 + Δ"6	N = N_D + $10N_N$	LDN_i = SEL - 49.4 +10 Log N	antilog $\frac{LDN_i}{10}$
C-135A	96% RPM	1600ft	200KTS	10	0	0	0	113.8	113.8	10	74.4	27542286.98

*For calculation of total DNL at a given ground position due to aircraft flyovers occurring at various power settings and slant distances

**Δ'6 = 10 $\log_{10}$ $\left(\frac{\text{reference airspeed}}{\text{test airspeed (knots)}}\right)$

***Δ"6 = Noise level adjustment for engine power setting other than reference (See Appendix A)

****The Sound Exposure Level for the test slant distance from AMRL/BBE OMEGA 6.6 data file.

$\sum^{i}$ antilog $\frac{LDN_i}{10}$ = 27542286.98

DNL = 10 log ($\sum^{i}$ antilog $\frac{LDN_i}{10}$) = 74.4

Case #2 Multiple Flight Operations With Day-Night, Airspeed, and Engine Power Setting Adjustments
TOTAL DNL FOR AIRCRAFT FLYOVER OPERATIONS*

Test Parameters				Number of Operations								
Aircraft	Power Setting	Slant Distance	Air-Speed	Day (N_D)	Night (N_N)	$\Delta'6$**	$\Delta''6$***	SEL_0****	$SEL = SEL_0 + \Delta'6 + \Delta''6$	$N = N_D + 10N_N$	$LDN_i = SEL - 49.4 + 10 \log N$	antilog $\frac{LDN_i}{10}$
C-135A	96% RPM	2000ft	200KTS	8	0	0	0	112.1	112.1	8	71.7	14791083.93
C-135A	96% RPM	2000ft	220KTS	0	2	-0.4	0	112.1	111.7	20	75.3	33884415.60
C-135A	94% RPM	2000ft	200KTS	4	0	0	-4.0	112.1	108.1	4	64.7	2951209.22

*For calculation of total DNL at a given ground position due to aircraft flyovers occurring at various power settings and slant distances

**$\Delta'6 = 10 \log_{10} \left(\frac{\text{reference airspeed}}{\text{test airspeed (knots)}}\right)$

***$\Delta''6$ = Noise level adjustment for engine power setting other than reference (See Appendix A)

****The Sound Exposure Level for the test slant distance from AMRL/BBE OMEGA 6.6 data file.

$$\sum^{i} \text{antilog} \frac{LDN_i}{10} = 51626708.75$$

$$DNL = 10 \log \left(\sum^{i} \text{antilog} \frac{LDN_i}{10}\right) = 77.13$$

Case #3 Flight Operations With Day-Night, Airspeed, Engine Power Setting, and Propagation-Noise Level Adjustments

TOTAL DNL FOR AIRCRAFT FLYOVER OPERATIONS*

Test Parameters				Number of Operations								
Aircraft	Power Setting	Slant Distance	Air-Speed	Day (N_D)	Night (N_N)	Δ'6**	Δ"6***	SEL_O****	SEL = SEL_O + Δ'6 + Δ"6	N = N_D + $10N_N$	LDN_i = SEL - 49.4 +10 Log N	antilog $\frac{LDN_i}{10}$
B-52G	95% RPM	4000ft	185KTS	22	3	-0.4	1.6	105.2	106.4	52	74.2	26302679.92

*For calculation of total DNL at a given ground position due to aircraft flyovers occurring at various power settings and slant distances

**$\Delta'6 = 10 \log_{10} \left(\frac{\text{reference airspeed}}{\text{test airspeed (knots)}}\right)$

***Δ"6 = Noise level adjustment for engine power setting other than reference (See Appendix A)

****The Sound Exposure Level for the test slant distance from AMRL/BBE OMEGA 6.6 data file.

$\sum^{i} \text{antilog} \frac{LDN_i}{10} =$ 26302679.92

$DNL = 10 \log (\sum^{i} \text{antilog} \frac{LDN_i}{10}) =$ 74.2

Case #4 Single Ground Runup With No Adjustments

TOTAL DNL FOR AIRCRAFT GROUND RUNUP OPERATIONS*

Test Parameters				Number of Operations								
Aircraft Engine	Power Setting & Angle	Runup Duration (D) Sec	10 LogD	Day (N_D)	Night (N_N)	ΔE**	Δ"6***	AL_0****	AL = AL_0 + ΔE + Δ"6	N = N_D + 10 N_N	LDN_i = AL − 49.4 + 10 Log D + 10 Log N	antilog $\frac{LDN_i}{10}$
C-135A	Max Power	30	14.8	4	0	0	0	106.5	106.5	4	77.9	61659499.91

*For calculation of total DNL at a given ground position due to ground runups occurring at various power settings and locations

**ΔE = 10 Log_{10} (Number of Engines operating at given power setting)

***Δ"6 = noise level adjustment for engine power setting other than reference

****The A-weighted sound pressure level for the test conditions from AMRL/BBE OMEGA 8.2 data file

$$\sum^{i} \text{antilog} \frac{LDN_i}{10} = 61659499.91$$

$$DNL = 10 \log \left(\sum^{i} \text{antilog} \frac{LDN_i}{10}\right) = 77.9$$

Case #5 Multiple Ground Runups With Adjustments for Engine Power Setting and Number of Engines

TOTAL DNL FOR AIRCRAFT GROUND RUNUP OPERATIONS*

Test Parameters				Number of Operations								
Aircraft Engine	Power Setting & Angle	Runup Duration (D) Sec	10 LogD	Day (N_D)	Night (N_N)	ΔE**	Δ"6***	AL_0****	$AL = AL_0 + \Delta E + \Delta''6$	$N = N_D + 10\ N_N$	$LDN_i =$ AL − 49.4 + 10 Log D + 10 Log N	antilog $\frac{LDN_i}{10}$
C-135A	88% RPM	20	13.0	5	2	6.0	18.6	72.5	97.1	25	74.7	29512092.13

*For calculation of total DNL at a given ground position due to ground runups occurring at various power settings and locations

**ΔE = 10 Log_{10} (Number of Engines operating at given power setting)

***Δ"6 = noise level adjustment for engine power setting other than reference

****The A-weighted sound pressure level for the test conditions from AMRL/BBE OMEGA 8.2 data file

$$\sum^{i} \text{antilog} \frac{LDN_i}{10} = \underline{29512092.13}$$

$$DNL = 10 \log \left(\sum^{i} \text{antilog} \frac{LDN_i}{10}\right) = \underline{74.7}$$

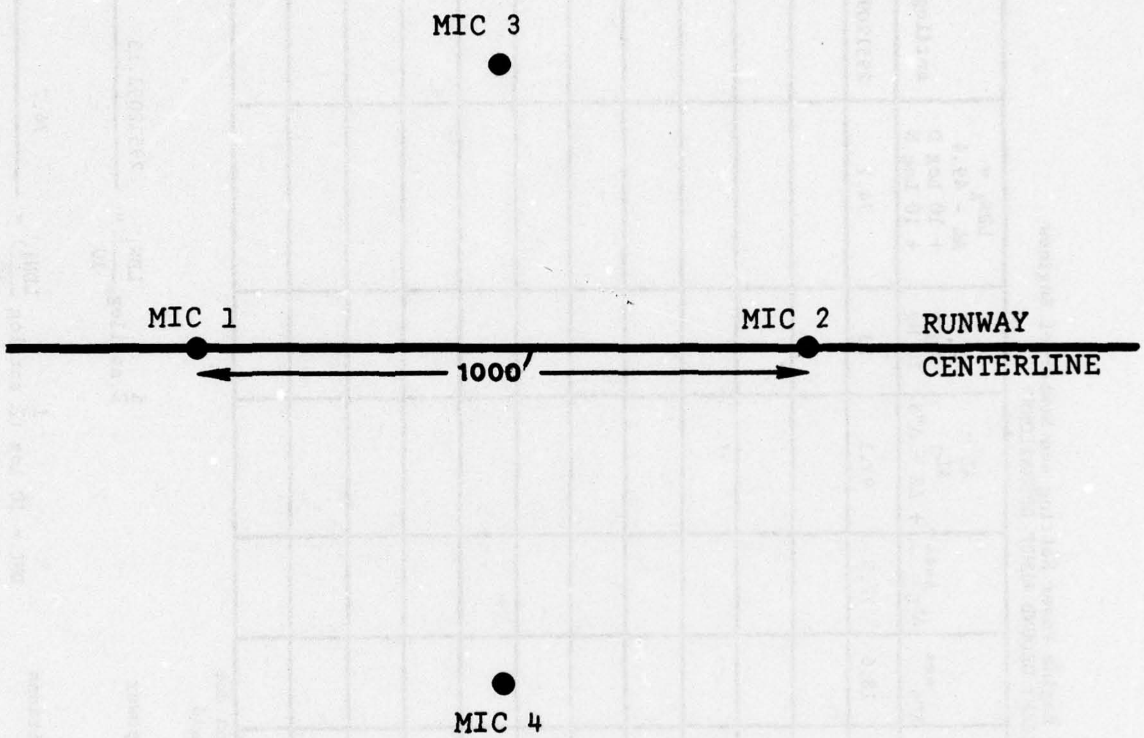

FIGURE 1. MICROPHONE ARRAY FOR LEVEL FLYOVERS

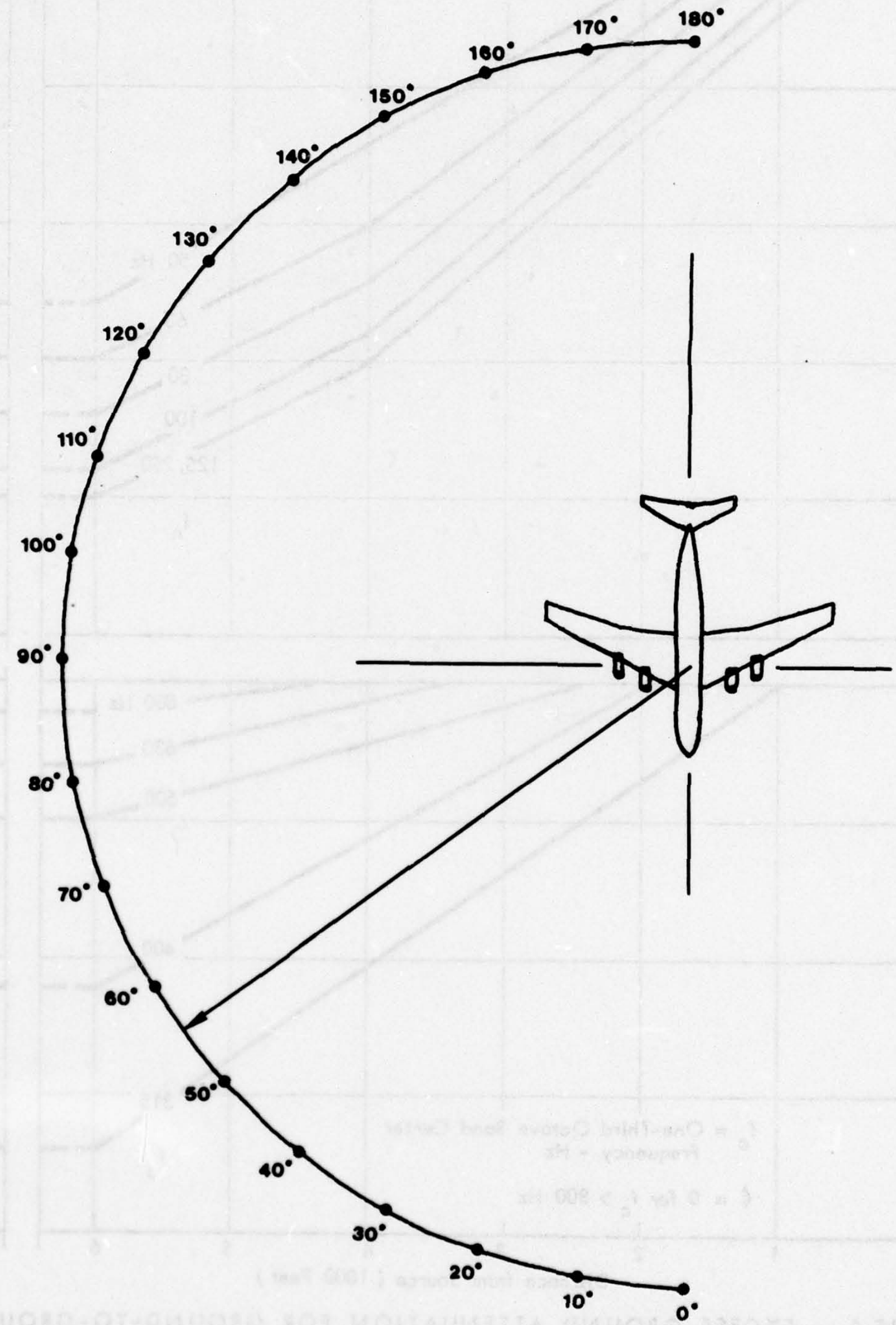

FIGURE 2. GROUND RUNUP MEASUREMENT LOCATIONS

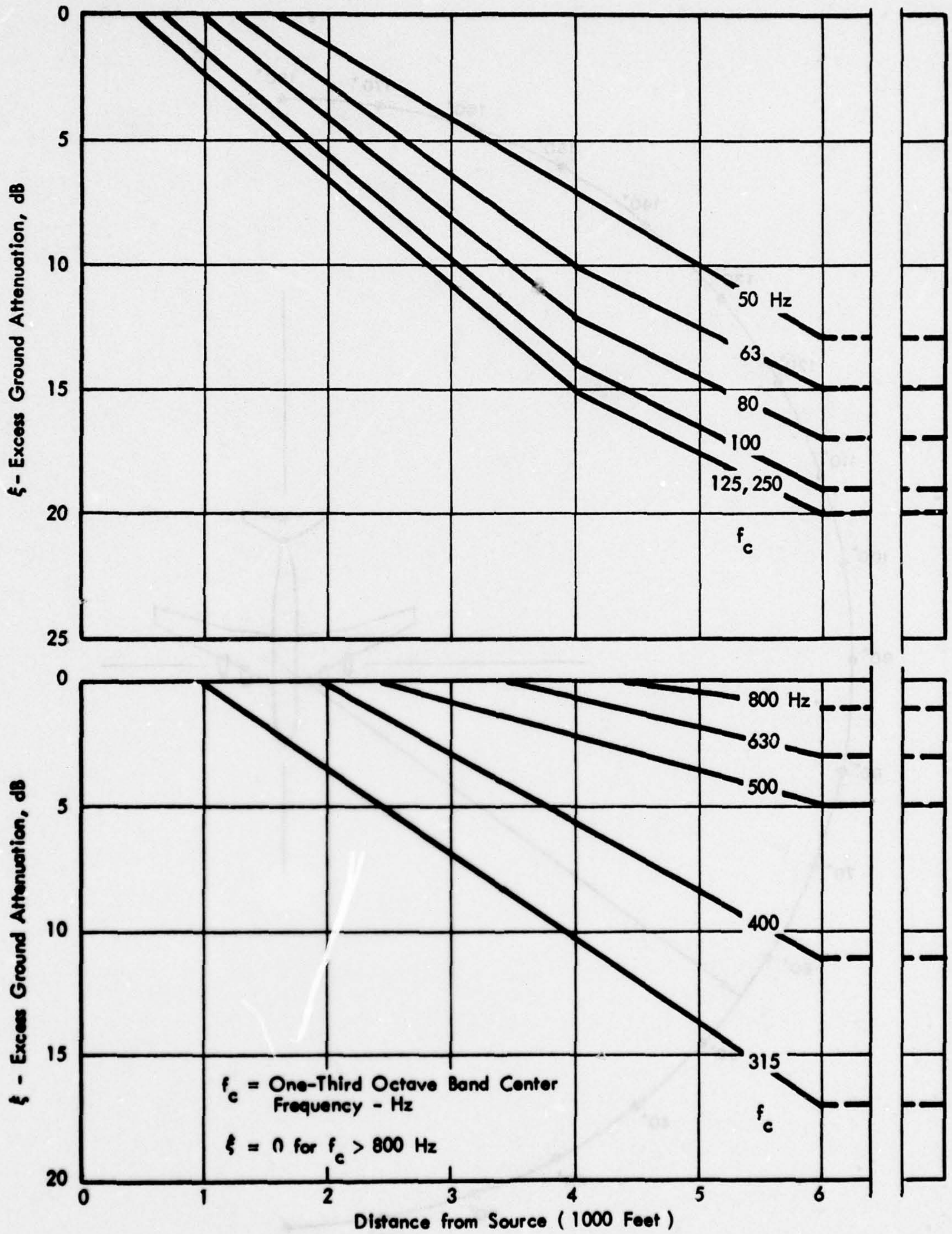

FIGURE 3. EXCESS GROUND ATTENUATION FOR GROUND-TO-GROUND SOUND PROPAGATION

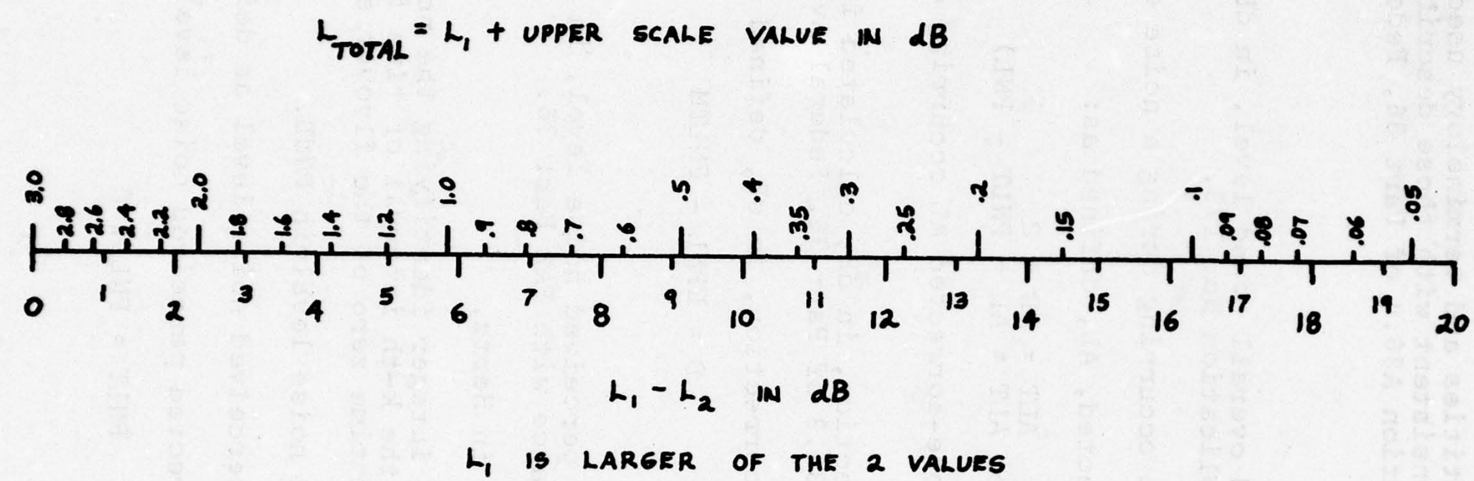

FIGURE 4. ENERGY SUMMATION OF NOISE LEVELS IN dB

GLOSSARY

The acoustical quantities and terminology used throughout this report are generally consistent with those described in AMRL-TR-73-107 (ref. 7) and in Section A36.4 of Part 36, Federal Aviation Regulations (ref. 17).

<u>Acoustical</u>

AL	A-weighted overall sound level, in dBA, as specified in IEC Publication No. 179.
ALM	Maximum AL occurring during a noise event.
ALT	Tone-corrected, AL, defined as: $$ALT = AL + C$$ $$(\text{or } ALT = AL + PNLT - PNL)$$
ALTM	Maximum tone-corrected AL occurring during a noise event.
C	Tone correction, in dB, calculated in accordance with Section B36.3 of Part 36, Federal Aviation Regulations.
D	Duration correction, in dB, defined as: $$D = EPNL - PNLTM$$
dB	Decibel
EPNL	Effective perceived noise level, in EPNdB, calculated in accordance with FAR Part 36.
f	Frequency in Hertz.
k	A running integer identifying the noise levels determined at the k-th interval of time from an arbitrary reference time zero of the flyover signal.
PNL	Perceived noise level in PNdB.
PNLM	Maximum perceived noise level as defined in FAR Part 36.
PNLT	Tone-corrected perceived noise level, where $$PNLT = PNL + C$$

Acoustical (Continued)

PNLTM Maximum PNLT occurring during a noise event.

SEL Sound exposure level, in dB, as defined in "Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare With an Adequate Margin of Safety," March 1974. The sound exposure level is the level of the time-integrated A-weighted sound level for an event, with a reference time T of one second:

$$SEL = 10 \log \frac{1}{T} \int_{-\infty}^{+\infty} 10^{\frac{AL}{10}} dt$$

For purposes of aircraft noise evaluation, SEL is computed from A-levels sampled at discrete intervals of 0.5 seconds or less. Thus the working expression for SEL becomes:

$$SEL = 10 \log \left[\sum_{k=0}^{k=\frac{d}{\Delta t}} 10^{\frac{AL(k)}{10}} \right] + 10 \log \Delta t$$

where d is the time interval during which AL(k) is within 10 dB of the maximum A-level, and Δt is the integration time of the noise level samples. Note that the SEL is identical to the single event noise exposure level (SENEL), in dB, as defined in "Noise Standards, Title 4, Subchapter 6, California Administration Code", 1970, except that the SENEL is defined in terms of integration (summation) from a threshold noise level approximately 30 dB below the maximum level, while, in this report, SEL is defined in terms of integration over noise levels within 10 dB of the maximum value. However, integration over only the upper 10 dB yields acceptable values that typically differ by 0.3 dB or less from values based on integration over 30 dB.

Acoustical (Continued)

SELT — Tone-corrected sound exposure level, in dB, defined for a noise event with a reference time T of one second:

$$SELT = 10 \log \frac{1}{T} \int_{-\infty}^{+\infty} 10^{\frac{ALT}{10}} dt$$

For purposes of aircraft noise evalution, SELT is computed from tone-corrected A-levels sampled at discrete time intervals of 0.5 seconds or less, as follows:

$$SELT = 10 \log \left[\sum_{k=0}^{k=\frac{d}{\Delta t}} 10^{\frac{ALT(k)}{10}} \right] + 10 \log \Delta t$$

where d is the time interval during which ALT(k) is within 10 dB of ALTM, and Δt is the time interval between noise level samples.

SPL — Sound pressure level in dB reference 0.0002 microbar.

ξ — Excess sound attenuation near the ground in dB.

Δ — Adjustment factors in dB to change test conditions to reference conditions or to adjust reference noise data to specified test parameters.

DELTA N — Adjustment factor in dB used to change from reference or field thrust or number of engine conditions to some other desired condition.

AIR-TO-GROUND — Atmospheric absorption coefficient values, α, used from SAE ARP 866, "Standard Values of Atmospheric Absorption as a Function of Temperature and Humidity for Use in Evaluating Aircraft Flyover Noise", August 1964 or later version. Air-to-ground noise data have

Acoustical (Continued)

AIR-TO-GROUND	(continued) been adjusted for atmospheric absorption and spherical divergence and should be used for all aircraft to observer elevation angles greater than approximately 7 degrees.
GROUND-TO-GROUND	Excess sound attenuation values were applied to the data in accordance with Figure 3. For the level fly-over data, an additional +5 dB of attenuation was applied at all frequencies/distances to provide consistency with the results of typical sideline attenuation measurements due to intervening obstacles such as buildings, terrain irregularities or trees and shrubs. This additional attenuation was not applied to the farfield ground runup data. Ground-to-ground flight noise data should be used for aircraft to observer elevation angles of 4 degrees or less with a linear interpolation made between the air-to-ground and ground-to-ground noise levels for angles between 7 and 4 degrees.

GENERAL

IDENT	Test record identification used by Biodynamic Environment Branch, Aerospace Medical Research Laboratory aircraft noise data bank purposes.
PROFILE VER	Descriptor used to note that some adjustment has been made from reference temperature, humidity, engine power setting, airspeed, number of engines, etc.
OMEGA	Identifies a specific Biodynamic Environment Branch, Aerospace Medical Research Laboratory data reduction algorithms/software program.
$\Delta 7$	Correction to PNLT for normalizing to reference weather conditions and account for inverse square losses.
$\Delta 8$	Correction to AL for normalizing to reference weather conditions and account for inverse square losses.
$\Delta 9$	Correction to ALT for normalizing to reference weather conditions and account for inverse square losses.

APPENDIX A

ENGINE POWER AND AIRSPEED ADJUSTMENTS FOR FLIGHT OPERATIONS
(dB Values to be Algebraically Added to NOISEFILE Values)

$\Delta 6 = \Delta' 6 + \Delta'' 6$

$\Delta' 6 = 10 \text{ Log } (\text{Airspeed}_{Ref} / \text{Airspeed}_{Test})$

$\Delta'' 6 = (\text{Power Cond.}_{Test} - \text{Power Cond.}_{Ref}) \times \text{Adj. Rate*}$

* Adjustment rates listed can introduce errors up to 1 dB for distances up to 4,000 ft.
* Adjustment rates listed can introduce errors of 2 to 4 dB for distances of 4,000 to 10,000 ft.
* Adjustment rates listed can introduce errors of 5 to 10 dB for distances greater than 10,000 ft.

Aircraft	Power Condition	Code Number	Ref Air-Speed	Ref Power Condition	Range of Application	Adjustment Rate
A-3	Takeoff	513031	350 KTS	96% RPM	91% - 97%	1.53 dB/1% RPM
	Approach	513051	200 KTS	89% RPM	89% - 93%	1.53 dB/1% RPM
	Approach	513051	200 KTS	89% RPM	88% - 89%	3.60 dB/1% RPM
	Intermediate	513061	300 KTS	88% RPM	87% - 89%	3.60 dB/1% RPM
A-4	Takeoff	130031	250 KTS	100% RPM	96% - 100%	2.00 dB/1% RPM
	Cruise	130041	300 KTS	83% RPM	80% - 87%	1.01 dB/1% RPM
	Approach	130051	150 KTS	93% RPM	93% - 96%	2.00 dB/1% RPM
	80% RPM	130991	300 KTS	80% RPM	76% - 84%	1.01 dB/1% RPM
	Approach	130051	150 KTS	93% RPM	87% - 93%	1.01 dB/1% RPM
A-4	Takeoff	130031	250 KTS	2.4 EPR	2.0 EPR-2.6 EPR	23.33 dB/1.0 EPR
	Cruise	130041	300 KTS	1.5 EPR	1.2 EPR-1.8 EPR	33.67 dB/1.0 EPR
	Approach	130051	150 KTS	1.8 EPR	1.8 EPR-2.1 EPR	23.33 dB/1.0 EPR
	Approach	130051	150 KTS	1.8 EPR	1.5 EPR-1.8 EPR	33.67 dB/1.0 EPR
A-5	Afterburner	131011	250 KTS	100% RPM	100%	
	Takeoff	131031	250 KTS	100% RPM	90% - 100%	.28 dB/1% RPM
	Approach	131051	160 KTS	83% RPM	75% - 94%	.28 dB/1% RPM
A-6	Takeoff	132031	250 KTS	100% RPM	96% - 100%	.92 dB/1% RPM
	Approach	132051	160 KTS	95% RPM	90% - 98%	.92 dB/1% RPM
A-6	Takeoff	132031	250 KTS	2.05 EPR	1.9 EPR-2.1 EPR	18.40 dB/1.0 EPR
	Approach	132051	160 KTS	1.8 EPR	1.5 EPR-2.0 EPR	18.40 dB/1.0 EPR

Aircraft	Power Condition	Code Number	Ref Air-Speed	Ref Power Condition	Range of Application	Adjustment Rate
A-7D,E	Takeoff	133031	300 KTS	96% RPM	89% - 96%	1.28 dB/1% RPM
	Cruise	133041	300 KTS	85% RPM	81% - 89%	1.28 dB/1% RPM
	Approach	133051	160 KTS	82% RPM	78% - 89%	1.28 dB/1% RPM
AV-8A	Takeoff	134031	300 KTS	103.5% RPM	88% - 105%	.35 dB/1% RPM
	Cruise	134041	350 KTS	75% RPM	70% - 90%	.35 dB/1% RPM
	Approach	134051	150 KTS	70% RPM	70% - 82%	.35 dB/1% RPM
A-10A	Max Rated Thrust	037111	350 KTS	6700 NF	6400 - 7000 NF	.65 dB/100 RPM
	Normal Rated Thrust	037121	300 KTS	6200 NF	5800 - 6600 NF	.64 dB/100 RPM
	Traffic Pattern	037131	160 KTS	5325 NF	4700 - 5900 NF	.64 dB/100 RPM
	Approach	037051	150 KTS	5225 NF	4600 - 5800 NF	.64 dB/100 RPM
A-37B	Takeoff	504031	300 KTS	100% RPM	95% - 100%	1.82 dB/1% RPM
	Cruise	504041	300 KTS	90% RPM	88% - 91%	2.20 dB/1% RPM
	Approach	504051	170 KTS	91% RPM	91% - 95%	1.82 dB/1% RPM
	Approach	504051	170 KTS	91% RPM	88% - 91%	2.20 dB/1% RPM
B-1	Afterburner	039011	275 KTS	97.5% RPM NC		
	Intermediate (Mil)	039141	270 KTS	98.5% RPM NC	97% - 100% RPM	1.9 dB/1% RPM
	Approach	039051	185 KTS	96.5% RPM NC	96.5% - 98% RPM	1.9 dB/1% RPM
	Cruise	039041	360 KTS	89.9% RPM NC	87% - 95% RPM	.94 dB/1% RPM
	Approach	039051	185 KTS	96.5% RPM NC	92% - 96.5% RPM	.94 dB/1% RPM
	Afterburner	039011	275 KTS	874 F T4B		
	Intermediate (Mil)	039141	270 KTS	877 F T4B	850 F-890 F T4B	0.81 dB/10 F T4
	Approach	039051	185 KTS	830 F T4B	830 F-850 F T4B	0.81 dB/10 F T4
	Cruise	039041	360 KTS	611 F T4B	570 F-800 F T4B	.28 dB/10 F T4
	Approach	039051	185 KTS	830 F T4B	800 F-830 F T4B	.28 dB/10 F T4
B-52B,C,D,E	Takeoff - Wet	519021	170 KTS	94% RPM	94%	
	Takeoff	519031	170 KTS	94% RPM	90% - 96%	1.58 dB/1% RPM
	Cruise	519041	250 KTS	83.5% RPM	80% - 86%	.96 dB/1% RPM
	Approach	519051	140 KTS	86% RPM	86% - 90%	1.58 dB/1% RPM
	Approach	519051	140 KTS	86% RPM	82% - 86%	.96 dB/1% RPM

Aircraft	Power Condition	Code Number	Ref Air-Speed	Ref Power Condition	Range of Application	Adjustment Rate
B-52G,F	Takeoff-Wet	043021	170 KTS	94% RPM	94%	
	Takeoff	043031	170 KTS	94% RPM	90% - 96%	1.58 dB/1% RPM
	Cruise	043041	250 KTS	83.5% RPM	80% - 86%	.96 dB/1% RPM
	Approach	043051	140 KTS	86% RPM	86% - 90%	1.58 dB/1% RPM
	Approach	043051	140 KTS	86% RPM	82% - 86%	.96 dB/1% RPM
B-52G,F	Takeoff - Wet	043021	170 KTS	2.77 EPR	2.77 EPR	
	Takeoff	043031	170 KTS	2.37 EPR	1.9 EPR-2.5 EPR	15.75 dB/1.0 EPR
	Cruise	043041	250 KTS	1.48 EPR	1.2 EPR-1.57 EPR	26.67 dB/1.0 EPR
	Approach	043051	140 KTS	1.57 EPR	1.57 EPR-2.0 EPR	15.75 dB/1.0 EPR
	Approach	043051	140 KTS	1.57 EPR	1.4 EPR-1.57 EPR	26.67 dB/1.0 EPR
B-52H	Takeoff	044031	170 KTS	1.65 EPR	1.3 EPR-1.7 EPR	9.00 dB/1.0 EPR
	Cruise	044041	250 KTS	1.10 EPR	1.0 EPR-1.25 EPR	32.00 dB/1.0 EPR
	Approach	044051	150 KTS	1.25 EPR	1.25 EPR-1.5 EPR	9.00 dB/1.0 EPR
	Approach	044051	150 KTS	1.25 EPR	1.0 EPR-1.25 EPR	32.00 dB/1.0 EPR
B-57B,C,E	Takeoff	070031	200 KTS	100% RPM	90% - 100%	.94 dB/1% RPM
	Approach	070051	150 KTS	82% RPM	77% - 90%	.94 dB/1% RPM
	Intermediate	070061	280 KTS	92% RPM	88% - 96%	.94 dB/1% RPM
FB-111A	Afterburner	080011	250 KTS	100% RPM		
	Takeoff	080031	240 KTS	100% RPM	90% - 100%	.78 dB/1% RPM
	Approach	080051	150 KTS	81% RPM	76% - 92%	.78 dB/1% RPM
	Intermediate	080061	350 KTS	86% RPM	82% - 90%	.78 dB/1% RPM
C-5A	Takeoff	022031	185 KTS	4.0 EPR	3.7 EPR-5.0 EPR	3.27 dB/1.0 EPR
	Cruise	022041	250 KTD	2.48 EPR	2.0 EPR-2.99 EPR	3.33 dB/1.0 EPR
	Approach	022051	150 KTS	2.99 EPR	2.99 EPR-3.5 EPR	3.27 dB/1.0 EPR
	Intermediate	022061	130 KTS	3.38 EPR	3.0 EPR-3.8 EPR	3.27 dB/1.0 EPR
	Traffic Pattern	022131	165 KTS	3.07 EPR	2.99 EPR-3.5 EPR	3.27 dB/1.0 EPR
	Approach	022051	150 KTS	2.99 EPR	2.5 EPR-2.99 EPR	3.33 dB/1.0 EPR

Aircraft	Power Condition	Code Number	Ref Air-Speed	Ref Power Condition	Range of Application	Adjustment Rate
C-7A	Takeoff	072031	160 KTS	50 In Hg	36 In - 50 In	.51 dB/1 In Hg
	Approach	072051	90 KTS	27 In Hg	18 In - 40 In	.51 dB/1 In Hg
	Intermediate	072061	140 KTS	35 In Hg	28 In - 44 In	.51 dB/1 In Hg
C-9A,C	Takeoff	073031	250 KTS	1.97 EPR	1.5 - 2.2 EPR	19.84 dB/1 EPR
	Approach	073051	160 KTS	1.35 EPR	1.0 - 1.7 EPR	19.84 dB/1 EPR
	Intermediate	073061	300 KTS	1.70 EPR	1.4 - 2.0 EPR	19.84 dB/1 EPR
YC-14	CTOL Takeoff	014031	120 KTS	3772 NF	3000 - 4000 NF	1.25 dB/100 NF
	CTOL Approach	014051	85 KTS	2068 NF	1700 - 2600 NF	1.25 dB/100 NF
	STOL Takeoff	014151	110 KTS	3640 NF	3000 - 4000 NF	1.16 dB/100 NF
	STOL Approach	014161	80 KTS	2118 NF	1700 - 2600 NF	1.16 dB/100 NF
	Cruise	014041	250 KTS	2468 NF	2200 - 3000 NF	1.25 dB/100 NF
	Traffic Pattern	014131	150 KTS	2605NF	2200 - 3000 NF	1.25 dB/100 NF
YC-15	CTOL Takeoff	015031	120 KTS	2.25 EPR	1.9 - 2.4 EPR	14.20 dB/1.0 EPR
	CTOL Approach	015051	85 KTS	1.56 EPR	1.56 - 1.8 EPR	14.20 dB/1.0 EPR
	Intermediate	015061	150 KTS	1.40 EPR	1.3 - 1.5 EPR	23.64 dB/1.0 EPR
	Traffic Pattern	015131	150 KTS	1.45 EPR	1.3 - 1.5 EPR	23.64 dB/1.0 EPR
	STOL Takeoff	015151	110 KTS	2.23 EPR	1.9 - 2.4 EPR	13.83 dB/1.0 EPR
	STOL Approach	015161	80 KTS	1.63 EPR	1.4 - 1.9 EPR	13.83 dB/1.0 EPR
	CTOL Approach	015051	85 KTS	1.56 EPR	1.3 - 1.56 EPR	23.64 dB/1.0 EPR
C-97L-Jets	Takeoff - Jets	081081	230 KTS	100% RPM	100% RPM	
	Approach - Jets	081091	130 KTS	60% RPM	60% RPM	
C-97L,G No Jets	Takeoff	081031	190 KTS	59 In Hg	42 In - 60 In	.25 dB/1 In Hg
	Approach	081051	125 KTS	35 In Hg	30 In - 46 In	.25 dB/1 In Hg
C-118A	Takeoff	507031	140 KTS	60 In Hg	42 In - 62 In	.38 dB/1 In Hg
	Cruise	507041	180 KTS	32 In Hg	14 In - 46 In	.38 dB/1 In Hg
	Approach	507051	120 KTS	27 In Hg	32 In - 42 In	.38 dB/1 In Hg
C-119L	Takeoff	074031	135 KTS	2900 RPM	2600-3000 RPM	2.90 dB/100 RPM
	Approach	074051	120 KTS	2600 RPM	2600-2800 RPM	2.90 dB/100 RPM
	Approach	074051	120 KTS	2600 RPM	2200-2600 RPM	1.17 dB/100 RPM
	Intermediate	074061	150 KTS	2000 RPM	1600-2400 RPM	1.17 dB/100 RPM

Aircraft	Power Condition	Code Number	Ref Air-Speed	Ref Power Condition	Range of Application	Adjustment Rate
C-121C,G,S,T	Takeoff	075031	165 KTS	58 In Hg	46 In - 60 In	.45 dB/1 In Hg
	Cruise	075041	150 KTS	33 In Hg	30 In - 35 In	3.00 dB/1 In Hg
	Approach	075051	140 KTS	35 In Hg	35 In - 48 In	.45 dB/1 In Hg
	Intermediate	075061	150 KTS	40 In Hg	36 In - 44 In	.45 dB/1 In Hg
	Approach	075051	140 KTS	35 In Hg	32 In - 35 In	3.00 dB/1 In Hg
C-121C,G,S,T	Takeoff	075031	165 KTS	2900 RPM	2800-3000 RPM	3.47 dB/100 RPM
	Cruise	075041	150 KTS	2350 RPM	2200-2500 RPM	.24 dB/100 RPM
	Approach	075051	140 KTS	2600 RPM	2600-2800 RPM	3.47 dB/100 RPM
	Intermediate	075061	150 KTS	2350 RPM	2200-2500 RPM	.24 dB/100 RPM
	Approach	075051	140 KTS	2600 RPM	2400-2600 RPM	.24 dB/100 RPM
C-123K	Takeoff	523031	140 KTS	60 In Hg	42 In - 62 In	.38 dB/1 In Hg
	Approach	523051	120 KTS	27 In Hg	14 In - 46 In	.38 dB/1 In Hg
	Takeoff-Jets	523081	200 KTS	100% RPM	100%	
	Approach-Jets	523091	150 KTS	91% RPM	91%	
C-130A,D	Takeoff	520031	170 KTS	970°C	720°C - 1000°C	.74 dB/100°C TIT
	Approach	520051	140 KTS	580°C	400°C - 760°C	.74 dB/100°C TIT
C-130B,E	Takeoff	006031	170 KTS	970°C	720°C - 1000°C	.74 dB/100°C TIT
	Approach	006051	140 KTS	580°C	400°C - 760°C	.74 dB/100°C TIT
C-130H,N,P	Takeoff	521031	170 KTS	970°C	720°C - 1000°C	.74 dB/100°C TIT
	Approach	521051	140 KTS	580°C	400°C - 760°C	.74 dB/100°C TIT
C-131A,B, D,E	Takeoff	028031	140 KTS	60 In Hg	42 In - 62 In	.38 dB/1 In Hg
	Cruise	028041	180 KTS	32 In Hg	14 In - 46 In	.38 dB/1 In Hg
	Approach	028051	120 KTS	27 In Hg	32 In - 42 In	.38 dB/1 In Hg
C-135A,D, F,G,H,K, L,N,Q,R,T	Takeoff-Wet	026021	200 KTS	96% RPM	96%	
	Takeoff	026031	200 KTS	96% RPM	92% - 96%	2.02 dB/1% RPM
	Approach	026051	160 KTS	90% RPM	90% - 94%	2.02 dB/1% RPM
	Approach	026051	160 KTS	90% RPM	86% - 90%	1.15 dB/1% RPM
	Cruise	026041	300 KTS	86% RPM	82% - 90%	1.15 dB/1% RPM

Aircraft	Power Condition	Code Number	Ref Air-Speed	Ref Power Condition	Range of Application	Adjustment Rate
C-135A,D	Takeoff-Wet	026021	200 KTS	2.85 EPR	2.85 EPR	
F,G,H,K	Takeoff	026031	200 KTS	2.45 EPR	2.1 - 2.5 EPR	17.29 dB/1.0 EPR
L,N,Q,R,T	Cruise	026041	300 KTS	1.50 EPR	1.2 - 1.7 EPR	18.40 dB/1.0 EPR
	Approach	026051	160 KTS	1.75 EPR	1.75 - 2.1 EPR	17.29 dB/1.0 EPR
	Approach	026051	160 KTS	1.75 EPR	1.5 - 1.75 EPR	18.40 dB/1.0 EPR
C-135B,	Takeoff	025031	250 KTS	1.8 EPR	1.5 - 1.9 EPR	7.65 dB/1.0 EPR
C,E,J,	Cruise	025041	300 KTS	1.09 EPR	1.0 - 1.29 EPR	14.00 dB/1.0 EPR
M,S,U,V	Approach	025051	160 KTS	1.29 EPR	1.29 - 1.6 EPR	7.65 dB/1.0 EPR
	Approach	025051	160 KTS	1.29 EPR	1.0 - 1.29 EPR	14.00 dB/1.0 EPR
C-140A,B	Takeoff	508031	180 KTS	100% RPM	90% - 100%	.64 dB/1% RPM
	Cruise	508041	250 KTS	89% RPM	84% - 94%	.64 dB/1% RPM
	Approach	508051	115 KTS	79.5% RPM	70% - 90%	.64 dB/1% RPM
C-141A	Takeoff	027031	250 KTS	1.90 EPR	1.5 - 2.0 EPR	10.00 dB/1.0 EPR
	Cruise	027041	300 KTS	1.52 EPR	1.3 - 1.7 EPR	10.00 dB/1.0 EPR
	Approach	027051	140 KTS	1.20 EPR	1.0 - 1.6 EPR	10.00 dB/1.0 EPR
	Intermediate	027061	140 KTS	1.20 EPR	1.0 - 1.6 EPR	10.00 dB/1.0 EPR
F-4C,D,	Afterburner	031011	300 KTS	100% RPM	100%	
E,F	Takeoff	031031	300 KTS	100% RPM	91% - 100%	.97 dB/1% RPM
	Cruise	031041	300 KTS	92% RPM	89% - 96%	.97 dB/1% RPM
	Approach	031051	190 KTS	87% RPM	84% - 92%	.97 dB/1% RPM
F-5A,B	Afterburner	509011	350 KTS	101% RPM	101%	
	Takeoff	509031	300 KTS	101% RPM	90% - 101%	1.07 dB/1% RPM
	Cruise	509041	325 KTS	86% RPM	82% - 90%	1.07 dB/1% RPM
	Approach	509051	170 KTS	82% RPM	78% - 90%	1.07 dB/1% RPM

Aircraft	Power Condition	Code Number	Ref Air-Speed	Ref Power Condition	Range of Application	Adjustment Rate
F-5E,F	Afterburner	046011	350 KTS	101% RPM	101%	
	Takeoff	046031	300 KTS	101% RPM	90% - 101%	1.07 dB/1% RPM
	Cruise	046041	325 KTS	86% RPM	82% - 90%	1.07 dB/1% RPM
	Approach	046051	170 KTS	82% RPM	78% - 90%	1.07 dB/1% RPM
F-14	Afterburner	136011	300 KTS	100% RPM	100%	
	Takeoff	136031	300 KTS	100% RPM	92% - 100%	1.04 dB/1% RPM
	Cruise	136041	350 KTS	82.5% RPM	80% - 85%	2.28 dB/1% RPM
	Approach	136051	150 KTS	85% RPM	85% - 92%	1.04 dB/1% RPM
	Approach	136051	150 KTS	85% RPM	80% - 85%	2.28 dB/1% RPM
F-15A	Afterburner	061011	350 KTS	91% RPM	91%	
	Takeoff	061031	300 KTS	90% RPM	82% - 90%	1.71 dB/1% RPM
	Cruise	061041	280 KTS	73.5% RPM	70% - 75%	0 dB/1% RPM
	Approach	061051	170 KTS	75% RPM	75% - 82%	1.71 dB/1% RPM
	Approach	061051	170 KTS	75% RPM	70% - 75%	0 dB/1% RPM
F-16	Afterburner	038011	350 KTS	90% RPM	90%	
	Takeoff	038031	350 KTS	90% RPM	86% - 90%	2.18 dB/1% RPM
	Intermediate	038061	300 KTS	85% RPM	83% - 87%	2.18 dB/1% RPM
	Traffic Pattern	038131	200 KTS	75% RPM	75% - 79%	1.33 dB/1% RPM
	Approach	038051	130 KTS	82% RPM	82% - 86%	2.18 dB/1% RPM
	Approach	038051	130 KTS	82% RPM	78% - 82%	1.33 dB/1% RPM
F-100C, D,F	Afterburner	030011	300 KTS	95% RPM	95%	
	Takeoff	030031	300 KTS	94.5% RPM	92% - 95%	1.05 dB/1% RPM
	Cruise	030041	370 KTS	92.3% RPM	90% - 94%	1.05 dB/1% RPM
	Approach	030051	160 KTS	89% RPM	85% - 93%	1.05 dB/1% RPM
F-101B,C, F	Afterburner	071011	350 KTS	96.5% RPM	96.5%	
	Takeoff	071031	350 KTS	96.0% RPM	91% - 97%	1.53 dB/1% RPM
	Approach	071051	200 KTS	89% RPM	89% - 93%	1.53 dB/1% RPM
	Intermediate	071061	300 KTS	88% RPM	87% - 89%	3.60 dB/1% RPM
	Approach	071051	200 KTS	89% RPM	88% - 89%	3.60 dB/1% RPM

Aircraft	Power Condition	Code Number	Ref Air-Speed	Ref Power Condition	Range of Application	Adjustment Rate
F-102A	Afterburner	512011	300 KTS	95% RPM	95%	
	Takeoff	512031	300 KTS	94.5% RPM	92% - 95%	1.05 dB/1% RPM
	Cruise	512041	370 KTS	92.3% RPM	90% - 94%	1.05 dB/1% RPM
	Approach	512051	160 KTS	89% RPM	85% - 93%	1.05 dB/1% RPM
F-104C,D,G	Afterburner	045011	240 KTS	100% RPM	100%	
	Takeoff	045031	240 KTS	100% RPM	97% - 100%	1.86 dB/1% RPM
	Cruise	045041	300 KTS	92% RPM	90% - 95%	0 dB/1% RPM
	Intermediate	045061	300 KTS	92% RPM	90% - 95%	0 dB/1% RPM
	Approach	045051	190 KTS	95% RPM	95% - 98%	1.86 dB/1% RPM
	Approach	045051	190 KTS	95% RPM	90% - 95%	0 dB/1% RPM
F-105B,D, F,G	Afterburner	077011	350 KTS	102.5% RPM	102.5%	
	Takeoff	077031	300 KTS	102% RPM	99% - 102%	1.56 dB/1% RPM
	Approach	077051	210 KTS	96.5% RPM	96.5% - 99%	1.56 dB/1% RPM
	Intermediate	077061	290 KTS	93% RPM	90% - 95%	.86 dB/1% RPM
	Approach	077051	210 KTS	96.5% RPM	92% - 96.5%	.86 dB/1% RPM
F-106A,B	Afterburner	078011	350 KTS	108% RPM	108%	
	Takeoff	078031	350 KTS	106% RPM	98% - 106%	1.37 dB/1% RPM
	Approach	078051	200 KTS	93% RPM	93% - 98%	1.37 dB/1% RPM
	Intermediate	078061	300 KTS	86.5% RPM	82% - 92%	.43 dB/1% RPM
	Approach	078051	200 KTS	93% RPM	88% - 93%	.43 dB/1% RPM
F-106A,B	Afterburner	078011	350 KTS	2.45 EPR	2.45 EPR	
	Takeoff	078031	350 KTS	2.3 EPR	2.0 - 2.3 EPR	29.67 dB/1.0 EPR
	Approach	078051	200 KTS	1.7 EPR	1.7 - 2.0 EPR	29.67 dB/1.0 EPR
	Intermediate	078061	300 KTS	1.4 EPR	1.2 - 1.6 EPR	9.33 dB/1.0 EPR
	Approach	078051	200 KTS	1.7 EPR	1.4 - 1.7 EPR	9.33 dB/1.0 EPR

Aircraft	Power Condition	Code Number	Ref Air-Speed	Ref Power Condition	Range of Application	Adjustment Rate
F-111A,E	Afterburner	510011	350 KTS	97% RPM	97%	
	Takeoff	510031	300 KTS	97% RPM	89% - 97%	1.16 dB/1% RPM
	Approach	510051	150 KTS	81% RPM	76% - 90%	1.16 dB/1% RPM
	Intermediate	510061	350 KTS	86% RPM	82% - 90%	1.16 dB/1% RPM
F-111D	Afterburner	511011	350 KTS	97% RPM	97%	
	Takeoff	511031	300 KTS	97% RPM	89% - 97%	1.16 dB/1% RPM
	Approach	511051	150 KTS	81% RPM	76% - 90%	1.16 dB/1% RPM
	Intermediate	511061	350 KTS	86% RPM	82% - 90%	1.16 dB/1% RPM
F-111F	Afterburner	079011	350 KTS	97% RPM	97%	
	Takeoff	079031	300 KTS	97% RPM	89% - 97%	1.16 dB/1% RPM
	Approach	079051	150 KTS	81% RPM	76% - 90%	1.16 dB/1% RPM
	Intermediate	079061	350 KTS	86% RPM	82% - 90%	1.16 dB/1% RPM
P-3	Takeoff	137031	140 KTS	3875 ESHP	2100 - 3900 HP	.26 dB/100 ESHP
	Cruise	137041	180 KTS	2000 ESHP	1500 - 2300 HP	.26 dB/100 ESHP
	Approach	137051	120 KTS	900 ESHP	700 - 2300 HP	.26 dB/100 ESHP
SR-71	Afterburner	517011	200 KTS	100% RPM	100%	
	Takeoff (Mil)	517031	200 KTS	70% RPM	50% - 70%	.40 dB/1% RPM
	Approach	517051	200 KTS	30% RPM	30% - 50%	.40 dB/1% RPM
S-3A	Takeoff	138031	250 KTS	97.2% RPM	80% - 100%	.31 dB/1% RPM
	Cruise	138041	250 KTS	60% RPM	55% - 65%	.72 dB/1% RPM
	Approach	138051	140 KTS	69% RPM	64% - 69%	.72 dB/1% RPM
	Approach	138051	140 KTS	69% RPM	69% - 85%	.31 dB/1% RPM
S-3A	Takeoff	138031	250 KTS	3.03 EPR	2.55-3.19 EPR	8.54 dB/1.0 EPR
	Cruise	138041	250 KTS	1.77 EPR	1.65-1.85 EPR	28.26 dB/1.0 EPR
	Approach	138051	140 KTS	2.0 EPR	2.0-2.55 EPR	8.54 dB/1.0 EPR
	Approach	138051	140 KTS	2.0 EPR	1.85-2.0 EPR	28.26 dB/1.0 EPR

Aircraft	Power Condition	Code Number	Ref Air-Speed	Ref Power Condition	Range of Application	Adjustment Rate
T-2C	Takeoff	139031	180 KTS	101.7% RPM	88% - 102%	.50 dB/1% RPM
	Cruise	139041	250 KTS	75.0% RPM	72% - 78%	.50 dB/1% RPM
	Approach	139051	140 KTS	72.5% RPM	70% - 88%	.50 dB/1% RPM
T-29	Takeoff	516031	140 KTS	60 In Hg	42 - 62 In	.38 dB/1% RPM
	Cruise	516041	180 KTS	32 In Hg	14 - 46 In	.38 dB/1% RPM
	Approach	516051	120 KTS	27 In Hg	32 - 42 In	.38 dB/1% RPM
T-33A	Takeoff	029031	200 KTS	100% RPM	88% - 100%	.55 dB/1% RPM
	Cruise	029041	300 KTS	90% RPM	84% - 96%	.55 dB/1% RPM
	Approach	029051	125 KTS	80% RPM	74% - 92%	.55 dB/1% RPM
T-37B	Takeoff	024031	170 KTS	99% RPM	89% - 100%	.33 dB/1% RPM
	Cruise	024041	225 KTS	90% RPM	82% - 96%	.33 dB/1% RPM
	Approach	024051	105 KTS	80% RPM	70% - 90%	.33 dB/1% RPM
T-38A	Afterburner	033011	300 KTS	100% RPM	100%	
	Takeoff	033031	300 KTS	100% RPM	95% - 100%	1.83 dB/1% RPM
	Cruise	033041	300 KTS	90% RPM	88% - 91%	2.20 dB/1% RPM
	Approach	033051	170 KTS	91% RPM	91% - 96%	1.83 dB/1% RPM
	Approach	033051	170 KTS	91% RPM	88% - 91%	2.20 dB/1% RPM
T-39A,B,F	Takeoff	032031	180 KTS	100% RPM	90% - 100%	.64 dB/1% RPM
	Cruise	032041	250 KTS	89% RPM	84% - 94%	.64 dB/1% RPM
	Approach	032051	115 KTS	79.5% RPM	70% - 90%	.64 dB/1% RPM
T-43A	Takeoff	083031	200 KTS	1.97 EPR	1.6 - 2.0 EPR	8.04 dB/1.0 EPR
	Approach	083051	140 KTS	1.46 EPR	1.46 - 1.8 EPR	8.04 dB/1.0 EPR
	Intermediate	083061	250 KTS	1.21 EPR	1.0 - 1.4 EPR	29.60 dB/1.0 EPR
	Approach	083051	140 KTS	1.46 EPR	1.2 - 1.46 EPR	29.60 dB/1.0 EPR

Aircraft	Power Condition	Code Number	Ref Air-Speed	Ref Power Condition	Range of Application	Adjustment Rate
U-2	Takeoff	518031	300 KTS	102% RPM	99% - 102%	1.56 dB/1% RPM
	Intermediate	518061	290 KTS	93% RPM	90% - 95%	.83 dB/1% RPM
	Approach	518051	210 KTS	96.5% RPM	96.5% - 99%	1.56 dB/1% RPM
	Approach	518051	210 KTS	96.5% RPM	93% - 96.5%	.83 dB/1% RPM
U-4B	Takeoff	076031	170 KTS	45 In Hg	34 - 48 In	.38 dB/1% RPM
	Approach	076051	100 KTS	24 In Hg	18 - 36 In	.38 dB/1% RPM
	Intermediate	076061	180 KTS	30 In Hg	24 - 36 In	.38 dB/1% RPM
OV-10	Takeoff	082031	150 KTS	100% RPM	98% - 100%	1.33 dB/1% RPM
	Approach	082051	100 KTS	97% RPM	93% - 99%	1.33 dB/1% RPM
	Intermediate	082061	140 KTS	97% RPM	94% - 99%	1.33 dB/1% RPM

APPENDIX B

AIRCRAFT LISTINGS FOR DATA VOLUMES

AMRL-TR-73-110, Vol. 2: Air Force Bomber/Cargo Aircraft Noise Data

B-1	C-9A,C
B-52B,C,D,E	C-135A,D,F,G,H,K,L,N,Q,R,T
B-52G,F	C-135B,C,E,J,M,S,U,V
B-52H	C-140A,B
B-57B,C,E	C-141A
FB-111A	SR-71
C-5A	

AMRL-TR-73-110, Vol 3: Air Force Attack/Fighter Aircraft Noise Data

A-7D,E	F-15A
A-10A	F-16
A-37B	F-104C,D,G
F-4C,D,E,F	F-111A,E
F-5A,B	F-111D
F-5E,F	F-111F

AMRL-TR-73-110, Vol 4: Air Force Trainer/Fighter Aircraft Noise Data

F-100C,D,F	T-37B
F-101B,C,F	T-38A
F-102A	T-39A,B,F
F-105B,D,F,G	T-43A
F-106A,B	U-2
T-33A	

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C-7A	C-130B,E
C-97L	C-130H,N,P
C-118A	C-131A,B,D,E
C-119L	OV-10
C-121C,G,S,T	T-29
C-123K	U-4B
C-130A,D	

AMRL-TR-73-110, Vol. 6: Navy Aircraft Noise Data

A-3	F-8
TA-4J	F-14A
RA-5C	P-3A
A-6A	S-3A
AV-8A	T-2C

NOTE: Inquiries for obtaining these NOISEFILE data in magnetic tape form should be directed to: Aerospace Medical Research Laboratory, Biodynamic Environment Branch, Wright-Patterson Air Force Base, Ohio 45433.

TOTAL DNL FOR AIRCRAFT FLYOVER OPERATIONS*

Test Parameters				Number of Operations								
Aircraft	Power Setting	Slant Distance	Air-Speed	Day (N_D)	Night (N_N)	$\Delta'6$**	$\Delta''6$***	SEL_0****	$SEL = SEL_0 + \Delta'6 + \Delta''6$	$N = N_D + 10N_N$	$LDN_i = SEL - 49.4 + 10 \text{ Log } N$	antilog $\frac{LDN_i}{10}$

*For calculation of total DNL at a given ground position due to aircraft flyovers occurring at various power settings and slant distances

**$\Delta'6 = 10 \log_{10} \left(\frac{\text{reference airspeed}}{\text{test airspeed (knots)}}\right)$

***$\Delta''6$ = Noise level adjustment for engine power setting other than reference (See Appendix A)

****The Sound Exposure Level for the test slant distance from AMRL/BBE OMEGA 6.6 data file.

$\sum^{i} \text{antilog} \frac{LDN_i}{10}$ = ____________

$DNL = 10 \log \left(\sum^{i} \text{antilog} \frac{LDN_i}{10}\right)$ = ____________

TOTAL DNL FOR AIRCRAFT GROUND RUNUP OPERATIONS*

Test Parameters				Number of Operations								
Aircraft Engine	Power Setting & Angle	Runup Duration (D) Sec	10 LogD	Day (N_D)	Night (N_N)	ΔE**	Δ"6***	AL_0****	$AL = AL_0 + \Delta E + \Delta''6$	$N = N_D + 10\ N_N$	$LDN_i = AL - 49.4 + 10 \text{ Log } D + 10 \text{ Log } N$	antilog $\frac{LDN_i}{10}$

*For calculation of total DNL at a given ground position due to ground runups occurring at various power settings and locations

**ΔE = 10 Log_{10} (Number of Engines operating at given power setting)

***Δ"6 = noise level adjustment for engine power setting other than reference

****The A-weighted sound pressure level for the test conditions from AMRL/BBE OMEGA 8.2 data file

$$\sum^{i} \text{antilog } \frac{LDN_i}{10} = \underline{\qquad\qquad}$$

$$DNL = 10 \log \left(\sum^{i} \text{antilog } \frac{LDN_i}{10}\right) = \underline{\qquad\qquad}$$

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