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JET ENGINE NOISE SOURCE AND NOISE FOOTPRINT COMPUTER PROGRAMS

By

D. G. Dunn, N. A. Peart, D. L. Miller, and K. C. Crowley

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16. Abstract

Calculation procedures are presented for predicting maximum passby noise levels and contours (footprints) of conventional jet aircraft with or without noise suppression devices. The procedures have been computerized and a user's guide is presented for the computer programs to be used in predicting the noise characteristics during aircraft takeoffs, fly-overs, and/or landing operations.

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ABBREVIATIONS & SYMBOLS

A	area, square meters
A_j	area enclosed by noise contour CNL_j, square meters
A_o	reference area, square meters
A_s	fan discharge area, square meters
B	number of blades on dominant noise rotor stage
c	speed of sound, meters per second
CNL	contour noise level, EPNdB or PNdB
C.O.B.	commercial (common) – octave bands
D	diameter, meters
D_R	reference tip diameter, meters
EPNL	effective perceived noise level, EPNdB
EPR	engine pressure ratio
f	frequency, hertz
f_o, f_1	characteristic frequency, hertz
f_o', f_1'	Doppler-shifted characteristic frequency, hertz
f_t	target frequency for lining design, hertz
H	effective duct height for lining design, meters
IGV	inlet guide vanes
ISA	international standard atmosphere
L	apparent treatment length for lining design, meters
LR	natural logarithm of off-axis range, meters
$\dot{m}$	mass flow, kilograms per second
M_B	Mach number of bypass flow in fan duct of turbofans

ABBREVIATIONS & SYMBOLS (continued)

M_I	Mach number of flow in inlet duct of turbofans or turbojets
M_o	aircraft Mach number
N	number of engines
NL	noise level, EPNdB or PNdB
OASPL	overall sound pressure level, decibels, reference to 20 micronewtons per square meter
P	propagation distance between observer and sound source, meters
PNL	perceived noise level, PNdB
PNLM	maximum passby perceived noise level, PNdB
P.O.B.	preferred-octave bands
$P_{TF}/P_{T\infty}$	fan pressure ratio
R	radius or off-axis range
S	rotor-vane spacing, percent, measured at the rotor tip (see sketch p. 16)
SD	sideline distance for noise estimate, meters
SPL	sound pressure level, decibels, reference to 20 micronewtons per square meter
SPLS	sound pressure level spectrum, decibels, reference to 20 micronewtons per square meter
U	sideline distance relative to flight track on the ground, meters
V	distance parallel to flight track on the ground, meters
V_J	jet exhaust velocity relative to nozzle, meters per second
V_R	jet exhaust velocity relative to ambient air, meters per second
V_T	effective tip-speed of dominant noise rotor stage, meters per second
V_{TO}	tip-speed of dominant noise rotor stage, meters per second

V_{TR}	reference tip-speed of dominant noise rotor stage, meters per second
w	bandwidth, octaves
$X \subset (X_1, X_N)$	variable X contained in the range X_1 to X_N
(x_i, y_i, z_i)	aircraft coordinates relative to fixed reference system, meters
α	elevation angle, degrees
$\overline{\alpha}$	average atmospheric absorption coefficient, decibels per kilometer
β_o	elevation angle for engine number and shielding effect, engine array end view, degrees
δ_E	engine attitude angle, degrees
Δ SPL	change in sound pressure level, decibels
ξ	angle between flight path and sound propagation path, degrees
Θ	elevation angle for extra ground attenuation, or direction angle for flight track vector, degrees
ρ	density, kilograms per cubic meter
ρ_o	reference density, kilograms per cubic meter
ψ	directivity angle for sound propagation, degrees
ψ_o	directivity angle for engine number and shielding effect, engine array top view, degrees
∞	free stream reference or infinity

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1.0 SUMMARY

The increase in commercial aviation in the last decade has been accompanied by increased complaints from communities directly exposed to the higher noise levels associated with aircraft operations. Initial attempts to reduce the community noise exposure have included changes in takeoff and approach procedures, development of acoustically treated inlets, and mounting jet noise suppressors on the exhaust nozzles. Federal noise regulations (ref FAR Part 36) have established noise limits for new airplanes that are significantly lower than first generation jet operation levels. The airplanes in the resultant new generation, i.e., the 747, the DC-10, and the L-1011, though much higher in gross weight are significantly quieter in operation than their predecessors.

Reflecting the increasing concern for analyzing and, where possible, reducing the total community noise exposure resulting from aircraft operations, *The Boeing Company*, under contract to *NASA-Ames*, has developed a noise computer program for predicting the noise generated by conventional turbojet and turbofan engines. A second program has been developed which calculates contours of equal noise exposure (footprints) and the area within the contours for an airplane during takeoff and approach operations. The footprint program is compatible with the NASA Ames flight simulator. Given the aerodynamic and engine performance data, contours of equal noise exposure can be calculated to simulate noise conditions over various communities.

These programs are also intended to assist aircraft designers by identifying those aircraft and engine configurations which are most compatible with the accepted community noise standards.

2.0 INTRODUCTION

The desire for "environmental quality" dictates that assessment of the community noise impact of new air transport systems be made prior to their introduction. This noise assessment is required to establish the relative acceptability between proposed airplane configurations, to establish the noise compatibility between the proposed airplane and airport communities which it will serve, and to allow planning of airport communities to assure air transport system compatibility and acceptability. Recent emphasis on reducing airplane noise has resulted in considerable acoustics-related research and development activities. These activities have been primarily directed toward defining the noise generating mechanisms of aircraft engines and defining ways of reducing noise at its source through design innovations and suppression devices.

Past efforts devoted to reducing airplane noise have resulted in a new generation of quieter airplanes (e.g., the Boeing 747, Douglas DC-10, Lockheed L-1011, and Cessna Citation) through the implementation of noise-reduction technology, in turbomachinery design, engine cycle design, and application of acoustical linings.

Numerous other programs are currently under way, each with the objective of either reducing the noise of current airplanes or developing noise technology for application to future aircraft. Throughout these research programs, there has been only minimal effort devoted to developing the methodology required for predicting the total community noise performance of new airplanes. This report presents the state-of-the-art calculation procedure for aircraft community noise prediction.

The calculation method and computer programs are described for estimating engine noise source levels and contours of equal noise levels (footprints) for conventional jet aircraft in fulfillment of phase A of contract NAS2-6969. Phase A consists of providing computerized procedures for: 1) state-of-the-art noise source estimation, applicable to aircraft with conventional turbojet or turbofan powerplants; and 2) noise contour estimation procedures, which are adaptable to the "real time" calculation requirements of the NASA-Ames Flight Simulator. The computer programs were developed to operate on the IBM System 360/67, with the additional requirement that the noise footprint program will operate on the SIGMA VII computer in conjunction with the flight simulator.

Phase B of contract NAS2-6969, to be completed in June 1973, consists of supplying computerized procedures for a more advanced noise source prediction program. This program will be designed to provide 1/3 octave band noise estimates for advanced technology quiet engines, lift fans, lift/cruise fans, propellers, and helicopters, in addition to that for conventional jet aircraft.

Described herein are the procedures and the computer program for estimating the noise levels due to the five major noise sources of conventional turbojet or turbofan engines. The major noise sources, as depicted in figures 1 and 2, are:

a) compressor/fan noise emitted from the inlet duct

b) combination tone or buzz-saw noise emitted from the inlet duct for turbofans without inlet guide vanes

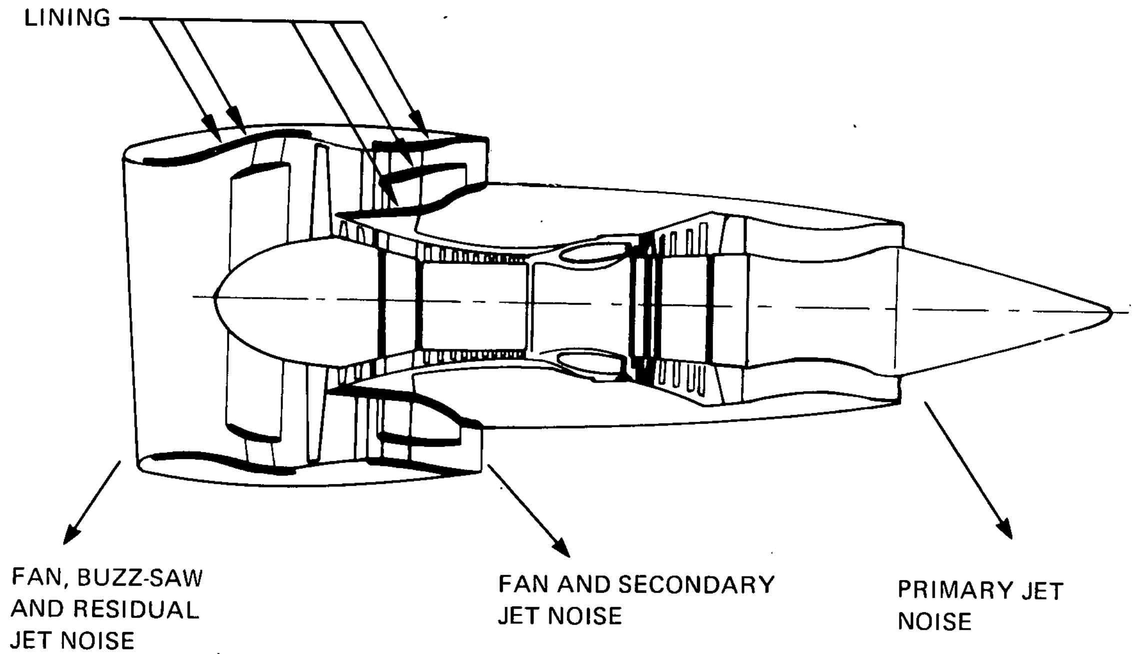
c) fan noise emitted from the fan discharge duct

d) primary jet noise generated in the primary jet exhaust

e) secondary jet noise generated in the secondary jet exhaust.

Other noise sources, such as combustor noise and turbulence upstream of the jet nozzle, are also present but are normally detectable only at low thrust settings or when suppression devices are employed. As a result, there is little data available and no standard prediction techniques have been developed for these other noise sources. However, the noise source estimation computer program has been developed to accommodate as many as seven individual

TURBOFAN ENGINE



TURBOJET ENGINE

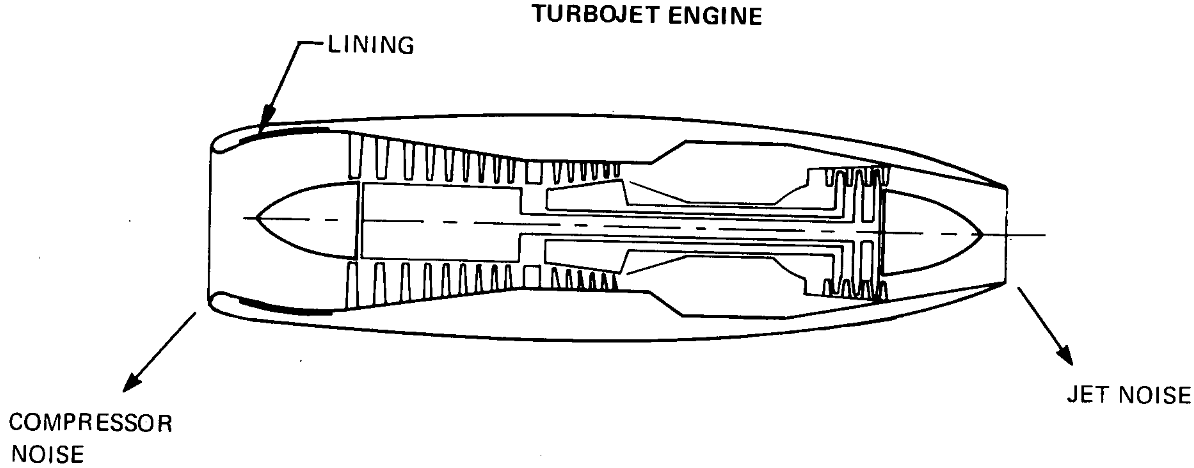
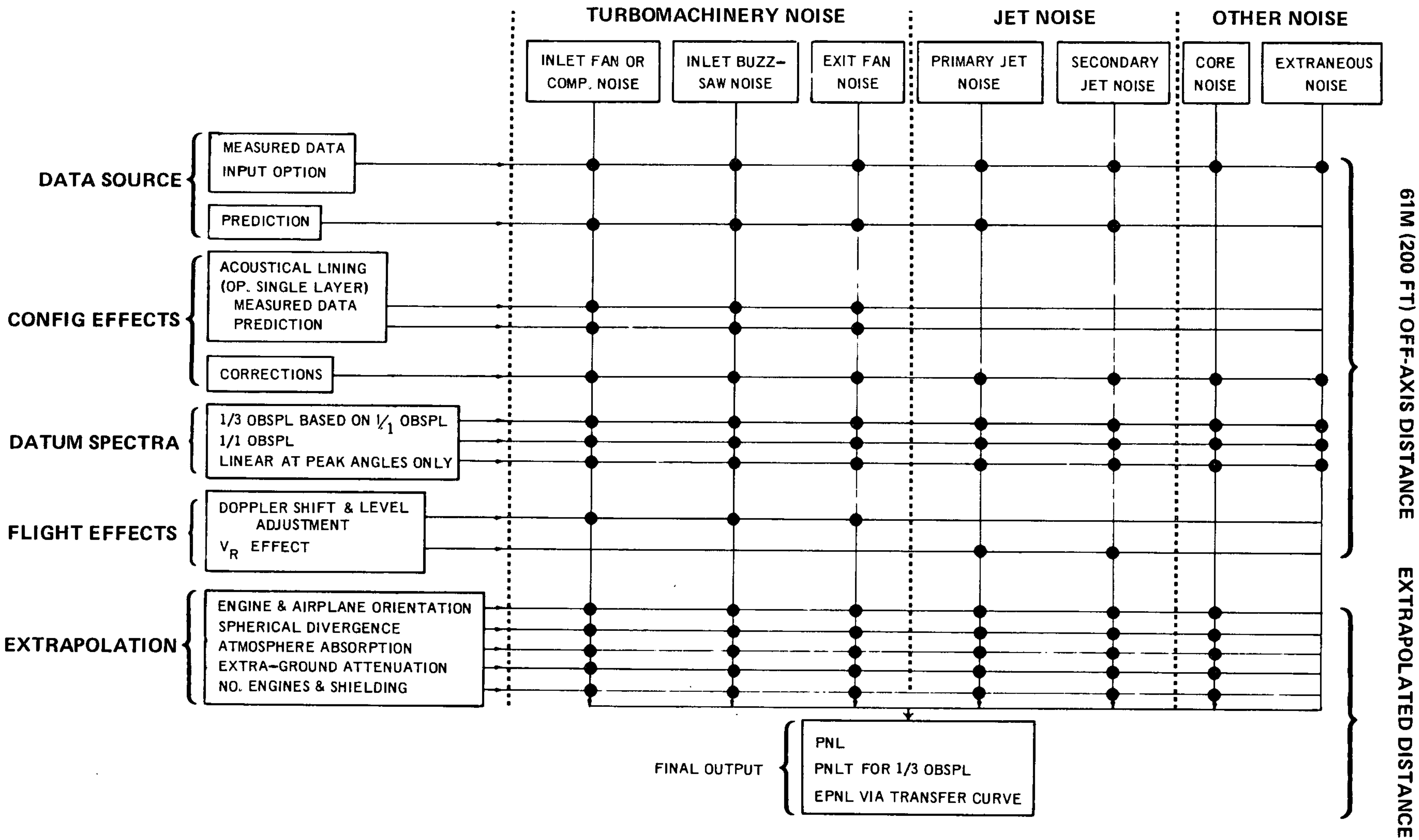


FIGURE 1.—MAJOR NOISE SOURCES FOR TURBOJET AND TURBOFAN ENGINES



● Denotes that computer program performs calculations or accepts user data.

* Includes single- and double-stage turbofans or turbojets.

FIGURE 2.—ENGINE/AIRCRAFT NOISE SOURCE ESTIMATION PROCEDURE*

noise sources. Five of these, itemized above, can be predicted; the other two are to be specified by the user (i.e., measured data). Furthermore, measured data may be used for all seven sources.

When source noise is determined for a conventional jet engine, the effect of noise suppression devices may be considered. Of the many suppression techniques employed to achieve prescribed community noise goals, the use of acoustic lining is often the best approach. In many instances, it is the most economical means to reduce turbomachinery noise. A calculation procedure applicable to optimized, single-layer linings is included in the noise source estimation program. The effect of other suppression devices (e.g., multi-layer lining or jet suppressors) can be accounted for by specifying, in the computer input, the reductions appropriate for individual noise sources.

After the individual noise source spectra are computed for a reference off-axis distance of 61 meters, extrapolation techniques are then used to adjust the reference spectra to user prescribed positions in the acoustic field for calculation of maximum perceived noise level (PNL) or effective perceived noise level (EPNL) during takeoff and/or landing.

At the discretion of the user, an additional output of the noise source program can be the tabulation of data to define an acoustic function of either peak perceived noise level or effective perceived noise level versus engine pressure ratio, off-axis range, and elevation angle. These data are illustrated in figure 3. This function is then used for calculating noise contours. The computer programs for this task are designed to run in "real time" on the SIGMA VII computer for flight simulations and in "batch mode" on the IBM System 360/67.

VARIABLES

1) NL	A THREE-DIMENSIONAL DATA ARRAY OF NOISE LEVEL AS A FUNCTION OF (EPR, LR, α). THE NOISE LEVEL VALUES REPRESENT EPNL OR PEAK PNL, ETC.
2) EPR	A ONE-DIMENSIONAL DATA ARRAY OF ENGINE PRESSURE RATIO VALUES FOR THE NL ARRAY.
3) LR	A ONE-DIMENSIONAL DATA ARRAY OF LOG (OFF-AXIS RANGE R) VALUES FOR THE NL ARRAY.
4) α	A ONE-DIMENSIONAL DATA ARRAY OF ELEVATION ANGLES FOR THE NL ARRAY.

Note: Data arrays (NL, EPR, LR, α) define the three-dimensional tabular function, $NL = f_1(EPR, LR, \alpha)$. The data corresponds to level flight ($\delta_E = o$) at a nominal aircraft velocity, and directivity angle ψ of peak noise radiation

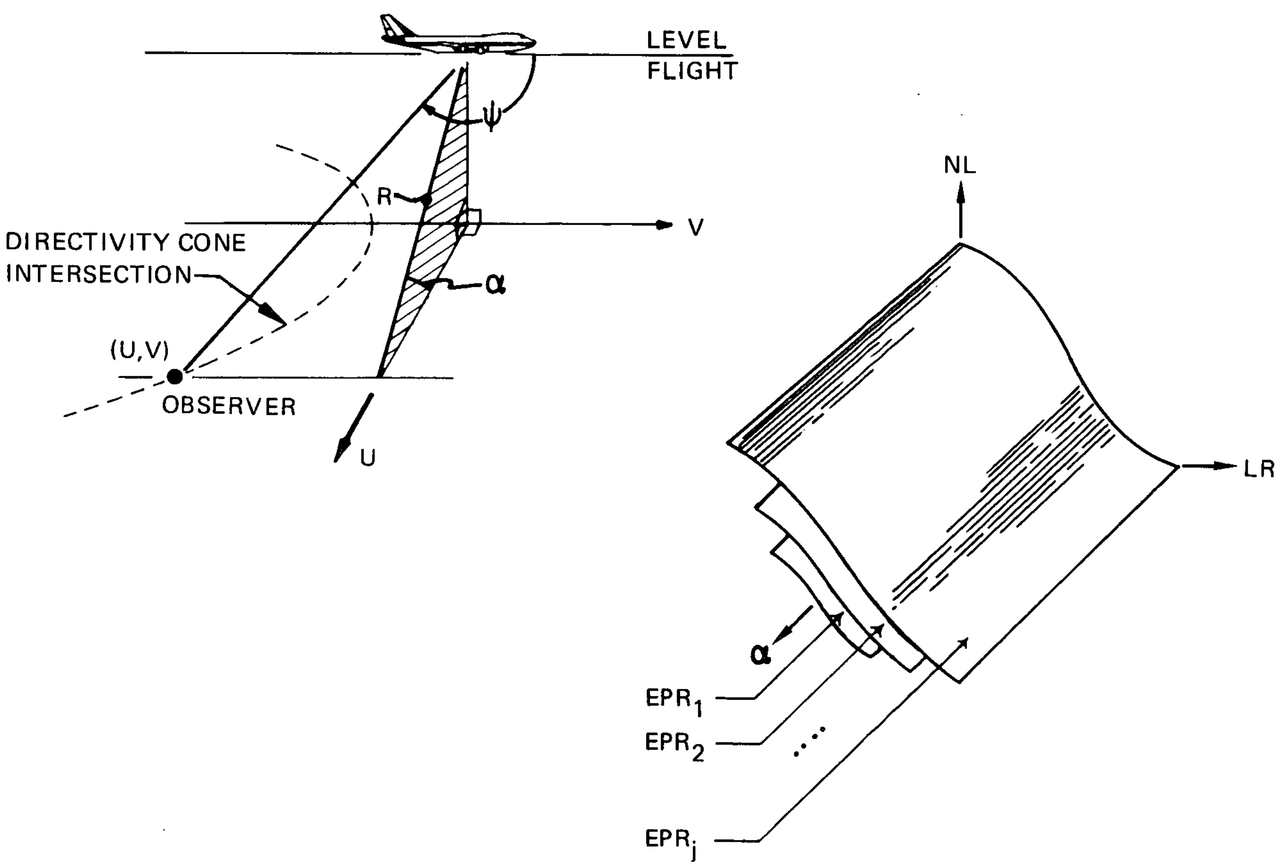


FIGURE 3.—ACOUSTIC DATA FOR NOISE CONTOUR COMPUTER PROGRAM

3.0 CONCLUSIONS

No comprehensive theoretical methods exist for predicting the noise of jet aircraft at the present time. The empirical procedures contained herein represent the state-of-the-art and are the best approaches readily at hand for estimating the noise levels of aircraft equipped with conventional turbojet or turbofan engines. Phase B of the current contract, NAS2-6969, will include an update and extension of the procedures presented in this report. Since prediction methods are subject to change as technology improves, the application and interpretation of these procedures will require periodic review and updating.

4.0 RECOMMENDATIONS

To achieve a more comprehensive aircraft noise prediction capability, further development work is required, particularly in the problem areas listed below. This effort will enable the computation of noise-time histories for flight operations of future engine-airframe configurations and the associated subjective ratings.

Problem Areas

a) The isolation of broadband and tone components of turbomachinery noise.

b) The definition of the noise contribution of each rotor/stator fan assembly for multistage turbofans.

c) Duct-geometry effects on turbomachinery noise.

d) Uncertainties concerning the prediction of noise levels for low velocity (V_J < 305 m/s) jets. (Core, combustion, and/or turbine noise is also present.)

e) Identification of the primary and secondary jet noise relationships with flow parameters for turbofan engines and the effect of airplane velocity on the generation of jet noise.

f) Definition of the radiation patterns for both jet and turbomachinery noise.

g) Installation effect for various engine mounting configurations.

These problem areas will be treated empirically on a 1/3 octave band spectrum basis during phase B of contract NAS2-6969.

5.0 DISCUSSION

The prediction procedure described for noise source estimation, section 5.1 of this document, provides passby[1] maximum noise estimates for jet aircraft during static, takeoff, and/or landing operations, with the observer positioned at distances greater than 50 meters from the noise source. It applies to conventional turbojet or turbofan engines (see fig. 1) having standard circular nozzles operating at pressure ratios on the order of three or less. The calculations are applicable for airplane speeds less than Mach 0.35, weather conditions between -1° and 32°C and between 20% and 100% relative humidity, and preferred full or one-third octave bands having center frequencies between 50 Hz and 10 000 Hz.

The Noise Contour Estimation, section 5.2, describes a fast technique to provide: noise contours (footprints), an area calculation for each contour, and a passby noise estimate. These calculations can be done in real-time on flight simulator computers. The main reason for this capability is that the noise contour computer program does not calculate noise data, but rather interpolates a three-dimensional tabular function of noise level versus engine pressure ratio, off-axis range, and elevation angle (see fig. 3). Although noise is a function of many parameters, this method will yield results within five percent of those obtained by more refined and lengthy calculations for a given engine-airframe configuration.

The following simplifying assumptions are inherent to the procedures discussed in this report.

a) Scaling

Jet nozzles can be compared if they are of the same scale, which requires that they pass equivalent mass flows when at identical gasdynamics. This means that thrust and acoustic data may be compared when the proper scale factor corrections have been considered. The scale factor is determined from mass flow measurements (ref. 1).

Scale factor = $\sqrt{\dot{m}_1/\dot{m}_2}$

where ($\dot{m}_1$, $\dot{m}_2$) are mass flows of two different engines operating at identical gasdynamics. The acoustic and performance data for engine two can be scaled to engine one by multiplying all linear dimensions, including acoustic wavelength, by the scale factor.

NOTE: Acoustic frequency is inversely proportional to wave length.

b) Source noise

For jet noise prediction, the exhaust hardware is a standard circular nozzle. The standard circular nozzle can be convergent or convergent-divergent, with or without a conventional plug. The nozzles for turbofan engines can be a standard primary with a short or long secondary duct, being coannular or coplanar.

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[1] "Passby" refers to conditions on a line parallel to the flight track projection on the ground.

c) Sound propagation

For the purpose of predicting the maximum perceived noise level (PNL) or overall sound pressure level (OASPL), sound in all frequency bands is radiated in the form of a directivity cone about the axis of the jet engine. Also, the engine centerlines all lie in a single plane and their spacing has negligible effect on noise beyond 50 meters. Downwind propagation is assumed for wind speeds less than 4.47 m/s (10 mph).

d) Noise extrapolation

SAE procedures (ref. 1, 2, and 3), with simplified ground effects equation and extended to include shielding effect, can be used for extrapolating the datum spectra for other positions in the sound field. The extrapolation procedures consider the attenuation of sound due to spherical divergence, atmospheric absorption, and the turbulent boundary layer near the ground.

e) Ground reflection

No additional corrections due to ground reflection are required for sound propagation from the datum positions to the extrapolated observer position. The predicted noise levels represent free-field levels plus three dB – the nominal effect of ground reflection (ref. 4).

5.1 NOISE SOURCE ESTIMATION

This procedure is applicable to both turbojets and turbofans. The noise source program consists of six basic computation modules. These are: jet noise, turbomachinery noise (fan or compressor), lining treatment, configuration corrections (if any), summation of component noises, and extrapolation to the observer position.

5.1.1 Noise Extrapolation

The predicted noise components are treated as index spectra (i.e., they contain no propagation loss terms) at a reference off-axis distance of 61 meters. This requires an adjustment of $(+\ 4.4 \times 10^{-4} f)$ dB to the sound pressure level spectra (SPLS) of each component to account for the loss terms at a 61-meter off-axis distance. This adjustment, shown in figure 4, assumes standard day conditions and typical jet engine noise spectra. This approach is a simplification of the procedure outlined in reference 1 and gives results which will be within 0.5 PNdB of that obtained by the older method. At the same time, this method eliminates the scaling discrepancy which results from reference 1 providing two definitions for scaling jet noise to a different size engine operating at identical gas dynamics.

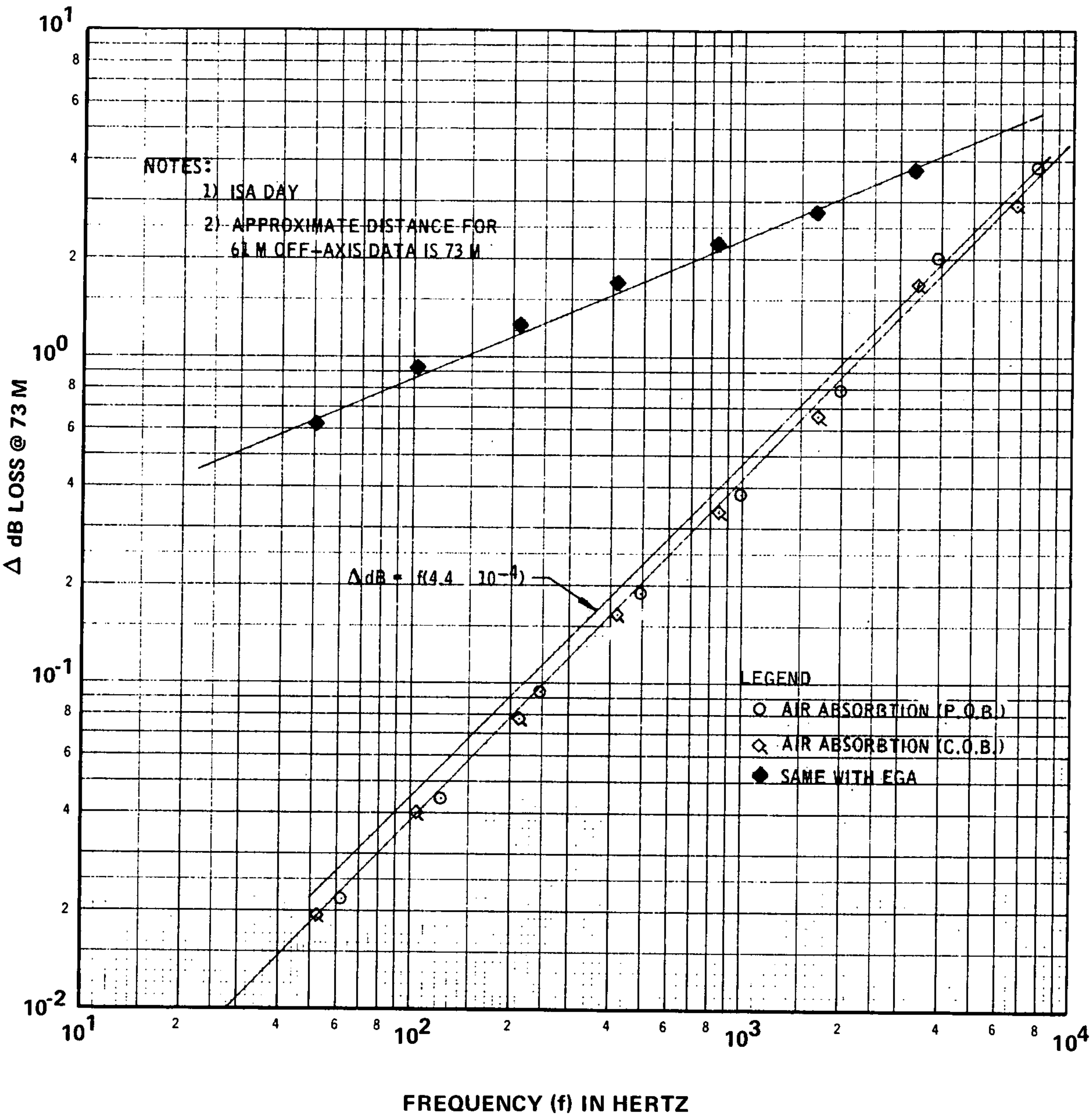
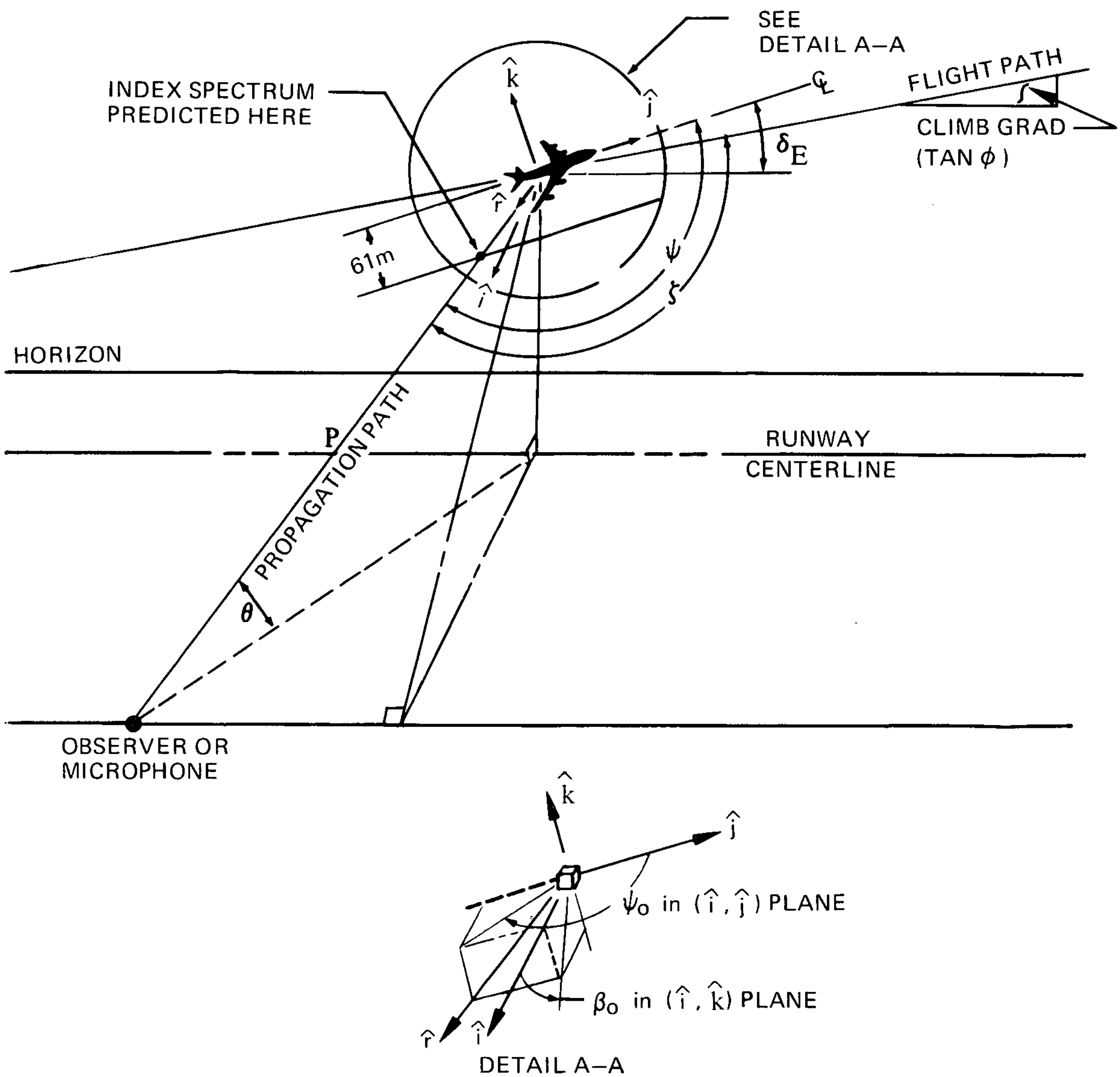


FIGURE 4.—INDEX SPECTRUM LOSS CORRECTION

The first method prescribes a $10 \log_{10} (A_2/A_1)$ adjustment to the SPLS and a frequency shift factor of D_1/D_2 based on the $\rho^2 A$ and Strouhal number relationships developed in the report. The second method uses a scale factor $\sqrt{\dot{m}_2/\dot{m}_1}$ to adjust all linear dimensions, including acoustic wave length. The first method assumes that the sound propagation losses to the reference distance are negligible and the latter method assumes that the losses in decibels, if not negligible, are proportional to the acoustic frequency and propagation distance. Clearly, the two methods are identical if, and only if, the spectrum at the reference distance contains no loss terms.

After predicting the index spectrum on a reference off-axis distance of 61 meters, the corrections for extrapolating contain the following:



1) Spherical divergence $\quad 20 \log_{10} \left| (P/61) \ \sin \Psi \right|$

2) Atmospheric absorption $\quad \overline{\alpha}(f) \ [P/1000]$

where $\overline{\alpha}$ (f) is the average loss coefficient (dB/KM) over the propagation path. This parameter is a function of frequency, ambient temperature, and relative humidity.

3) Extra-ground attenuation $\quad$ EGA (P, θ, f)

4) Engine shielding and number effect $\quad$ ESN (β_o, Ψ_o, N)

$$\text{where ESN}(\beta_o, \Psi_o, N) = \left\{ 10 - \frac{20}{N} \left[\frac{\cos^8 \left(90 \left[\beta_o/90\right]^{.8}\right)}{1 + (1 + \cot \Psi_o)^2} \right] \right\} \log_{10}(N)$$

with β_o and Ψ_o in degrees.

NOTE: When $\Psi_o = 0^o$ and/or $\beta_o = 90^o$, ESN $(\beta_o, \psi_o, N) = 10 \log_{10}(N)$

When $\beta_o = 0$, $\Psi_o = 135^o$ and $N = 4$; ESN $(\beta_o, \Psi_o\ N) = 5 \log_{10}(N)$

5.1.2 Jet Noise

The jet noise prediction procedure is equivalent to that provided by the Society of Automotive Engineers (ref. 1), with some modifications to extend the range of application. The procedure provides a method for calculating the maximum passby noise levels at an off-axis range of 61 meters. This maximum generally occurs at a directivity angle of 110^o or 130^o relative to the inlet axis for turbofan or turbojet engines respectively. Forward radiation of jet noise has been observed to influence the maximum passby noise levels in the inlet quadrant. This noise is called residual jet noise and is approximately 10 dB less than the maximum jet noise radiating aft. This forward radiating jet noise is calculated and combined with the turbomachinery noise components in the inlet quadrant.

The SAE procedure does not provide a method to predict jet noise for jet velocities less than 304.8 m/sec (1000 ft/sec). However, four normalized jet noise curves are provided (see fig. 5) for jet velocities less than 304.8 m/sec. Curve 1 is used for the primary jet exhaust of present engines. For velocities above 304.8 m/sec, curve 1 is identical to that in reference 1. Below 304.8 m/sec, the curve follows approximately a "V^5" extension of the SAE curve. Curve 3 is used for the secondary jet exhaust from the fan discharge duct or "clean"[1] jets. For the higher jet velocities, this curve is identical to the SAE curve and is a straight line extension for velocities below 304.8 m/sec. To reflect anticipated future improvements in engine design for lower jet noise levels, curves 2 and 4 are provided. These curves, 2 and 4, are replacements for curves 1 and 3 respectively, except they are applicable to future, 1979 and later, engines.

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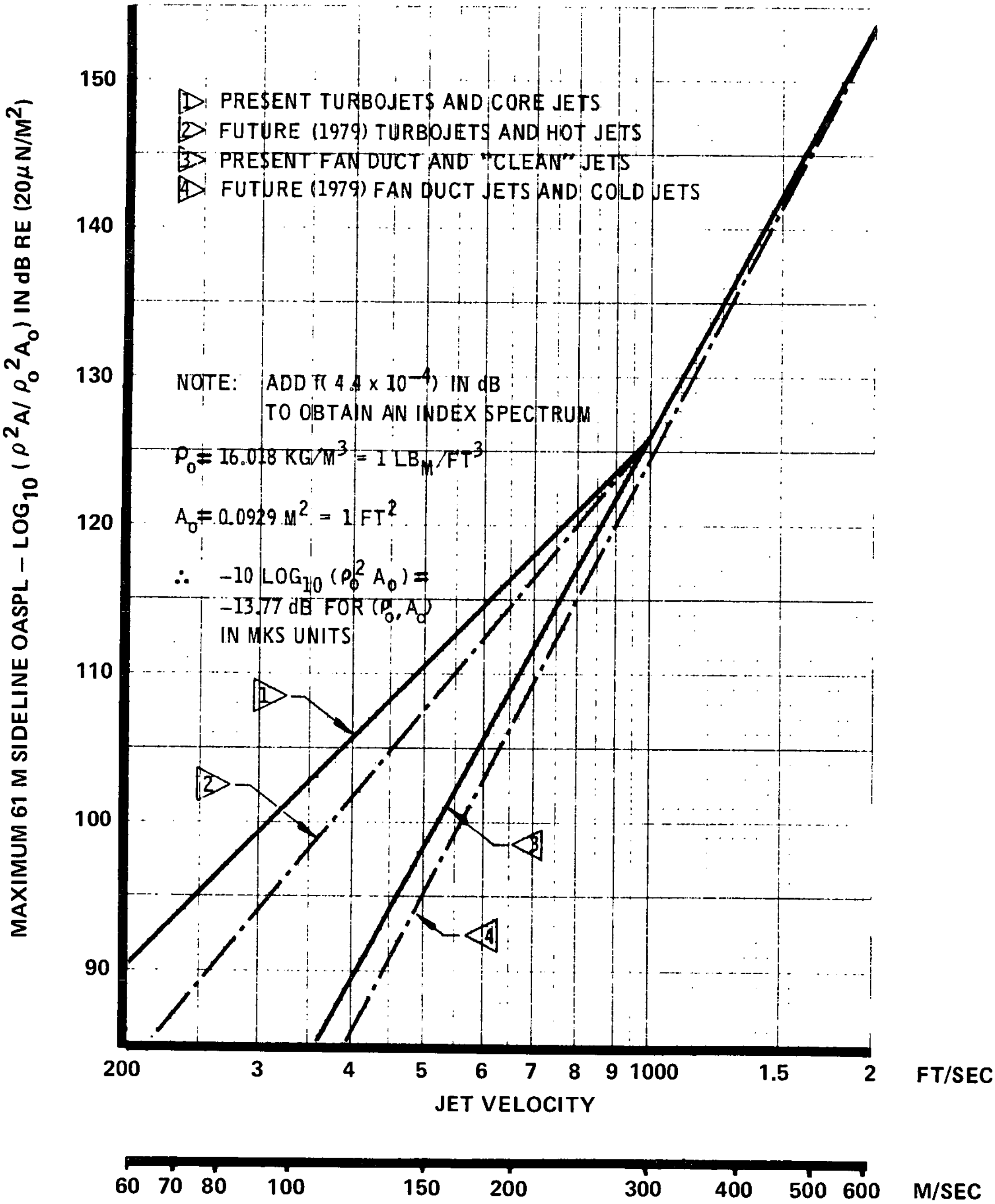
[1] "Clean" refers to jets having no upstream turbulence or acoustic signals due to the turbine stages, combustion, etc.



FLAG	FORMULA	CONSTANT (C_i) IN dB	U. S. UNITS	MKS UNITS
1	$50.51\ LOG_{10}\ (V) + C_1$	C_1	−25.43	0.63
2	$60.46\ LOG_{10}\ (V) + C_2$	C_2	−55.28	−24.08
3	$93.01\ LOG_{10}\ (V) + C_3$	C_3	−152.94	−104.95
4	$97.16\ LOG_{10}\ (V) + C_4$	C_4	−167.14	−117.01

FIGURE 5.—MAXIMUM JET OVERALL SOUND PRESSURE LEVEL AS A FUNCTION OF JET VELOCITY

The remainder of the jet noise prediction (ref. 1) is unchanged with the exception of the assumed directivity angles specified in the Summation of Component Noise section 5.1.6 and the use of index spectra defined in the Noise Extrapolation section 5.1.1.

5.1.3 Turbomachinery Noise (Fan or Compressor)

The turbomachinery noise prediction procedures, defined below, are to estimate the noise levels of the three major noise sources resulting from the rotating machinery of jet engines. The three major noise sources are: fan or compressor noise emitted from the inlet duct of turbofans or turbojets; combination-tone (buzz-saw) emitted from the inlet duct for turbofans without inlet-guide-vanes; and fan noise emitted from the fan discharge duct. The noise radiation in the forward quadrant from the inlet duct generally has a maximum passby noise directivity angle between 60° and 70° relative to the engine inlet axis and approximately 110° for the exit quadrant.

This prediction procedure is empirically based on full-octave band levels generated by jet engines having axial flow compressor/fans, some with conventional inlet guide vanes, and rotor/stator assemblies without acoustic treatment in the inlet or discharge ducts. Since turbomachinery noise is a combination of discrete tones and broad-band signals, and these parts of the total noise produced by jet engines have not been satisfactorily isolated, the calculation steps below will provide only an approximate estimate for the maximum overall sound pressure level, OASPL, or perceived noise level PNL. The tolerance on the predicted results is ± 5 PNdB.

5.1.3.1 Inlet compressor noise (turbojets).–

a) Required data

B	The number of blades on the compressor producing the predominant noise
D	The tip diameter, in meters, of the compressor producing the predominant noise
V_{TO}	The tip speed, in meters/sec, of the compressor producing the predominant noise
W	Band width in octaves for SPLS
f	The array of geometric-mean-center frequencies in Hz for each octave pass band

The output is the jet engine compressor noise sound pressure level spectrum, SPL(f).

b) Calculation steps

1) Fundamental blade passage frequency f_o

$$f_o = B\, V_{TO} / (\pi D) \qquad \text{(MKS units)}$$

$$= 0.31831 \quad B \quad V_{TO} / D$$

2) SPL centered on the fundamental blade passage frequency f_o

$$SPL\ (f_o) = 46.\ \log_{10} (V_{TO}/V_{TR}) + 10 \log_{10} \left[(D/D_R)^2 W\right] - 69.$$

where $V_{TR} = 0.3048$ m/sec = 1 ft/sec and $D_R = 2.54 \times 10^{-2}$ m = 1 inch

3) Inlet compressor spectrum (61 m off-axis, $\sphericalangle = 70^o$ re inlet axis)

$$SPL(f) = SPL(f_o)\Big|_{\text{from (2) above}} + F_o\ (f/f_o)$$

Formulas for $F_o\ (f/f_o)$ are the following:

$$\text{Let } X_o = \log_2 (f/f_o) = 1.442695041 \log_e (f/f_o)$$

$$\text{For } X_o \subset (o, \infty),\ F_o\ (f/f_o) = -3\ X_o$$

$$\text{For } X_o \subset (-2, 0),\ F_o\ (f/f_o) = 6\ X_o$$

$$\text{For } X_o \subset (-\infty\ ,\ -2),\ F_o\ (f/f_o) = 2\ X_o - 8$$

NOTE: Add (4.4×10^{-4}f) in dB to obtain index spectrum.

5.1.3.2 Inlet fan noise (turbofans).—

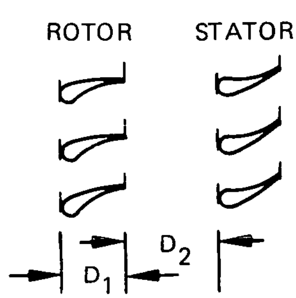
a) Required data (see table 1)

w Bandwidth in octaves for SPLS

f Geometric-mean frequencies in Hz for SPLS

D Dominant noise rotor stage diameter in meters

S Rotor-vane spacing in percent, measured at the rotor tip



$S = 100\ D_2/D_1$

B Number of blades on dominant-noise rotor stage

V_{TO} Mechanical tip speed of dominant-noise rotor stage in meters/sec

P_{TF}/P_{T_∞} Fan pressure ratio

TABLE 1.—PERTINENT ENGINE GEOMETRY FOR NOISE PREDICTION OF FOUR COMMON TURBOFANS

Variable	Description	Type of Engine JT3D-3B (a)	JT8D-9 (a)	JT9D-3A (b)	CF-6-6D (b)
IGV	Inlet-guide-vanes	Yes	Yes	None	None
B	Number [c] of fan blades	35	27	46	38
D	Fan diameter [c], m	1.30	1.03	2.34	2.19
S	Minimum rotor vane spacing [c] % of axial cord at rotor tip	55	70	300	250
A_I	Inlet area, m^2	1.16	0.74	3.50	3.30
A_S	Fan discharge area, m^2	0.53	0.32	2.29	2.58
A_1	Primary nozzle discharge area, m^2	0.35	0.38	0.62	0.54
A_2	Secondary nozzle discharge area, m^2	0.33	0.38	1.87	1.56
V_{TO}	Mechanical tip speed[d], mps	438	438	405	398
P_{TF}/P_{T_∞}	Fan pressure ratio[d]	1.70	1.95	1.50	1.52
EPR	Engine pressure ratio[d]	1.77	2.0	1.38	1.37

[a]Double-stage turbofan

[b]Single-stage turbofan

[c]Dimensions for fan refer to the rotor stage producing the dominant turbomachinery noise, usually the first stage

[d]Maximum rated takeoff thrust at $M_o = 0.3$, $T_{S_\infty} = 298.16^\circ$ K $(25^\circ$ C)

b) Calculation steps

1) Effective tip speed (V_T) based on blade loading for level calculation

$$V_T = F_1 \left(P_{TF}/P_{T_\infty}\right) \qquad \text{from figure 6}$$

NOTE: If the fan pressure ratio is not known, the tip speed, V_{TO}, can be used in lieu of the effective tip speed.

2) SPL Centered at fundamental frequency (f_o)

$$SPL\ (f_o) = 10 \log_{10} \left[\left(\frac{D}{D_R} \right)^2 w \right] + F_2\ (V_T) \qquad \text{from figure 7}$$

$$D_R = 2.54 \times 10^{-2}\ \text{m} = 1\ \text{inch}$$

3) Rotor-vane spacing correction

$$SPL\ (f_o) = SPL(f_o) \Big|_{\text{from (2) above}} + F_3\ (S) \qquad \text{from figure 8}$$

4) Fundamental blade passage frequency (f_o)

$$f_o = \frac{B\ V_{TO}}{\pi D} \qquad \text{(MKS units)}$$

$$= 0.32831 \quad B \quad V_{TO}/\ D$$

NOTE: Do not use V_T in place of V_{TO}

5) Inlet fan spectrum (61 m off-axis, $\measuredangle = 60^o$ re inlet)

$$SPL(f) = SPL(f_o) \Big|_{\text{from (3) above}} + F_4\ (f/f_o) \qquad \text{from figure 9}$$

NOTE: Add (4.4×10^{-4} f) in dB to obtain index spectrum

5.1.3.3 Inlet "buzz-saw" noise applicable to turbofans without inlet guide vanes.—

a) Required data (see table 1)

w	Bandwidth in octaves for SPLS
f	Geometric-mean frequencies in Hz for SPLS
D	Dominant-noise rotor stage diameter in meters

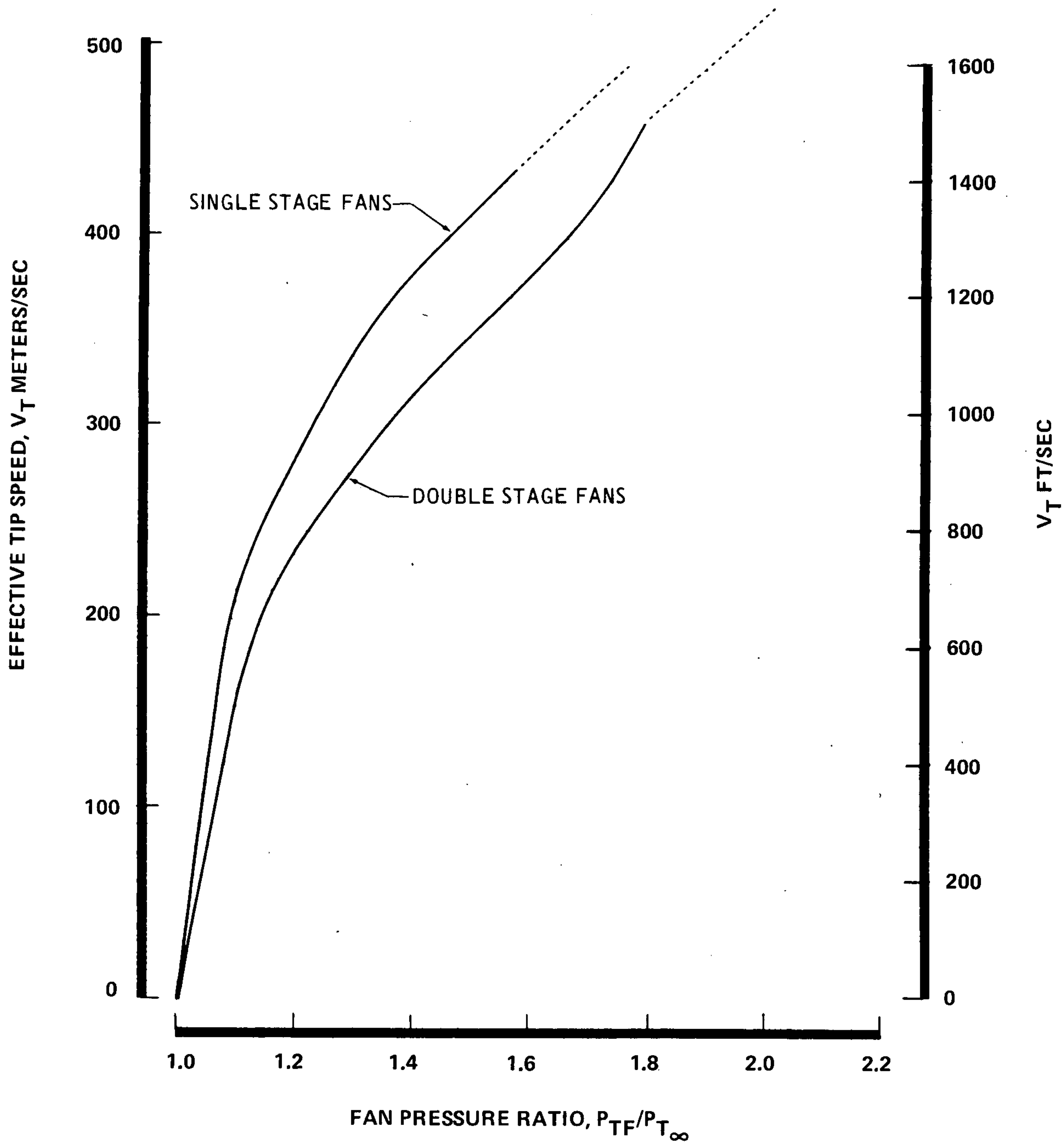


FIGURE 6.—EFFECTIVE FAN TIP SPEED VS FAN PRESSURE RATIO

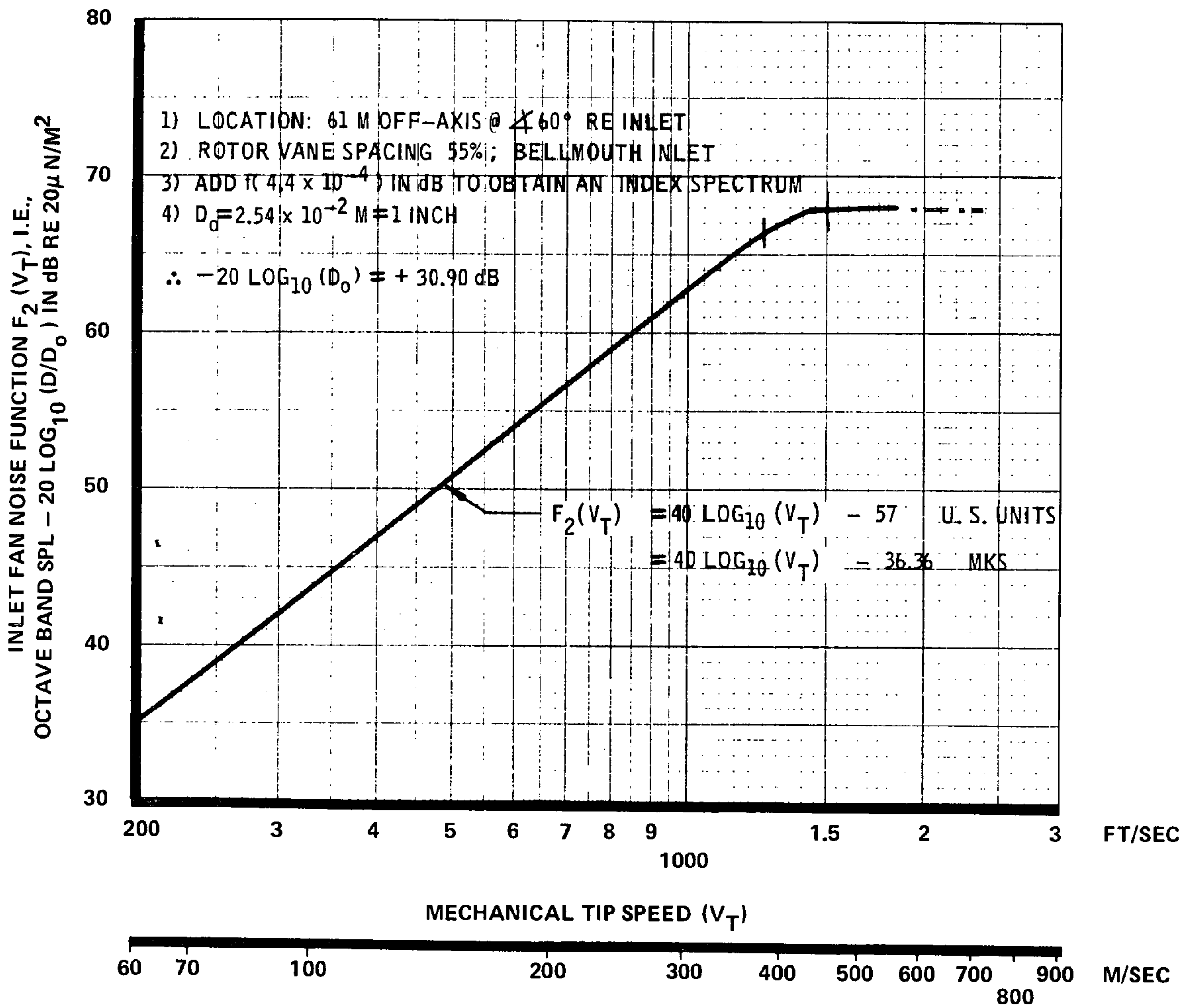


FIGURE 7.—MAXIMUM INLET FAN NOISE AT FUNDAMENTAL FREQUENCY — f_o

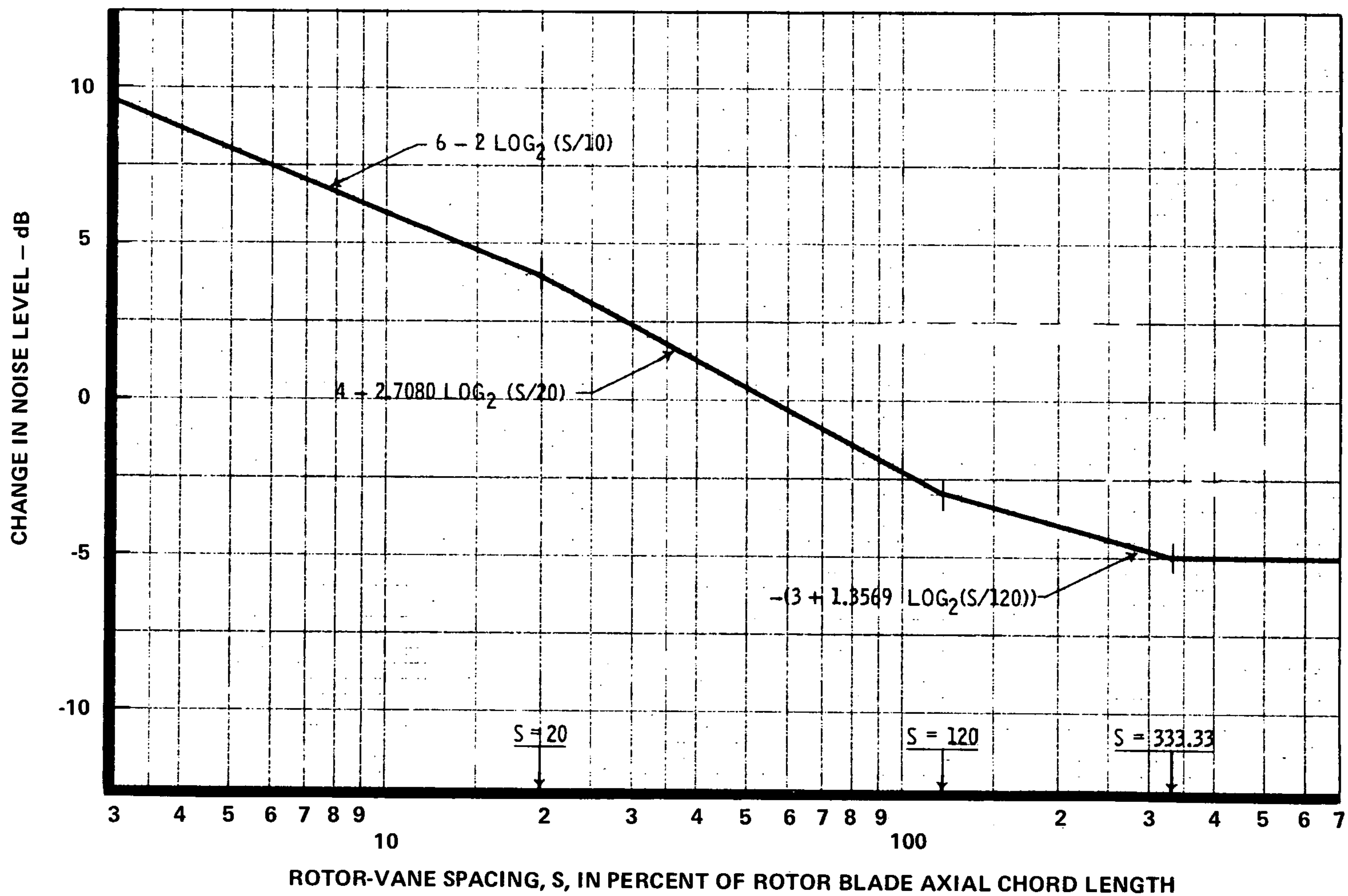
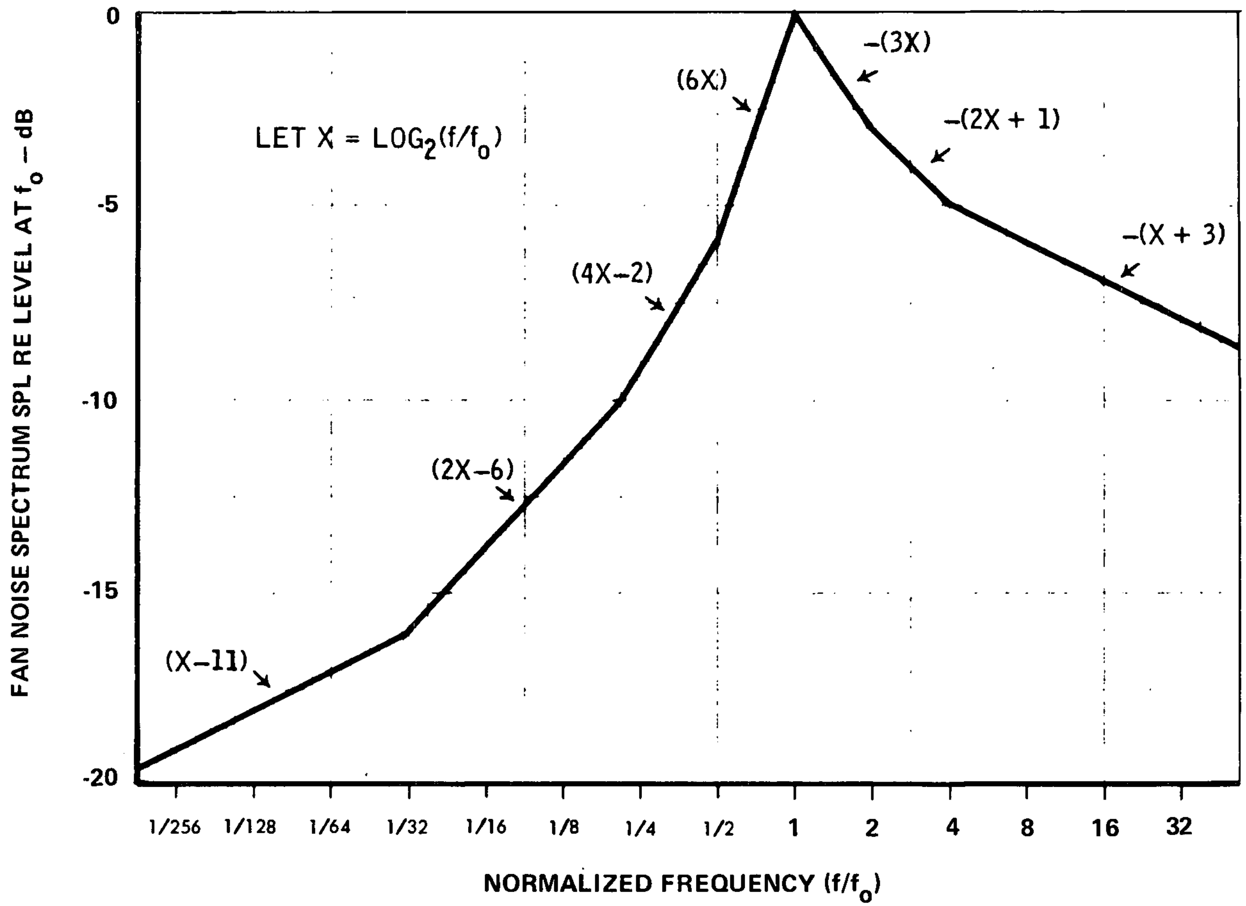


FIGURE 8.—ROTOR-VANE SPACING CORRECTION – FUNCTION $F_3(S)$



Note: Add f(4.4×10^{-4}) in dB to obtain index spectrum

FIGURE 9.—TURBOMACHINERY NOISE SPECTRUM SHAPING FUNCTION

B	Number of blades on dominant-noise rotor stage
V_{TO}	Mechanical tip speed of dominant-noise rotor stage in meters/sec

b) Calculation steps

1) SPL centered on fundamental frequency (f_1)

$$SPL(f_1) = 10 \log_{10} \left[\left(\frac{D}{D_R} \right)^2 W \right] + F_5 (V_{TO}) \qquad \text{from figure 10}$$

$D_R = 2.54 \times 10^{-2} m = 1$ inch

2) Fundamental buzz-saw frequency (f_1)

$f_1 = B\, V_{TO} / \ (3\pi \ D)$ (MKS units)

$= f_o/3$ from section 5.1.3.2 (4)

3) Inlet buzz-saw spectrum (61 m off-axis $\measuredangle = 60^o$ re inlet axis)

$$SPL(f) = SPL(f_1)\Big|_{\text{from (1) above}} + F_6 (f/f_1) \qquad \text{see sketch on figure 10}$$

Formulas for $F_6 (f/f_1)$ are the following:

Let $X_1 = \log_2 (f/f_1)$

For $X_1 \subset (0, \infty)$, $F_6 (f/f_1) = -10\, X_1$

For $X_1 \subset (-\infty, 0)$, $F_6 (f/f_1) = 5\, X_1$

NOTE: Add ($4.4 \times 10^{-4} f$) in dB to obtain index spectrum.

5.1.3.4 Exit fan noise (turbofans).–

a) Required data (see table 1)

The inputs are the same as those in section 5.1.3.2 except with the following addition:

A_s Fan discharge area in square meters

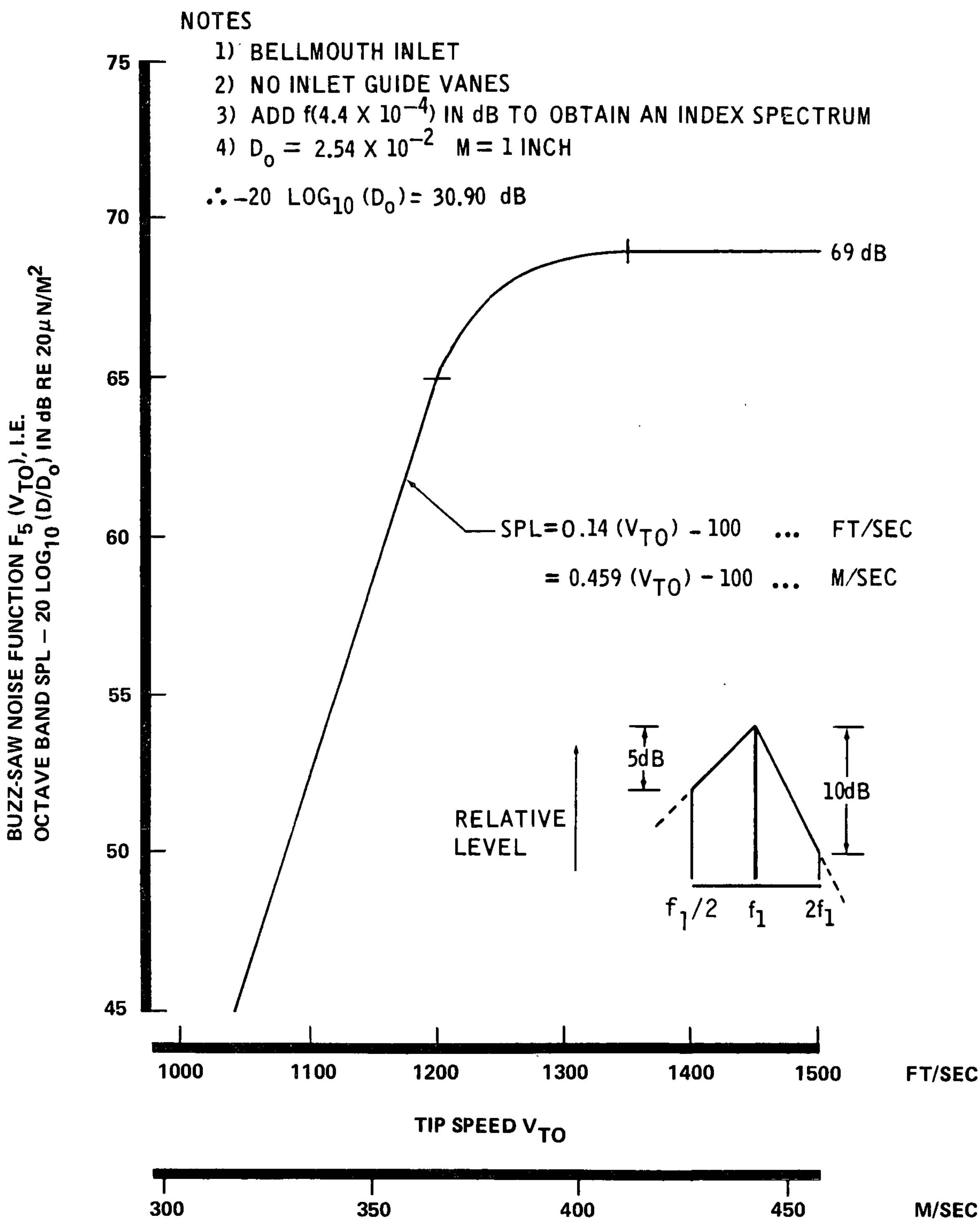


FIGURE 10.—BUZZ-SAW NOISE AT FUNDAMENTAL OCTAVE-BAND CENTER FREQUENCY (f_1) NORMALIZED TO 2.5 X 10^{-2}M DIAMETER INLET

b) Calculation steps (same as in 5.1.3.2 except for equation 2)

2) SPL centered at fundamental frequency (f_o)

$$SPL(f_o) = 10 \log_{10}(w\, A_s/A_{so}) + 50 \log_{10}(V_T/V_0)$$

$$= 10 \log_{10}(w\, A_s) + 50 \log_{10}(V_T) - 19.50$$

with $A_{so} = 0.339\ m^2$ and $V_O = 3.048$ m/sec

NOTE: The calculated spectrum corresponds to an off-axis distance of 61 meters at an angle of 110^o relative to the inlet.

5.1.3.5 Flight effects on turbomachinery noise.—Flight causes a Doppler shift and a level change to noise emitted from a moving source (ref. 5). The calculation is outlined below.

a) Required data

M_o aircraft Mach number

ξ angle between flight path and sound propagation path

b) Calculation

1) Doppler shift

$$f_o' = f_o / (1 - M_o \cos \xi) \text{ and } f_1' = f_1 / (1 - M_o \cos \xi)$$

2) Level change

$$SPL|_{flight} = SPL|_{static} - 40 \log_{10} (1 - M_o \cos\xi)$$

5.1.4 Lining Treatment

Current technology in predicting the attenuation of acoustic linings incorporates a combination of experimental correlation and theoretical analysis. An optimized attenuation prediction procedure based on this technology is incorporated in the computer program. The acoustic wave attenuation analysis is based on a rectangular duct with mean flow and boundary layer effects. Equivalent duct heights for nonrectangular duct geometries are obtained by equating flow areas, treated areas, and duct lengths. A far field attenuation directivity factor has been obtained from engine ground test data. The current impedance model is applicable to single layer linings.

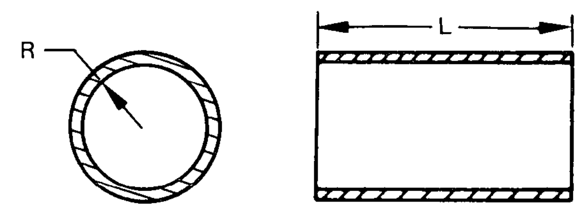
The source noise computer program contains this lining procedure as an option for lining treatment of the inlet and exit fan noise (turbofans) or the inlet compressor noise (turbojets). Within the procedure, there are several methods available for calculating the lining attenuation spectra. These methods are as follows:

a) For each target frequency, the user defines the magnitude of maximum attentuation and the percentage of the total area that is treated. The program then determines the spectrum shape.

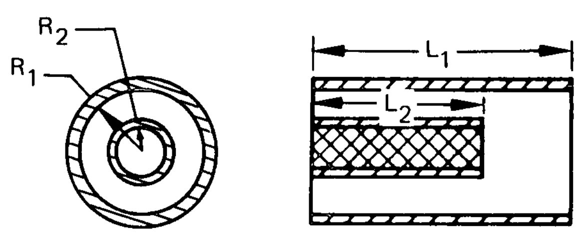
b) For each target frequency, the user defines the effective duct height, the ratio of apparent treatment length to effective duct height, and the percentage of the total area that is treated. The program then determines the spectrum shape.

c) The user defines the geometry of the lining in terms of the length and radii of cylindrical walls, and the percentage of the total area that is treated for each target frequency. The program then determines the spectrum shape.

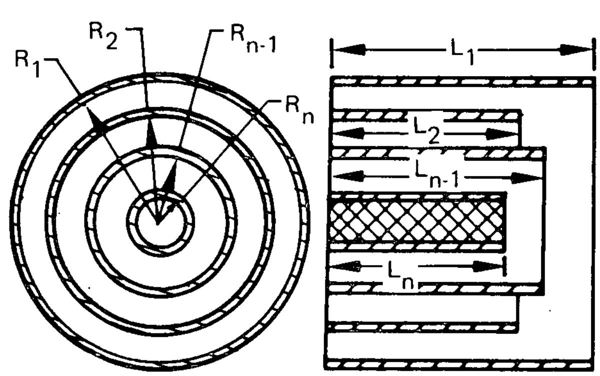
The user is limited to the following configurations when defining the linings geometrically:



a) Circular Duct
(Number of walls = 1)
$(H = R)$



b) Annular Duct
(Number of walls = 2)
Innermost and outermost walls are lined on one side.
$(H = R_1 - R_2)$



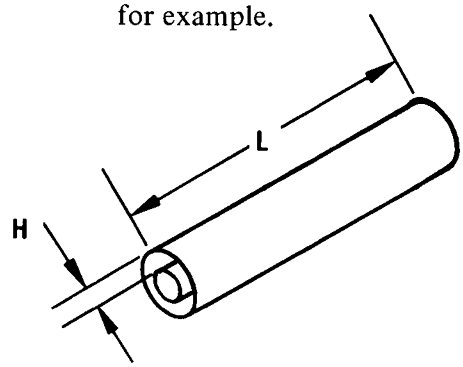
c) "n" Concentric Walls
(Number of walls = n)
Innermost and outermost walls are lined on one side, interior walls are lined on both sides.
$(H_{n-1} = R_{n-1} - R_n)$

The lining attenuation prediction procedure involves the successive use of five curves. These curves consider: duct geometry, treatment area, target frequency, speed of sound, duct Mach number, attenuation over a range of power settings, attenuation spectrum shape, and directivity angle. Depending on user requirements, any or all of the procedures may be used. The use of each curve is explained in detail below.

Figure 11 is an estimate of the peak attenuation obtainable for an optimum lining at a single power setting and a zero Mach number.

Required data

1) L/H — One half the ratio of actual treatment area to duct cross sectional flow area. Actual treatment area is typically about 65% of that which would be calculated from a nacelle half-section drawing. L is the apparent treatment length. H is the effective duct height. See sketch for example.



Inside of outer cylinder is lined
Outside of inner cylinder is lined

2) $\frac{f_t H}{c}$ — Nondimensional target frequency, where f_t is the target frequency, i.e., the frequency for peak attenuation, and c is the speed of sound.

Figure 12 shows the correction of obtainable peak attenuation for duct Mach number and for multiple-power-setting requirement, if applicable. The upper curve of figure 12 is an estimate of the effect of duct Mach number on realizable attenuation for a single target frequency.

NOTE: This curve compares optimum linings at the same frequency and different Mach numbers. It does not apply to the same lining at different Mach number, as is the case in typical duct data and theoretical analysis.

The lower curve of figure 12 represents the case in which a lining design is compromised in order to operate effectively over a range of power settings, which is the usual case in airplane lining design. The inlet mode attenuation is compromised more than the exhaust mode. As the power setting is changed, the engine blade passage frequencies and the frequency of peak lining attenuation shift in opposite directions for the inlet mode, and in the same direction for the exhaust mode.

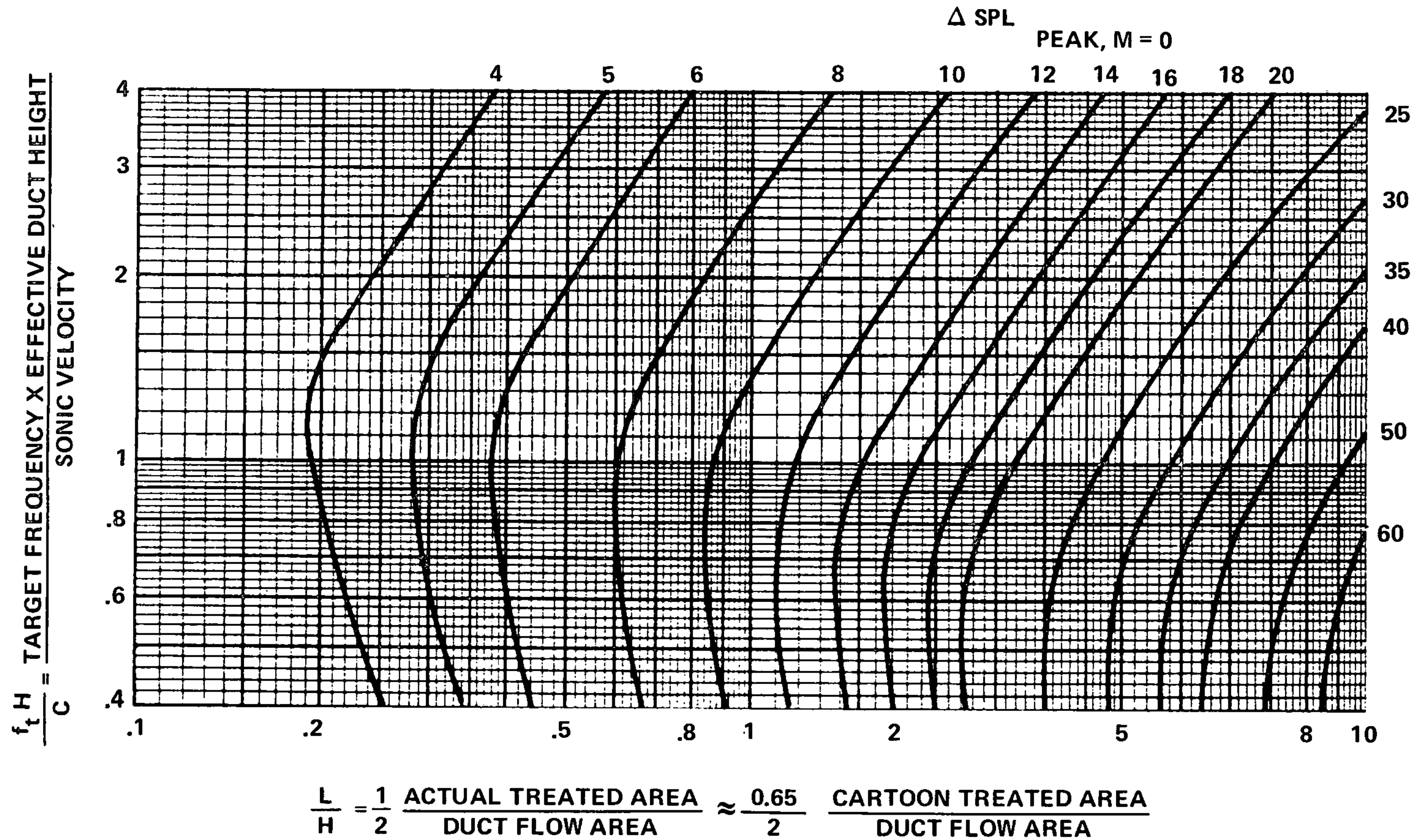


FIGURE 11.—EFFECT OF DUCT GEOMETRY, TREATED AREA, TARGET FREQUENCY, AND SPEED OF SOUND ON REALIZABLE LINING ATTENUATION

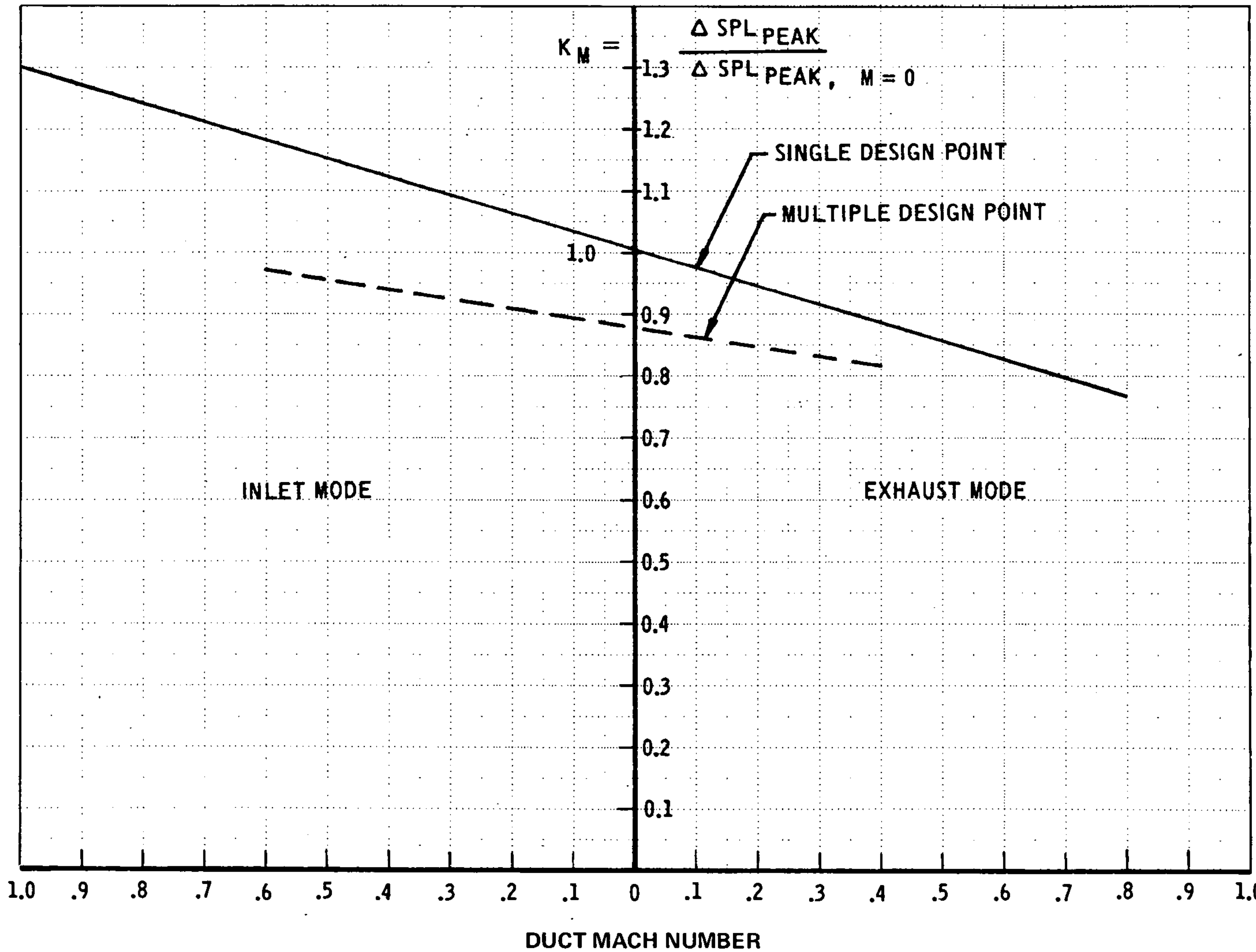


FIGURE 12.—EFFECT OF DUCT MACH NUMBER ON REALIZABLE LINING ATTENUTATION

Required data

M_I Inlet duct Mach number (turbofans and turbojets)

M_B Bypass fan duct Mach number (turbofans)

Figure 13 gives the attenuation spectrum shape. This is used to obtain the attenuation for frequencies other than the target frequency. It is considered representative of an average case, and represents a reasonable compromise between the maximum obtainable attenuation at the target frequency and the requirement for attenuation spectrum breadth.

Figure 14 gives the far field directivity of the attenuation spectrum. This index is applied to the entire spectrum. Figure 15 shows the comparison between the predicted attenuation and the experimental data.

5.1.5 Configuration Corrections

Corrections for each noise component may be used for: a Δ dB to be subtracted from the OASPL, Δ dB's to be subtracted from the noise spectrum, or a completely new spectrum to be used instead of the predicted spectrum. This option is available to account for changes in inlet or exit quadrant directivity angles, the use of suppressor nozzles, and/or other installation effects as required by test results.

5.1.6 Summation of Component Noise

Those noise components having the same directivity angle (Ψ) are added together in the usual manner for logarithmic quantities, in order to obtain the total inlet and exit maximum passby noise spectra. After this step, the composite[1] noise spectrum is obtained by comparing the total inlet and exit noise spectra and choosing the maximum level of the two for each octave (or 1/3 octave) band level. Thus, the resulting spectrum represents the maximum octave (or 1/3 octave) band levels observed, regardless of when the levels occur in time. Clearly, this represents the situation when the airplane is moving. Therefore, composite noise becomes meaningless when the airplane is static. The use of composite noise is for conservative purposes, in order to represent a predicted upper noise limit: a level that equals or exceeds the maximum noise observed at any instant in time. The perceived noise level, PNL, corresponding to the extrapolated spectral data, is computed as defined in reference 6. The effective perceived noise level (EPNL) is calculated by means of a transfer curve (see fig. 16 and ref. 7). As indicated by the tolerance band in figure 16, EPNL is not just a function of peak PNL and range, in that it requires a knowledge of the tone-corrected PNL-time history at the observer position. Unfortunately, the state-of-the-art in aircraft noise prediction cannot provide this capability at this time (see Recommendations section 4.0).

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[1] This is not the usual adding of logarithmic quantities.

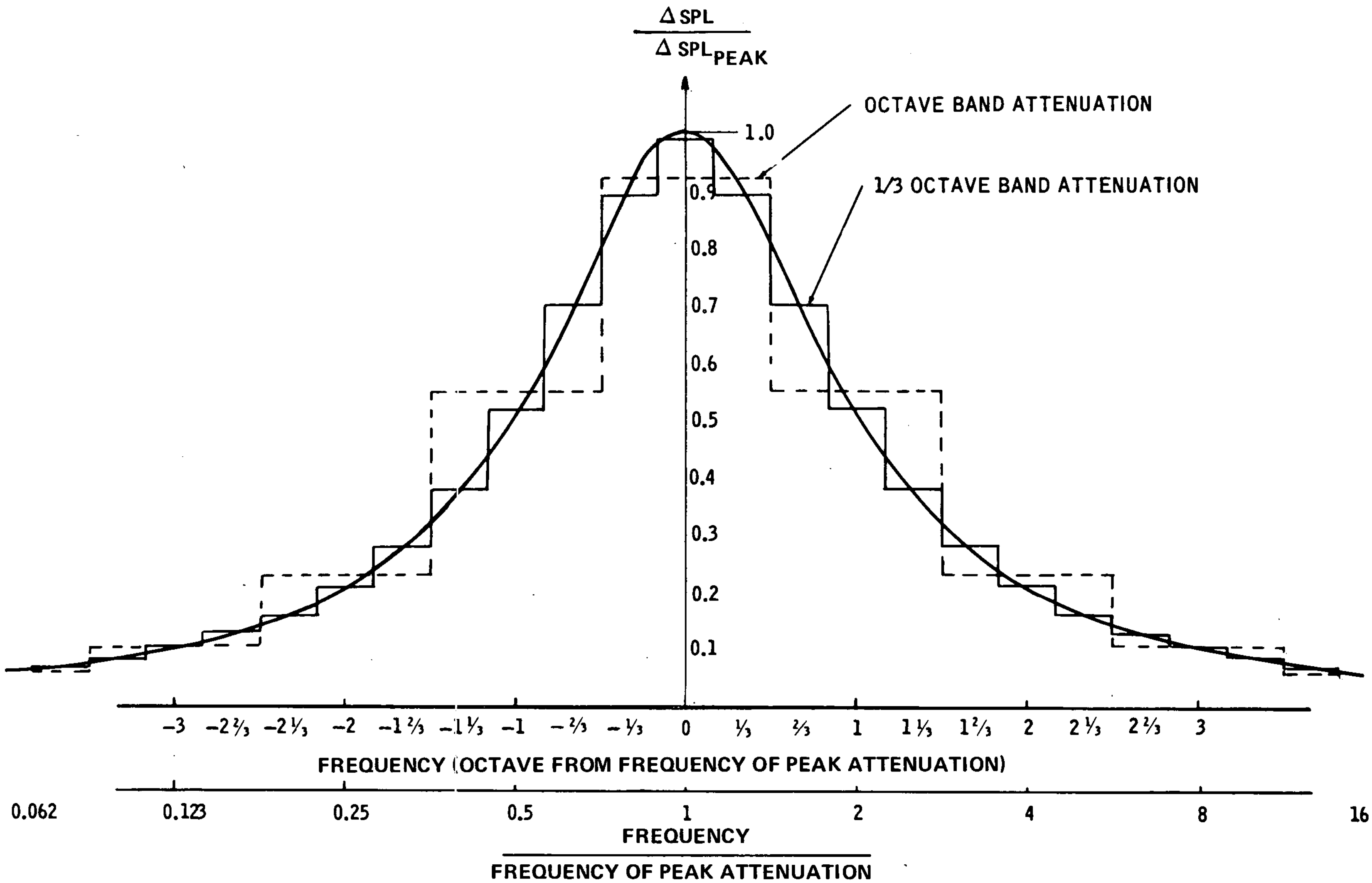


FIGURE 13.—TYPICAL SHAPE OF LINING ATTENUATION SPECTRA

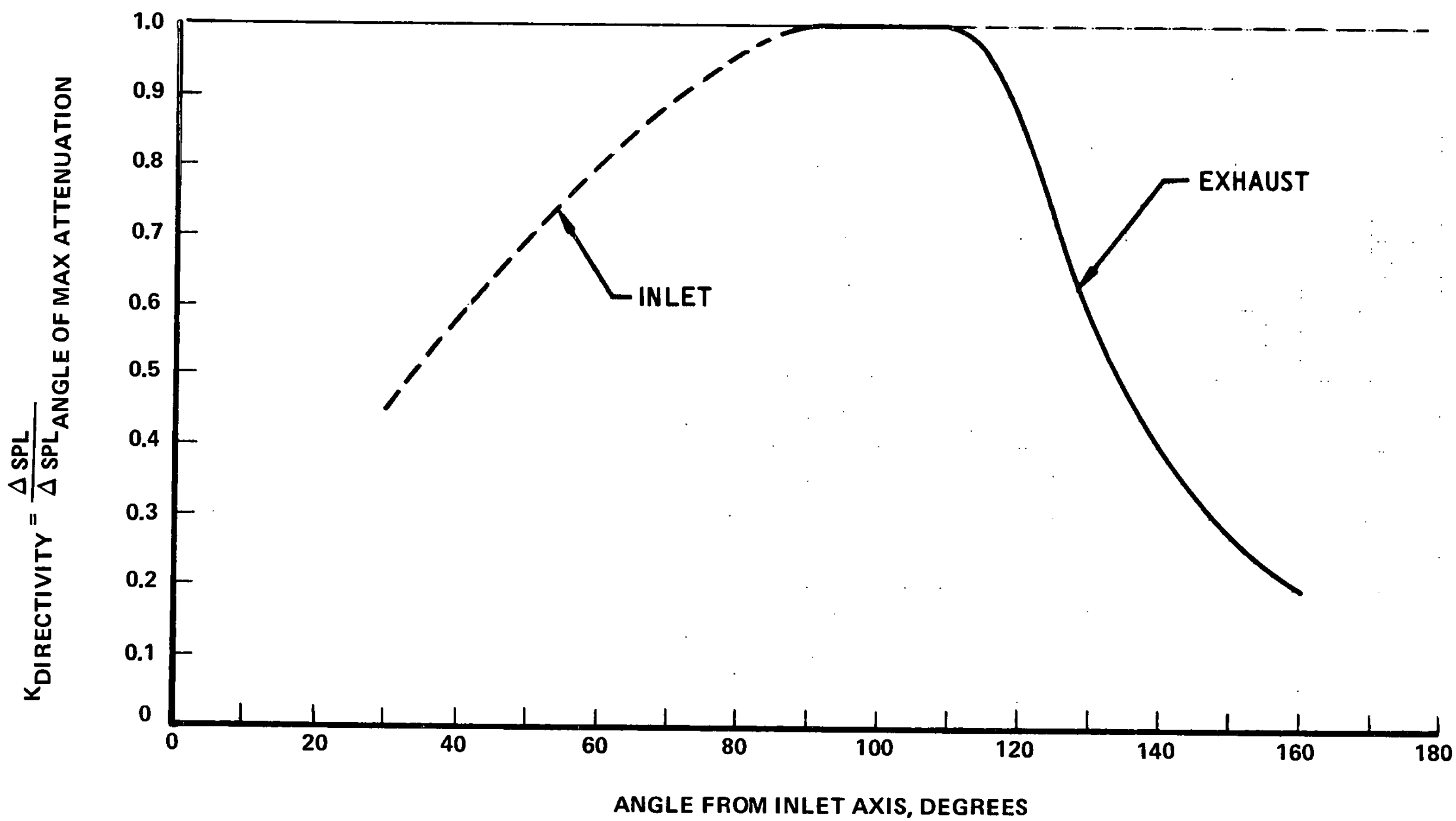


FIGURE 14.—DIRECTIVITY OF LINING ATTENUATION

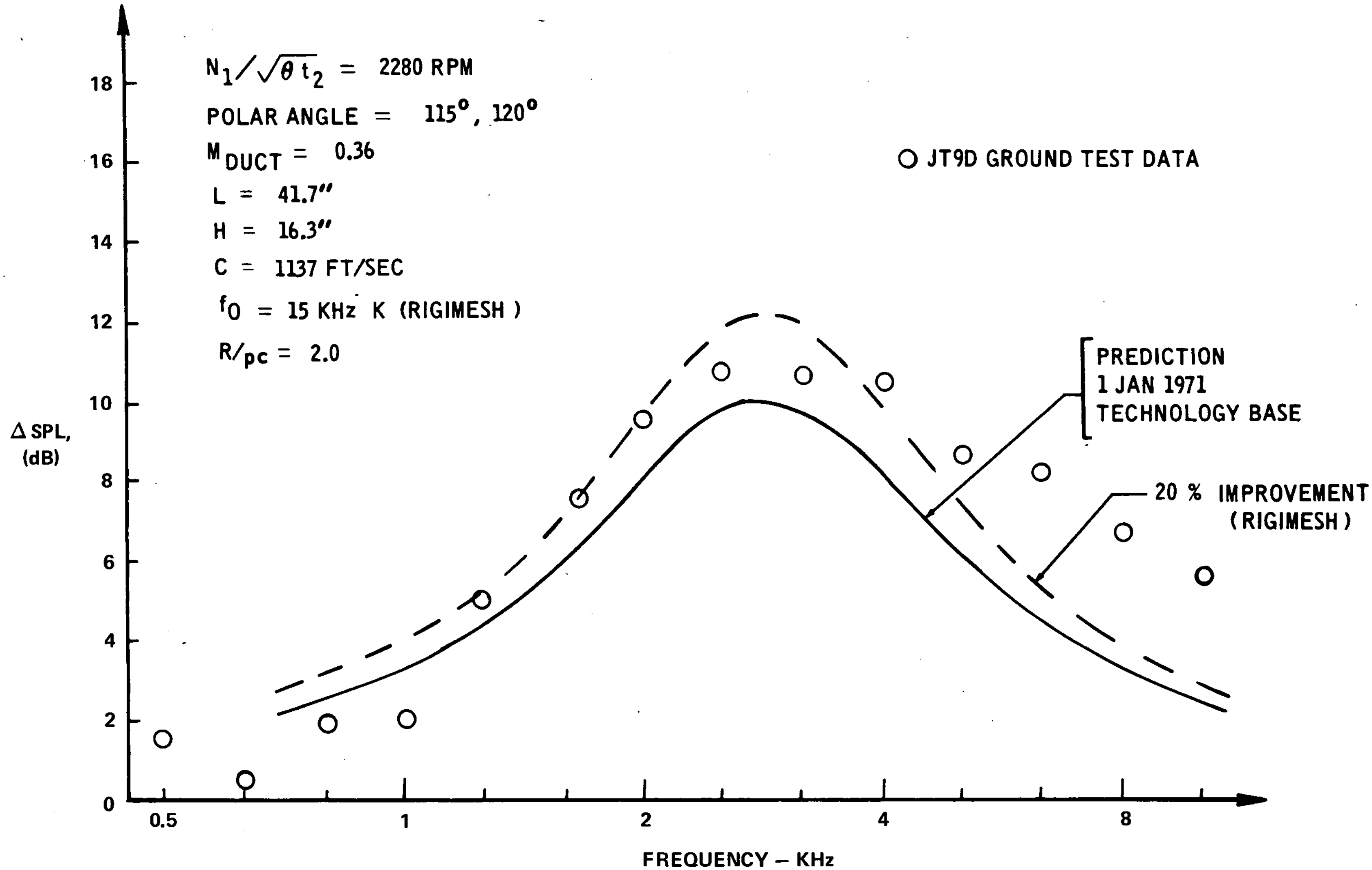
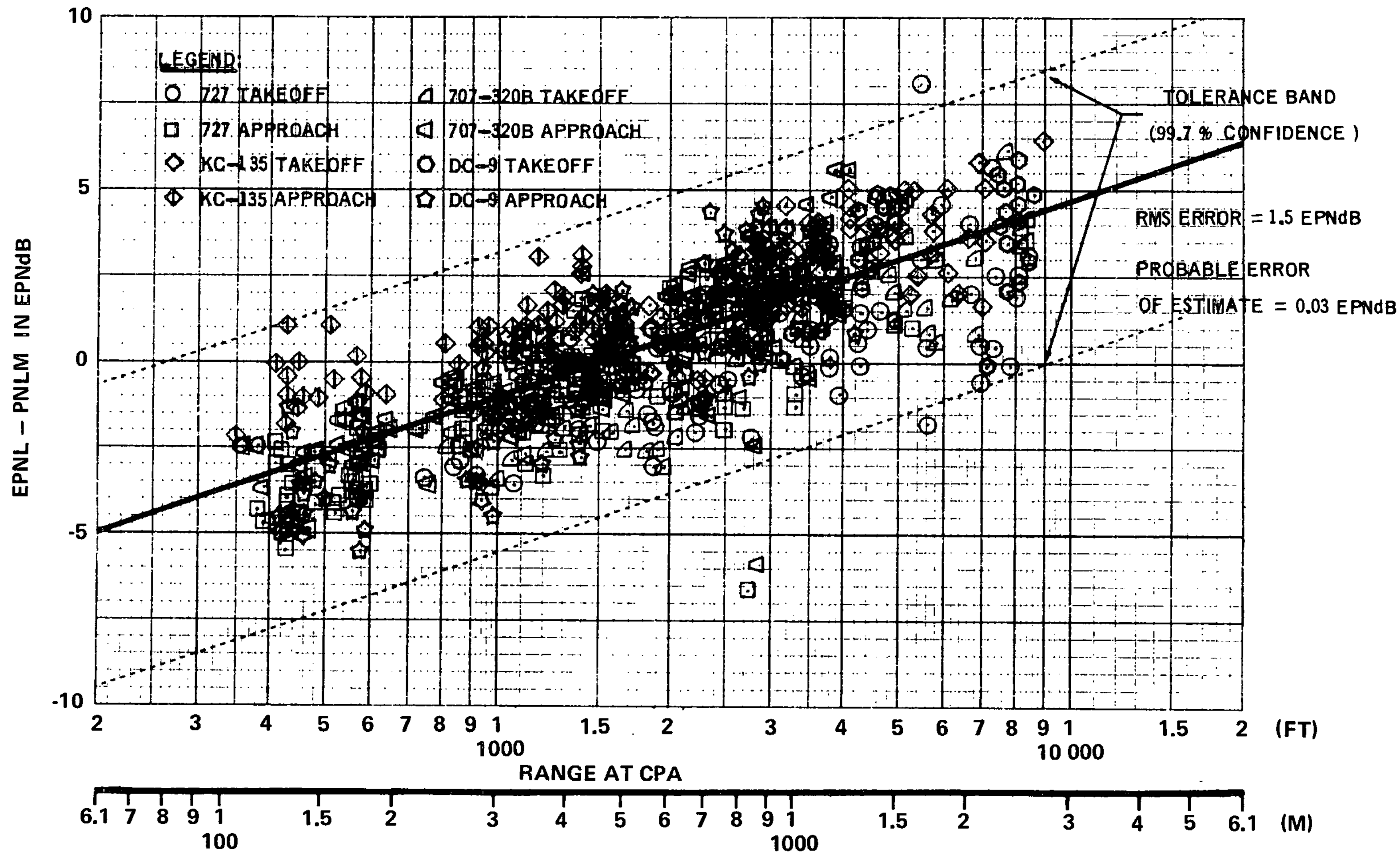


FIGURE 15.—COMPARISON OF PREDICTED AND ACTUAL ATTENUATION



Reference 7: C. S. Tanner/R. E. Glass (Hydrospace Research Corp), "Analysis of Operational Noise Measurements in Terms of Selected Human Response Noise Evaluation Measures," FAA-RD-71-112, revised 12 June 1972

FIGURE 16.—PNLM TO EPNL TRANSFER CURVE

The computer program has default values for the directivity angles which will permit combining the noise component levels in the inlet and exit quadrants to obtain the total radiated levels. However, these angles (one for each quadrant) may be changed by the user when test data indicates a need. Corrections to the predicted spectra can also be specified for each component. Caution should be exercised when changing the directivity angles, because the program will combine all components for each quadrant regardless of the input angles. The default values for the angles are listed in table 2.

TABLE 2.—MAXIMUM SOUND RADIATION ANGLE FOR MAJOR NOISE CONTRIBUTORS

Noise component	Turbofans	Turbojets
Inlet turbomachinery noise		
Compressor	---	70°
Fan	60°	...
Buzz-saw for no IGV's	60°	...
Residual jet noise	60°	...
Exit turbomachinery noise		
Fan	110°	...
Core[1] (optional)	110°	130°
Jet noise		
Primary jet	110°	130°
Secondary jet	110°	...
Extraneous noise[1] (optional)		70°

[1] Requires a spectrum input or ΔdB relative to a spectrum component.

An additional program option allows the user to consider two additional noise components that are not presently defined in a prediction procedure. These components are denoted as core and extraneous noise. The core noise is a real component that is caused by combustion and upstream turbulence in the nozzle, but adds to the total exit noise only at low thrust settings. The extraneous noise can be any other noise emitted from the engine and not accounted for by the prediction procedure – screech, feedback phenomena, tones, etc.

5.2 NOISE CONTOUR ESTIMATION

A noise contour is the locus of points on the ground in which the noise is at a constant acoustic level. The calculation of a noise contour requires the establishment of the relationships between the aircraft's noise performance and the aero/propulsion parameters during takeoff and landing. The following optimized method is presented which will fit within the computer time and storage constraints of the Ames flight simulator.

The relationships mentioned above are established when data points are given for noise level (NL), engine pressure ratio (EPR), off-axis range (R), and elevation angle (α), for an aircraft during level flight (see fig. 3 and table 3). This data can then be formed into tabular functions of NL versus EPR, log R and α , or log R versus α , and EPR, for each noise contour. When the airplane coordinates and EPR are given, interpolation using these functions at the geometry shown in figure 17 provides two points (one for each side of the flight track) on the ground for a specific noise level. If a series of these points is calculated during an aircraft's takeoff or landing, a noise contour is determined. The area enclosed by this contour can be calculated.

Although there exist more refined methods for calculating noise contours, they require rather lengthy calculations, and result in increased computer time and storage. This makes them undesirable candidates for flight simulator use. The approach presented here has the advantage of minimizing computations and reducing storage requirements. It should be recognized, however, that this method is an approximation. It follows, then, that if little is known about an aircraft's noise characteriestics, little is also known about the noise contour. If sufficient data points are provided by measurement or by prediction, however, this procedure will provide reasonably accurate noise contours.

5.2.1 Acoustic Data

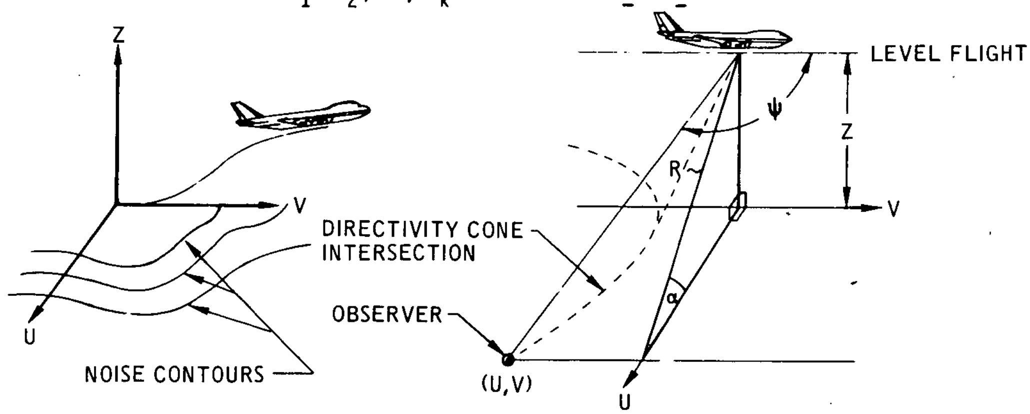
The acoustic data required for noise contour estimation consists of a directivity angle for peak noise radiation and a tabulated function of three variables – noise level versus EPR, R, and α (see fig. 3). It is of particular importance, when constructing this function, that the data is for level flight and that it is sampled in the manner indicated in table 3; i.e., in equal steps of log R for angular increments of $\sin \alpha = 0, 0.125, 0.25, 0.5, 0.707107$, and 1.0. The noise contour computer program has been optimized for data given in this form and provides the greatest accuracy for a minimum amount of data. Also, the noise levels are to be strictly monotonic: decreasing noise with respect to increasing values of log R. If this constraint is not adhered to, the whole procedure fails. This constraint poses no restriction to actual jet engine noise or to that provided by the noise source estimation procedure.

5.2.2 Aero/Propulsion Data

The aero/propulsion data required for noise contour estimation consists of a series of points along the aircraft's takeoff or landing flight path which define the airplane position (x, y, z), the engine attitude (δ_E), and the engine pressure ratio (EPR). The choice of EPR as the key engine performance variable is due to its relationship to other engine cycle parameters, i.e., there is a one-to-one correspondence between EPR and all other engine cycle parameters and this correspondence is constant with altitude for a fixed aircraft

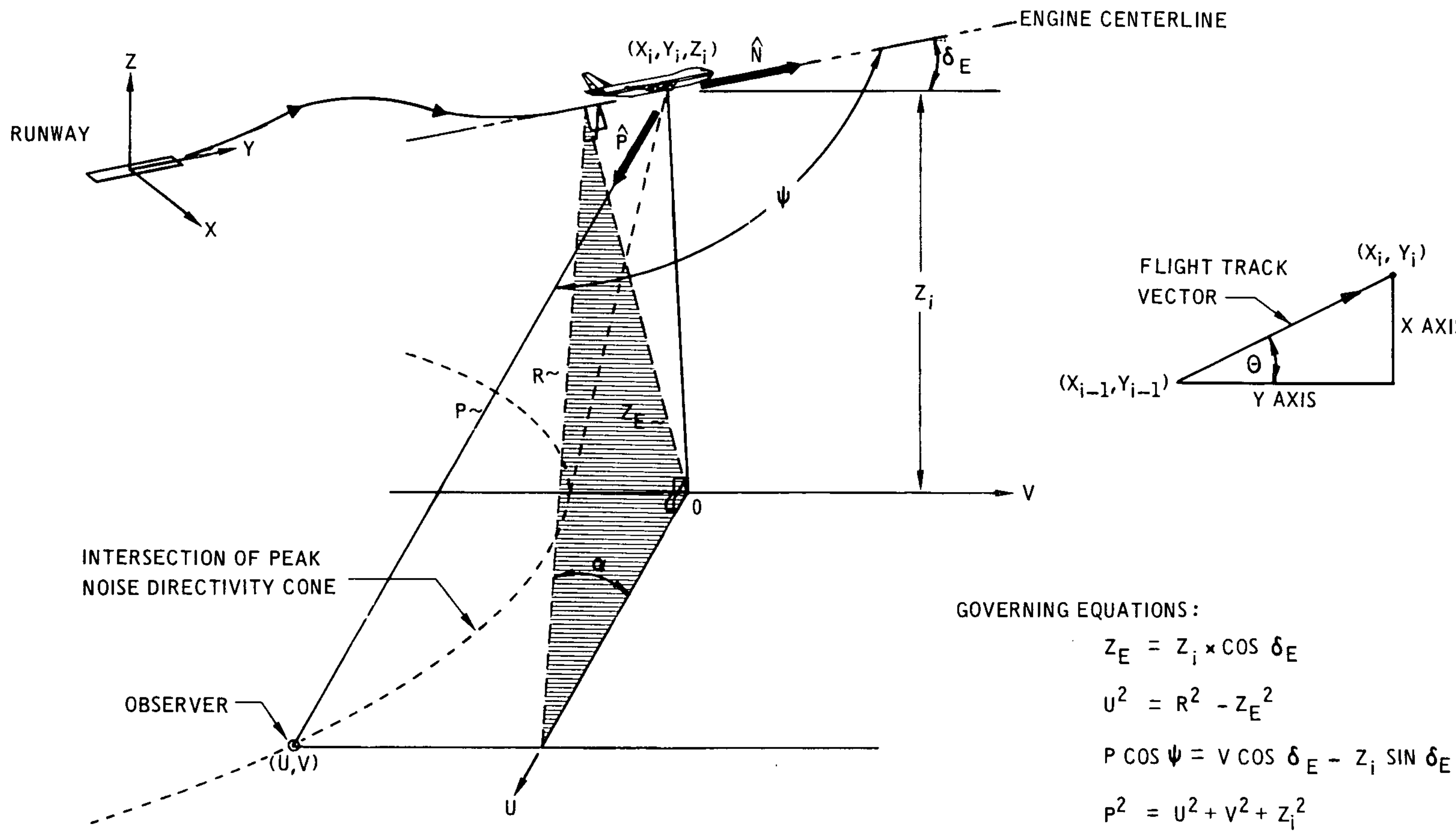
TABLE 3.—SAMPLE NOISE DATA GRID FOR NOISE CONTOUR COMPUTER PROGRAM

INDEPENDENT VARIABLES	RANGE
1) $EPR = EPR_1, EPR_2, \ldots, EPR_i$	$1.0 < EPR$
2) $R = R_1, R_2, \ldots, R_j$	$.05 \leq R \leq 12.8$ KM
3) $\alpha = \alpha_1, \alpha_2, \ldots, \alpha_k$	$0° \leq \alpha \leq 90°$



NOISE DATA GRID: 54 OBSERVER POSITIONS, 22 ALTITUDES

VARIABLE	DISTANCES (KM)								
R	.05	.1	.2	.4	.8	1.6	3.2	6.4	12.8
$\alpha = 0°$ SIN α = 0									
U =	.05	.1	.2	.4	.8	1.6	3.2	6.4	12.8
Z =	0	0	0	0	0	0	0	0	0
$\alpha = 7.18°$ SIN α = .125									
U =	.0496	.0992	.198	.397	.794	1.59	3.17	6.35	12.7
Z =	.00625	.0125	.025	.05	.1	.2	.4	.8	1.6
$\alpha = 14.46°$ SIN α = .25									
U =	.0469	.0968	.194	.387	.774	1.55	3.10	6.20	12.4
Z =	.0125	.025	.05	.1	.2	.4	.8	1.6	3.2
$\alpha = 30°$ SIN α = .5									
U =	.0433	.0866	.173	.346	.693	1.38	2.77	5.54	11.1
Z =	.025	.05	.1	.2	.4	.8	1.6	3.2	6.4
$\alpha = 45°$ SIN α = .707107									
U =	.0354	.0707	.141	.283	.566	1.13	2.26	4.52	9.05
Z =	.0354	.0707	.141	.283	.566	1.13	2.26	4.52	9.05
$\alpha = 90°$ SIN α = 1.0									
U =	0	0	0	0	0	0	0	0	0
Z =	.05	.1	.2	.4	.8	1.6	3.2	6.4	12.8



GOVERNING EQUATIONS:

$$Z_E = Z_i \times \cos \delta_E$$

$$U^2 = R^2 - Z_E^{\,2}$$

$$P \cos \psi = V \cos \delta_E - Z_i \sin \delta_E$$

$$P^2 = U^2 + V^2 + Z_i^{\,2}$$

FORMULAS FOR TRANSFORMING COORDINATES

$$\begin{cases} X = U \cos \Theta - V \sin \Theta + X_i \\ Y = V \cos \Theta + U \sin \Theta + Y_i \\ -\Theta = \arctan \left[(X_i - X_{i-1}) / (Y_i - Y_{i-1}) \right] \end{cases}$$

FIGURE 17.—NOISE CONTOUR GEOMETRICAL RELATIONSHIPS

velocity. Since the noise produced by jet engines is directly related to the engine cycle, it will also follow this correspondence with EPR at a reference off-axis distance.

5.2.3 Noise Contour Calculation

The noise contour calculation can be broken down into four basic steps. The first is the formation of the acoustic data functions

$$NL = f_1 (EPR, \log R, \alpha) \text{ and}$$

$$\text{Log } R = f_2 (\alpha, EPR)$$

for each noise contour from the given data points (NL_K, EPR_k, R_k α_k). This step is done only once. Thereafter, the calculation requires interpolation for log R at a desired contour noise level (CNL) and geometry, as shown in figure 17. The next steps are the geometric solutions for the contour points (U, V) in a moving reference frame and finally, the transformation of coordinates (U, V) to the fixed (X, Y, Z) coordinate system (see fig. 17). The details are outlined below.

a) Formation of the acoustic data functions, f_1 and f_2

Data points (NL_k, EPR_k, R_k, α_k) are assumed to be given from the use of the noise source estimation computer program or from measurements (table 3). Sort the given data with respect to increasing values of EPR_k, R_k, α_k as these variables will be treated as independent for the function f_1. Next, determine the distinct values for the given arrays (EPR_k, R_k, α_k) and use the results for the independent variable data arrays specifying where noise levels are defined.

NOTE: The three-dimensional function $NL = f_1 (EPR, \log R, \alpha)$ is now formed.

Specifying the desired contour noise levels (CNL_j) permits the transformation of the function f_1 to a function of $\log R = f_2 (\alpha, EPR)$ for each CNL_j. This is done by one-dimensional interpolation on f_1 at $NL = CNL_j$ for J = 1, 2, etc.

NOTE: The transformation assumes that the function f_1 is monotonic: decreasing with respect to increasing values of log R.

b) Calculation of log R for a specific contour CNL_j

At each point along the aircraft's flight path the following data is required.

z_i	aircraft height above the ground
δ_{Ei}	engine attitude angle
EPR_i	engine pressure ratio

Calculation:

let $Z_E = Z_i \cos(\delta_{Ei})$

Iterate the calculations below until $|\alpha - \alpha_o| \leq (\epsilon\alpha)$. In this iteration, α_o is set initially to the value $\pi/4$ for each noise contour and is updated at each aircraft position along the flight path. The value, ϵ, is a tolerance constant for the iteration; a reasonable value is 1.2×10^{-3}.

$\log R$ = interpolation on f_2 at (α_o, EPR_i)

$\alpha = \arcsin(Z_E/R)$

Test α for convergence with α_o and

update α_o if another iteration is required.

NOTE: In the computer program, a test for contour closure is made just before the calculation of α above. Closure occurs when $R < z_i$. The action taken is to set an error code, $R = Z_E$, and stop the iteration.

c) Calculation of contour points (U, V)

Required data:

R	off-axis range calculated for the noise contour in step (b).
Z_E	engine-to-ground distance perpendicular to engine centerline.
z_i	aircraft height above the ground.
δ_{Ei}	engine attitude angle
ψ	directivity angle for peak passby noise propagation

Calculation:

$$U^2 = R^2 - Z_E^2$$

$$V = \text{Solution of} \left\{ \begin{array}{lcl} P\cos\psi & = & V\cos\delta_{Ei} - z_i \sin\delta_{Ei} \\ P^2 & = & U^2 + V^2 + z_i^2 \end{array} \right\}$$

NOTE: Singularities can exist when $\delta_{Ei} = \pm 90^o$, and/or the directivity cone does not intersect the ground at sideline distances $\pm$ U.

d) Coordinate transformations

Required data:

$(x_{i-1}, y_{i-1}), (x_i, y_i)$	aircraft coordinates for the previous and present position along the flight path.
(U, V)	contour points in moving reference frame calculated in (c).

Calculation:

let $dx = x_i - x_{i-1}$

$$dy = y_i - y_{i-1}$$

$$ds_i^2 = dx^2 + dy^2$$

$$\sin\theta = -\, dx/ds_i$$

$$\cos\theta = dy \,/\, ds_i$$

$$x = U\cos\theta - V\sin\theta + x_i$$

$$y = V\cos\theta + U\sin\theta + y_i$$

5.2.4 Area Calculation

The area enclosed by each noise contour is calculated after the points, (U,V), are determined for aircraft positions (x_i, y_i, z_i), i = 1, 2, etc. The procedure is as follows:

$A_j = \sum_i \Delta A_{ij}$ . . . for each contour CNL_j

where $\Delta A_{ij} = (U_i + U_{i-1})\,(V_i - V_{i-1} + ds_i)$ from section 5.2.3

NOTE: The formula assumes negligible error due to changes in the flight track vector from iteration (i-1) to (i).

5.2.5 Noise Estimate on Sideline

Multiple sideline noise estimates are included with the noise contour computer program. The observer locations for these noise numbers are on the sideline in the (U, V, Z) coordinate system, as shown in figure 17. The sideline distances can be specified by the user; the default values are 1.0 m, 152.4 m (500 feet), 463.3 m. If any or all of the valves need to be changed, they may be as a user input.

a) Required data:

Noise level ··· f_1 (EPR, log R, α)

SD ··· set of sideline distances

z_i ··· aircraft height above ground

δ_{Ei} ··· engine attitude angle

EPR_i ··· engine pressure ratio

b) Calculation:

let $Z_E = z_i \cos \delta_{Ei}$

$$R_i^2 = SD^2 + Z_E^2$$

$$\alpha_i = \arccos (SD / R_i)$$

A three-dimensional interpolation on f_1 at (EPR_i, log R_i, α_i,)

yields the specified noise estimate.

Commercial Airplane Group
The Boeing Company
Seattle, Washington, October 5, 1972

APPENDIX A

SOURCE NOISE COMPUTER PROGRAM

USER'S GUIDE

INTRODUCTION

The noise source prediction computer program has been specifically designed to provide flexibility for the user in data input requirements and computational procedures. This approach is deemed desirable when a single computer program is to be used for a variety of reasons: e.g., estimating the noise performance for one configuration; performing a parametric study using a series of different engines; establishing the benefits of different lining configurations; or estimating the change in noise exposure resulting from different atmospheric conditions. However, if the user is not interested in the various available options, these options can be ignored as the program will automatically select the most commonly accepted calculation method. A perusal of the available options will clarify the method selected when the user does not specify a choice.

The program is designed to process one or more cases of data in a single run. Prior to reading the input data for the first case, the program initializes all parameters to specific values. These values are called default values and are used by the program for each case until new values are specified by input data cards. A new parameter value remains effective for all succeeding cases until the user again changes its value. In this manner, the user is required to input only those parameters which have values different from the default values, or which change from one case to the next.

The first card in a given case (a case consists of all data for one configuration) is the title card. The entire contents of this card (columns 1-80) are printed at the top of each page of printed output.

Immediately following the title card are the cards which define the various input parameters. These cards are coded in a FORTRAN NAMELIST format. Thus, the sequence for specifying the input parameters is not important, because the variable name is first defined and then followed by the assigned value or values. Variable names and descriptions are defined in the section discussing program variables. Each parameter (variable name plus prescribed value) must be separated by a comma. Blank spaces on a data card are ignored. The first data card, following the title card, must contain the characters "&PARAM" in columns 2 through 8. Input data defined on the first parameter card are contained in columns 9 through 80. All subsequent parameter cards contain input data starting in column 2 and ending in column 80. The characters "&END" are used to denote the end of a data set, i.e., the program will commence computation each time it encounters these characters. The location of "&END" on a card is immaterial within columns 2-80, but must follow the last input variable.

A variable name can be followed by a single quantity, or a series of values in the case of those variables which require an array of data.

The general input format is as follows:

Variables having single values

VARB = c

Where VARB is the name of the variable and "c" is the assigned value. The value "c" may be written either as an integer or as a real FORTRAN constant.

EXAMPLE:

VARB = 3.4

The variable whose name is VARB will be assigned a value of 3.4.

Variables having multiple values (tables)

When defining values for a table having space for "n" entries, the following form is used:

VARB = $d_1, d_2, \ldots d_i, \ldots d_n$ or VARB(1) = $d_1, d_2, \ldots d_i, \ldots d_n$

where VARB is the name of the table and the values $d_1, d_2 \ldots$ are stored consecutively from the beginning of the table. The d_i values are simple constants or repeated constants of the form k*c: the constant "c" is to be repeated "k" times. The number of constants, including repeated values, submitted for an array must be less than or equal to the allocated storage space, as defined in the variable description.

All tabular inputs must be distinct points defining single valued functions.

EXAMPLE

VARB(1) or VARB = 1500, 1.7E3, 18E2, 2000.0, 250E1, 3E3, 3500, 4000,
5000, 6000

The above values define quantities to be assumed by the variable, VARB. For this example, the variable, VARB, has space for 10 entries, and since 10 values are defined, starting with VARB(1), it is possible to use the unsubscripted name of the table.

When defining only a portion of a table which has space for "n" entries, and the user does not wish to specify, or change, the first entries, the following form must be used:

VARB(j) = $d_1, d_2, \ldots d_i \ldots d_n$

where the values are stored consecutively, beginning with the "jth" position of the table. The total number of constants, including repeated values, for a subscripted array having space for "n" entries must not exceed (n+1-j).

EXAMPLE

VARB(4) = 2000, 250E1, 3E3, 3500, 4000, 5000, 6000

Four sample cases are given in sections A.11 and A.12. These samples show typical input and output from the program. At the discretion of the user, the output of the source noise prediction program will be tailored to meet the input requirements of the footprint program (refer to comment in section A.10, "Control Cards"). The source noise prediction program will permit input parameters to be specified in either MKS or English units, depending on the setting of the input variable IUNIT. The normal mode will be MKS unless specified otherwise by the user. The units for output will correspond to the input mode.

A.1 FLIGHT PATH PARAMETERS

Variable Name	Units	Default Value	Description
ELEV	m(ft)	0	Ground elevation from sea level
ALT	m(ft)		Altitude of airplane
SLØPE		0	Airplane climb gradient. (Tangent of climb angle)
DELTAE	degrees		Angle between engine inlet axis and horizontal
ENG		1	Number of engines
AMACH		0	Mach number of aircraft
NØBS			Number of observers defined in SLDIST table, maximum of 10
SLDIST(1)	m(ft)		Sideline position of 1st observer
. . .	. . .	. . .	. . .
SLDIST(N)	m(ft)		Sideline position of Nth observer (see NØBS)

A.2 ENGINE PARAMETERS

Variable Name	Units	Default Value	Description
IUNIT		0	Specifies whether input parameters are in MKS or English units 0 = MKS 1 = English units
ITENG		0	Specifies the type of engine. Set equal to: 0 for turbofan 1 for turbojet
IPARM		0	Specifies the type of input parameters to be used for calculating the jet noise. Set equal to: 0 for nozzle pressure ratio, total temperature, and nozzle exit area (ISENTROPIC FLOW). 1 for mass flow, velocity, and expanded exit area (losses included in continuity equation)
IØPTP		0	Specifies which curve from the graph showing jet noise as a function of jet velocity (fig. 5) will be used to calculate the primary jet noise for a turbofan or jet noise of a turbojet. This variable also specifies whether the velocity argument will be relative to the nozzle or ambient air. Set equal to:

IØPTP	Curve No.	Velocity Relative to
0	1	Ambient air
1	2	” ”
2	3	” ”
3	4	” ”
4	1	Nozzle
5	2	”
6	3	”
7	4	”

Variable Name	Units	Default Value	Description
IØPTS		0	Specifies which curve from the graph showing jet noise as a function of jet velocity (fig. 5) will be used to calculate the secondary jet noise of a turbofan engine. This variable is used in

Variable Name	Units	Default Value	Description
			the same manner as IØPTP except it applies to the secondary jet noise.
IFLTGD		0	Specifies whether the flight or ground spectrum shape vs Strouhal number is to be used for calculating the jet noise spectrum. Set equal to: 0 for ground 1 for flight
ISPTRM		1	Specifies the type of frequency bands to be used in the calculations. Set equal to: 0 for 24 preferred 1/3 octave bands 1 for 8 preferred 1/1 octave bands
IND		0	Specifies whether the mechanical tip speed or fan pressure ratio is to be used in calculating the level of inlet fan or aft fan noise. Set equal to: 0 for mechanical tip speed 1 for single-stage fan pressure ratio 2 for double-stage fan pressure ratio (Note: See PTFPTØ if IND = 1 or 2 on p. 48)
IGV		0	Specifies whether a turbofan engine has inlet guide vanes. If the engine has IGV's the program does not estimate the buzz-saw noise. Set equal to: 0 if no IGV's 1 for IGV's
IDØPLR		0	Specifies whether corrections for turbomachinery flight effects (i.e., level change and Doppler shift) are to be applied while extrapolating the noise from the airplane to the observer. Set equal to: 0 if no correction is to be made 1 if correction is desired

Variable Name	Units	Default Value	Description
DAITF	degrees	60^o	Directivity angle of inlet quadrant for turbofan engine.
DAETF	degrees	110^o	Directivity angle of exit quadrant of turbofan.
DAITJ	degrees	70^o	Directivity angle of inlet quadrant for turbojet engine.
DAETJ	degrees	130^o	Directivity angle of exit quadrant of turbojet.
D	m(in)		Diameter of dominant noise rotor stage.
B			Number of blades on dominant noise rotor stage.
S	%	55%	Minimum rotor-vane spacing in percent of rotor blade axial projected chord length (see sketch p. 16)
VTØ	m/sec(ft/sec)		Mechanical tip speed of dominant noise rotor stage.
PTFPTØ			Fan Pressure Ratio. (Note: Required for fan noise prediction if IND = 1 or 2, or if the program is to calculate the Mach number in the exit duct for lining attenuation.)
AF	$m^2(ft^2)$		Fan discharge area.
EPR			Engine pressure ratio. If IPARM = 0, this variable is calculated by the program, unless it is input. (Note: Used only for table output for noise contour estimation program.)

A.2.1 Turbofan Engine (Isentropic Flow Parameters)

Note: These parameters are used when IPARM = 0.

Variable Name	Units	Default Value	Description
PT1PSØ			Primary nozzle pressure ratio; total pressure divided by ambient static pressure.
PT2PSØ			Secondary nozzle pressure ratio
TTF	$^oK(^oR)$	ambient total temp	Fan total temperature
TT1	$^oK(^oR)$		Primary nozzle total temperature
TT2	$^oK(^oR)$	ambient total temp	Secondary nozzle total temperature
A1	$m^2(ft^2)$		Exit area of primary nozzle
A2	$m^2(ft^2)$		Exit area of secondary nozzle
GAMMA1		1.3	Ratio of specific heats for primary flow
GAMMA2		1.4	Ratio of specific heats for secondary flow
AI	$m^2(ft^2)$		Inlet area (Note: This quantity is used only for calculating inlet Mach no. for lining)

A.2.2 Turbofan Engine (Continuity Parameters)

Note: These parameters are used when IPARM = 1.

AX1	$m^2(ft^2)$	Expanded exit area of primary exhaust
AX2	$m^2(ft^2)$	Expanded exit area of secondary exhaust
VJX1	m/sec(ft/sec)	Expanded exit velocity of primary exhaust
VJX2	m/sec(ft/sec)	Expanded exit velocity of secondary exhaust
W1	kg/sec(1bm/sec)	Mass flow through primary exhaust
W2	kg/sec(1bm/sec)	Mass flow through secondary exhaust

A.2.3 Turbojet Engine (Isentropic Flow Parameters)

Note: These parameters are used when IPARM = 0.

Variable Name	Units	Default Value	Description
PT1PSØ			Jet nozzle pressure ratio
TT1	$^{o}K(^{o}R)$		Jet nozzle total temperature
A1	$m^2(ft^2)$		Exit area of primary nozzle
GAMMA1		1.3	Ratio of specific heats for jet exhaust
GAMMA2		1.4	Ratio of specific heat for ambient air
AI	$m^2(ft^2)$		Inlet area (Note: This quantity is used only for calculating inlet Mach no. for lining)

A.2.4 Turbojet Engine (Continuity Parameters)

Note: These parameters are used when IPARM = 1.

AX1	$m^2(ft^2)$		Expanded exit area of jet exhaust
VJX1	m/sec(ft/sec)		Expanded exit velocity of jet exhaust
W1	kg/sec(1bm/sec)		Mass flow through jet

A.3 LINING PARAMETERS

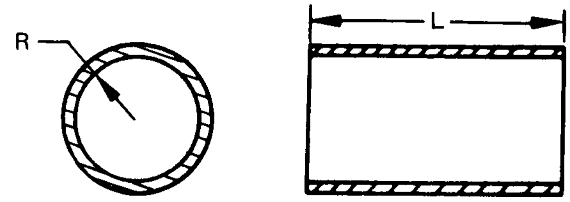
There are several methods available for calculating the lining attenuation spectra. These methods are as follows:

1. For each target frequency, the user defines the magnitude of maximum attenuation and the percentage of the total area treated. The program then determines the spectrum shape.

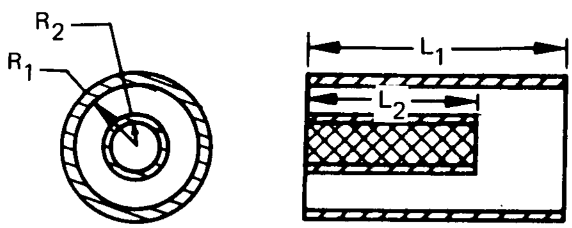
2. For each target frequency, the user defines the effective duct height, the ratio of apparent treatment length to effective duct height, and the percentage of the total area treated. The program then determines the spectrum shape.

3. The user defines the geometry of the lining in terms of the length and radii of cylindrical walls, and the percentage of the total area that is treated for each target frequency. The program then determines the spectrum shape.

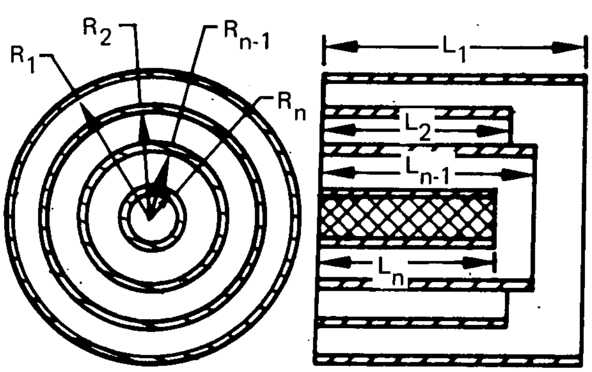
The user is limited to the following configurations when defining the linings geometrically:



a) Circular Duct
(Number of walls = 1)
(H = R)



b) Annular Duct
(Number of walls = 2)
Innermost and outermost walls are lined on one side.
($H = R_1 - R_2$)



c) "n" Concentric Walls
(Number of walls = n)
Innermost and outermost walls are lined on one side, interior walls are lined on both sides.
($H_{n-1} = R_{n-1} - R_n$)

Variable Name	Units	Default Value	Description
IDPØPT		2	Design point option. Set equal to: 1 for single design point 2 for multiple design point

E

A.3.1 Inlet Lining Parameters

Variable Name	Units	Default Value	Description
ILASPT		0	Specifies whether the program calculates or the user inputs the inlet lining attenuation. Set equal to: 0 program calculates 1 user inputs (See AISPEC in sec. A.4.4) (Note: See IATNFI on p. 60)
NTFINF		1	Number of target frequencies in inlet lining. Maximum number is 10. (Note: NTFINF is used only if ILASPT = 0. If NTFINF is set to zero, the computer will reset the target frequency for inlet lining to the current calculated fundamental frequency of the turbomachinery noise.)
IMIATN		0	Specifies whether program calculates or user defines the peak inlet attenuation for each target frequency. Set equal to: 0 program calculates 1 user defines PILATN values on p. 53 (Note: Used only if ILASPT = 0.)
LGMINF		0	Specifies whether program calculates peak inlet attenuation using lining geometry or user-defined effective duct height (H) and ratio of treatment length to effective duct height (L/H). Set equal to: 0 user inputs H and L/H (See EDHI and ELØHI on p. 53) 1 user inputs inlet lining geometry (See RINF and TLINF on p. 53) (Note: Used only if IMIATN = 0.)
NWLINF		0	Number of walls in inlet lining. Maximum is 10. (Note: Used only if LGMINF = 1.)

Variable Name	Units	Default Value	Description

The following table defines the target frequencies for inlet lining. (See NTFINF)

TFINF(1)	Hz	fundamental frequency of turbomachinery noise	First target frequency (Note: If NTFINF is input as zero, the computer will reset TFINF(1) in the current calculated fundamental frequency.)
. . .	. . .	. . .	. . .
TFINF(N)	Hz	0	Nth target frequency (See NTFINF).

The following table defines the percentage of the inlet area treated for the above target frequencies.

PCTINF(1)	%	100%	Percent treated for 1st target frequency.
. . .	. . .	. . .	. . .
PCTINF(N)	%	0	Percent treated for Nth target frequency (See NTFINF).
PILATN(1)	dB		Peak inlet attenuation for 1st target frequency.
. . .	. . .		. . .
PILATN(N)	dB		Peak inlet attenuation for Nth target frequency (Note: Used only if IMIATN = 1).
ELØHI			Ratio of inlet treatment length to duct height (Note: Used only if LGMINF = 0).
EDHI	m (ft)		Effective duct height of inlet lining (Note: Used only if LGMINF = 0).
RINF(1)	m (ft)		Radius of 1st wall in inlet.
. . .	. . .		. . .
RINF(N)	m (ft)		Radius of Nth wall in inlet (See NWLINF) (Note: Used only if LGMINF = 1).
TLINF(1)	m (ft)		Treatment length of 1st wall in inlet.
. . .	. . .		. . .

Variable Name	Units	Default Value	Description
TLINF(N)	m (ft)		Treatment length of Nth wall in inlet (See NWLINF).
FMI			Mach number in inlet of turbofan or turbojet engine (Note: Required only when IPARM = 1 in sec. A.2.2 and sec. A.2.4).

A.3.2 Exit Lining Parameters

IAASPT		0	Specifies whether the program or user inputs the exit lining attenuation. Set equal to: 0 program calculates 1 user inputs (see AASPEC in sec. A.4.4) (Note: See IATNFA on p. 61)
NTFAFT		1	Number of target frequencies in exit lining. Maximum number is 10. (Note: NTFAFT is used only if IAASPT = 0. If NTFAFT is set to zero, the computer will reset the target frequency for exit lining to the current calculated fundamental frequency of the turbomachinery noise).
IMAATN		0	Specifies whether program calculates or user defines the peak exit lining attenuation for each target frequency. Set equal to: 0 program calculates 1 user defines (see PALATN on p. 55) (Note: Used only if IAASPT = 0).
LGMAFT		0	Specifies whether program calculates peak exit attenuation using lining geometry or user defined effective duct height (H) and ratio of treatment length to effective duct height (L/H). Set equal to: 1 user inputs exit lining geometry (See RAFF & TLAFF on p. 56) 0 user inputs H & L/H (See EDHA & ELØHA) (Note: Used only if IMAATN = 0)

Variable Name	Units	Default Value	Description
NWLAFF		0	Number of walls in exit lining. Maximum is 10. (Note: Used only if LGMAFT = 1).

The following table defines the target frequencies for exit lining.

TFAFT(1)	Hz	fundamental frequency of turbomachinery noise	First target frequency (Note: If NTFAFT is input as zero, the computer will reset TFAFT(1) to the current calculated fundamental frequency).
. . .	. . .	. . .	. . .
TFAFT(N)	Hz	0	Nth target frequency (see NTFAFT).

The following table defines the percentage of the exit area treated for the above target frequencies.

PCTAFF(1)	%	100	Percent treated for 1st target frequency
. . .	. . .	. . .	. . .
PCTAFF(N)	%	0	Percent treated for Nth target frequency (see NTFAFT).
PALATN(1)	dB		Peak exit lining attenuation for 1st target frequency.
. . .	. . .		. . .
PALATIN(N)	dB		Peak exit lining attenuation for Nth target frequency (see NTAFT). (Note: Used only if IMAATN = 1).
ELØHA			Ratio of exit lining treatment length to duct height. (Note: Used only if LGMAFT = 0).
EDHA	m (ft)		Effective duct height of exit lining. (Note: Used only if LGMAFT = 0).

Variable Name	Units	Default Value	Description
RAFF(1)	m (ft)		Radius of 1st wall in exit lining.
. . .	. . .		. . .
RAFF(N)	m (ft)		Radius of Nth wall in exit lining.
			(Note: Used only if LGMAFT = 1).
TLAFF(1)	m (ft)		Treatment length of 1st wall in exit lining.
. . .	. . .		. . .
TLAFF(N)	m (ft)		Treatment length of Nth wall in exit lining.
			(Note: Used only if LGMAFT = 1).
FMF			Mach number in bypass duct of a turbofan engine.
			(Note: Required only if IPARM = 1 in sec. A.2.2 and sec. A.2.4).
CF	m/sec (ft/sec)		Speed of sound in bypass duct of a turbofan engine.
			(Note: Required only if IPARM = 1).

A.4 OPTIONS SELECTED BY THE USER

NLØPT		0	Specifies table output for noise contour estimation, file TAPE20. NLØPT = 0 no output = 1 for EPNL versus engine pressure ratio, elevation angle, $\log_{10}$ of off-axis range = 2 same except peak PNL

Variable Name	Units	Default Value	Description
ICØRE		0	Specifies whether exit quadrant core noise is present and whether the user defines the noise level or the program derives the noise level from another noise source. Set equal to: 0 if no core noise 1 if user defines SPL's 2 derived from primary jet 3 derived from inlet fan or compressor 4 derived from inlet buzz saw 5 derived from aft fan 6 derived from secondary jet (Note: If ICØRE = 1, see CRSPEC in sec. A.4.2. If ICØRE = 2 thru 6 see CRSDEL and CRCDEL in sec. A.4.1).
IEXTR		0	Specifies whether extraneous noise is present and whether the user defines the noise level or the program derives the noise level from another noise source. IEXTR is used in the same manner as ICØRE. (Note: If IEXTR = 1, see IEXQD and EXSPEC in sec. A.4.2 If IEXTR = 2 thru 6, see IEXQD, EXCDEL and EXSPEL in sec. A.4.1).
IEXQD		0	Specifies whether the inlet or exit quadrant contains the extraneous noise. Set equal to: 0 for inlet quadrant 1 for exit quadrant (Note: Used only if IEXTR = 1 thru 6).

Variable Name	Units	Default Value	Description
IPJSPT		0	Specifies whether the primary jet noise is calculated by program or is defined by user. Set equal to: 0 if program is to predict the noise (see PJSDEL and PJCDEL in sec. A.4.1) 1 if user inputs measured SPL's (see PJSPEC in sec. A.4.2)
ISJSPT		0	Specifies whether the secondary jet noise for a turbofan engine is calculated by program or defined by user. Set equal to: 0 if program is to predict the noise (see SJSDEL and SJCDEL in sec. A.4.1) 1 if user inputs measured SPL's (see SJSPEC in sec. A.4.2)
IIFSPT		0	Specifies whether the inlet fan noise for a turbofan or inlet compressor noise for a turbojet is calculated by program or defined by user. Set equal to: 0 if program is to predict the noise (see FISDEL and FICDEL in sec. A.4.1) 1 if user inputs measured SPL's (see FISPEC in sec. A.4.2)
IBZSPT		0	Specifies whether the inlet buzz-saw noise for a turbofan is calculated by program or defined by the user. Set equal to: 0 if program is to predict the noise (see BZSDEL and BZCDEL in sec. A.4.1) 1 if user inputs measured SPL's (see BZSPEC in sec. A.4.2)

Variable Name	Units	Default Value	Description
IAFSPT		0	Specifies whether the aft fan noise for a turbofan engine is calculated by program or defined by user, or whether the aft compressor noise is defined by the user for a turbojet engine. The program does not have a prediction procedure for aft compressor noise of a turbojet. Set equal to: 0 if program is to predict aft fan noise for a turbofan (see FASDEL and FACDEL in sec. A.4.1) 1 if user inputs measured SPL's for aft fan of turbofan or aft compressor of turbojet. (see FASPEC in sec. A.4.2)
IRJSPT		0	Specifies whether the residual jet noise of a turbofan engine is calculated by the program or defined by the user. Set equal to: 0 if program is to predict the noise (see RJSDEL and RJCDEL in sec. A.4.1) 1 if user inputs measured SPL's (see RJSPEC in sec. A.4.2)
IATNPJ		0	Specifies whether configuration corrections are to be applied to the primary jet noise (e.g., suppressor). Set equal to: 0 if no corrections 1 for corrections (see APSPEC in sec. A.4.4)
IATNSJ		0	Specifies whether configuration corrections are to be applied to the secondary jet noise of a turbofan engine (e.g., suppressor). Set equal to: 0 if no corrections 1 for corrections (see ASSPEC in sec. A.4.4)

Variable Name	Units	Default Value	Description
IATNFI		0	Specifies whether lining configuration corrections are to be applied to the inlet turbomachinery noise of a turbofan or turbojet engine. Set equal to: 0 if no corrections 1 for corrections (see ILASPT in sec. A.3.1)
IATNBZ		0	Specifies whether configuration corrections (other than linings) are to be applied to the inlet buzz-saw noise of a turbofan engine. Set equal to: 0 if no corrections 1 for corrections (see ABSPEC in sec. A.4.4)
IATNRJ		0	Specifies whether configuration corrections are to be applied to the residual jet noise of a turbofan engine. Set equal to: 0 if no corrections 1 if corrections (see ARSPEC in sec. A.4.4)
IATNCR		0	Specifies whether configuration corrections are to be applied to the core noise if present (i.e., ICØRE $\neq$ 0). Set equal to: 0 if no corrections 1 if corrections (see ACSPEC in sec. A.4.4)
IATNEX		0	Specifies whether configuration corrections are to be applied to the extraneous noise if present (i.e. IEXTR $\neq$ 0). Set equal to: 0 if no corrections 1 if corrections (see AESPEC in sec. A.4.4)

Variable Name	Units	Default Value	Description
IATNFA		0	Specifies whether lining configuration corrections are to be applied to the exit turbomachinery noise of turbofan or turbojet engines. Set equal to: 0 if no corrections 1 if corrections (see IAASPT in sec. A.3.2).
NTCP		2	Number of points for peak PNL to effective PNL transfer curve. Maximum = 10.
RØ(1)	m(ft)	See fig. 16	Data array for range at CPA of the peak PNL to effective PNL transfer curve.
. . .	. . .		. . .
RØ(N)	m(ft)		Nth item in above array.
DEPNL(1)	EPNdB	See fig. 16	Data array of (effective PNL minus peak PNL) for transfer curve.
. . .	. . .		. . .
DEPNL(N)	EPNdB		Nth item in above array.

A.4.1 User Defined Corrections to Predicted Noise Spectra

The following table defines the SPL corrections that are to be subtracted from each band of the predicted primary jet spectrum.

PJCDEL	dB	0	A constant SPL correction that is subtracted from all bands of the predicted primary jet spectrum.
PJSDEL(1)	dB	0	SPL correction for 1st band.
. . .	. . .	. . .	. . .
PJSDEL(N)	dB	0	SPL correction for Nth band, where N = 8 for 1/1 O.B. or = 24 for 1/3 O.B.

Variable Name	Units	Default Value	Description

The following table defines the SPL corrections that are to be subtracted from each band of the predicted secondary jet spectrum.

SJCDEL	dB	0	A constant SPL correction that is subtracted from all bands of the predicted secondary jet spectrum.
SJSDEL(1)	dB	0	SPL correction for 1st band.
. . .	. . .	. . .	. . .
SJSDEL(N)	dB	0	SPL correction for Nth band.

The following table defines the SPL corrections that are to be subtracted from each band of the predicted inlet fan noise spectrum of a turbofan engine or inlet compressor spectrum of a turbojet engine.

FICDEL	dB		A constant SPL that is subtracted from each band of the predicted inlet fan noise spectrum of a turbofan engine or inlet compressor noise spectrum of a turbojet engine.
FISDEL(1)	dB	0	SPL correction for 1st band.
. . .	. . .	. . .	. . .
FISDEL(N)	dB		SPL correction for Nth band.

The following table defines the SPL corrections that are to be subtracted from each band of the predicted buzz-saw spectrum of a turbofan engine.

BZCDEL	dB	0	A constant SPL correction that is subtracted from all bands of the predicted buzz-saw spectrum of a turbofan engine.
BZSDEL(1)	dB	0	SPL correction for 1st band.
. . .	. . .	. . .	. . .
BZSDEL(N)	dB	0	SPL correction for Nth band.

Variable Name	Units	Default Value	Description

The following table defines the SPL corrections that are to be subtracted from each band of the predicted residual jet noise spectrum of a turbofan engine.

RJCDEL	dB	0	A constant SPL correction that is subtracted from all bands of the predicted residual jet noise spectrum of a turbofan engine.
RJSDEL(1)	dB	0	SPL correction for 1st band.
...	...	...	...
RJSDEL(N)	dB	0	SPL correction for Nth band.

The following table defines the SPL corrections that are to be subtracted from each band of the predicted aft fan spectrum of a turbofan engine.

FACDEL	dB	0	A constant SPL correction that is subtracted from all bands of the predicted aft fan spectrum of a turbofan engine.
FASDEL(1)	dB	0	SPL correction for 1st band.
...	...	...	...
FASDEL(N)	dB	0	SPL correction for Nth band.

The following table defines the SPL corrections that are to be subtracted from each band of the predicted extraneous noise spectrum.

EXCDEL	dB	0	A constant SPL correction that is subtracted from all bands of the predicted extraneous noise spectrum.
EXSDEL(1)	dB	0	SPL correction for 1st band.
...	...	...	...
EXSDEL(N)	dB	0	SPL correction for Nth band.

The following table defines the SPL corrections that are to be subtracted from each band of the predicted core noise spectrum.

CRCDEL	dB	0	A constant SPL correction that is subtracted from all bands of the predicted core noise spectrum.

Variable Name	Units	Default Value	Description
CRSDEL(1)	dB	0	SPL correction for 1st band.
. . .	. . .	. . .	. . .
CRSDEL(N)	dB	0	SPL correction for Nth band.

A.4.2 User Defined Spectral Data

The following table is used to define the measured primary jet noise spectrum (Note: used only if IPJSPT = 1).

PJSPEC(1)	dB		SPL of 1st band.
. . .	. . .		. . .
PJSPEC(N)			SPL of Nth band where N = 8 for 1/1 octave bands or N = 24 for 1/3 octave bands.

The following table is used to define the measured secondary jet noise spectrum (Note: used only if ISJSPT = 1).

SJSPEC(1)	dB		SPL of 1st band.
. . .	. . .		. . .
SJSPEC(N)	dB		SPL of Nth band.

The following table is used to define the measured inlet fan noise spectrum of a turbofan engine or inlet compressor noise spectrum of a turbojet engine (Note: used only if IIFSPT = 1).

FISPEC(1)	dB		SPL of 1st band
. . .	. . .		. . .
FISPEC(N)	dB		SPL of Nth band.

The following table is used to define the measured buzz-saw spectrum of a turbofan engine (Note: used only if IBZSPT = 1).

BZSPEC(1)	dB		SPL of 1st band.
. . .	. . .		. . .
BZSPEC(N)	dB		SPL of Nth band.

Variable Name	Units	Default Value	Description

The following table is used to define the measured residual jet noise spectrum of a turbofan engine (Note: used only if IRJSPT = 1).

RJSPEC(1)	dB		SPL of 1st band.
. . .	. . .		. . .
RJSPEC(N)	dB		SPL of Nth band.

The following table is used to define the measured aft fan noise of a turbofan engine or aft compressor noise of a turbojet engine (Note: used only if IAFSPT = 1).

FASPEC(1)	dB		SPL of 1st band.
. . .	. . .		. . .
FASPEC(N)	dB		SPL of Nth band.

The following table is used to define the measured core noise spectrum (Note: used only if ICØRE = 1).

CRSPEC(1)	dB		SPL of 1st band.
. . .	. . .		. . .
CRSPEC(N)	dB		SPL of Nth band.

The following table is used to define the measured extraneous noise spectrum (Note: used only if IEXTR = 1).

EXSPEC(1)	dB		SPL of 1st band.
. . .	. . .		. . .
EXSPEC(N)	dB		SPL of Nth band.

A.4.3 User Defined Corrections to Predicted Lining Attenuation

The following table defines the SPL corrections that are to be added to each band of the predicted inlet lining attenuation.

AICDEL	dB	0	A constant SPL correction that is added to all bands of the predicted inlet lining attenuation.

F

Variable Name	Units	Default Value	Description
AISDEL(1)	dB	0	SPL correction for 1st band.
. . .	. . .	. . .	. . .
AISDEL(N)	dB	0	SPL correction for Nth band where N = 8 for 1/1 octave bands or N = 24 for 1/3 octave bands.

The following table defines the SPL corrections that are to be added to each band of the predicted exit lining attenuation.

AACDEL	dB	0	A constant SPL correction that is added to all bands of the predicted exit lining attenuation.
AASDEL(1)	dB	0	SPL correction for 1st band.
. . .	. . .	. . .	. . .
AASDEL(N)	dB	0	SPL correction for Nth band.

A.4.4 User Defined Configuration Corrections

The following table is used to define the configuration correction for primary jet noise (Note: used only if IATNPJ = 1).

APSPEC(1)	dB	0	SPL for 1st band.
. . .	. . .	. . .	. . .
APSPEC(N)	dB	0	SPL for Nth band.

The following table is used to define the configuration correction for secondary jet noise of a turbofan engine (Note: used only if IATNSJ = 1).

ASSPEC(1)	dB	0	SPL for 1st band.
. . .	. . .	. . .	. . .
ASSPEC(N)	dB	0	SPL for Nth band.

Variable Name	Units	Default Value	Description

The following table is used to define the configuration corrections for the inlet fan noise (Note: used only if IATNFI = 1 and ILASPT = 1 in sec. A.3.1).

AISPEC(1)	dB	0	SPL for 1st band.
. . .	. . .	. . .	. . .
AISPEC(N)	dB	0	SPL for Nth band.

The following table is used to define the configuration corrections for the buzz-saw noise of a turbofan engine (Note: used only if IATNBZ = 1).

ABSPEC(1)	dB	0	SPL for 1st band.
. . .	. . .	. . .	. . .
ABSPEC(N)	dB	0	SPL for Nth band.

The following table is used to define the configuration corrections for the residual jet noise of a turbofan engine (Note: used only if IATNRJ = 1).

ARSPEC(1)	dB	0	SPL for 1st band.
. . .	. . .	. . .	. . .
ARSPEC(N)	dB	0	SPL for Nth band.

The following table is used to define the configuration corrections for the aft fan noise of a turbofan engine or aft compressor noise of a turbojet (Note: used only if IATNFA = 1 and IAASPT = 1 in sec. A.3.2).

AASPEC(1)	dB	0	SPL for 1st band.
. . .	. . .	. . .	. . .
AASPEC(N)	dB	0	SPL for Nth band.

The following table is used to define the configuration corrections for the core noise (Note: used only if IATNCR = 1).

ACSPEC(1)	dB	0	SPL for 1st band.
. . .	. . .	. . .	. . .
ACSPEC(N)	dB	0	SPL for Nth band.

Variable Name	Units	Default Value	Description

The following table is used to define the configuration corrections for the extraneous noise (Note: used only if IATNEX = 1).

AESPEC(1)	dB	0	SPL for 1st band.
...	...	...	...
AESPEC(N)	dB	0	SPL for Nth band.

A.4.5 User Defined Atmospheric Conditions

IATMØS		0	Specifies the type of atmospheric conditions. Set equal to: 0 for nonhomogeneous international standard atmosphere (ISA) which is an integral part of the program. 1 for nonhomogeneous ISA plus user defined constants for temperature, pressure, and relative humidity which the program adds to ISA conditions (Note: See DTEMP, DPRES and DHUMID). 2 for nonhomogeneous atmospheric conditions that are defined by the user (Note: See NTEMP, TALT, TEMP NPRES, PALT, PRES, NHUMID, RALT, RHUMID). 3 homogeneous atmosphere of 1 ATM = 14.696 psia; 288.16^{o}K(15^{o}C) = 518.688^{o}R(59^{o}F); 70% R.H. 4 homogeneous atmosphere defined by user (Note: See CPRES, CTEMP and CRHUMD).
DTEMP	^{o}K (^{o}R)		Constant temperature delta that is added to ISA. (Note: Used only if IATMØS = 1).
DPRES	ATM (lb/in^2)		Constant pressure delta that is added to ISA (Note: Used only if IATMØS = 1).

Variable Name	Units	Default Value	Description
DHUMID	% RH		Constant % relative humidity delta that is added to ISA (Note: Used only if IATMØS = 1).
NTEMP			Specifies the number of entries in each of the temperature (TEMP) vs altitude (TALT) tables that have been defined by the user for non-homogeneous atmospheric conditions. There must be at least two entries, but not more than 50 (Note: Used only if IATMØS = 2).
TALT(1) . . . TALT(N)	m (ft) . . . m (ft)		Each entry in this table defines the altitude for the temperature defined by the corresponding entry in the TEMP table (Note: Used only if IATMØS = 2, see NTEMP).
TEMP(1) . . . TEMP(N)	^oK (^oR) . . . ^oK (^oR)		Each entry in this table defines the temperature for the altitude defined by the corresponding entry in the TALT table (Note: Used only if IATMØS = 2, see NTEMP).
NPRES			Specifies the number of entries in each of the pressure (PRES) vs altitude (PALT) tables that have been defined by the user for nonhomogeneous atmospheric conditions. There must be at least two entries, but not more than 50 (Note: Used only if IATMØS = 2).
PALT(1) . . . PALT(N)	m (ft) . . . m (ft)		Each entry in this table defines the altitude for the pressure defined by the corresponding entry in the PRES table (Note: Used only if IATMØS = 2, see NPRES).
PRES(1) . . . PRES(N)	ATM (lb/in^2) . . . ATM (lb/in^2)		Each entry in this table defines the pressure for the altitude defined by the corresponding entry in the PALT table (Note: Used only if IATMØS = 2, see NPRES).
NHUMID			Specifies the number of entries in each of the % relative humidity (RHUMID vs altitude (RALT) tables that have been defined by the user for nonhomogeneous atmospheric conditions. There must be at least two entries, but not more than 50 (Note: Used only if IATMØS = 2).

Variable Name	Units	Default Value	Description
RALT(1) . . . RALT(N)	m (ft) . . . m (ft)		Each entry in this table defines the altitude for the % RH defined by the corresponding entry in the RHUMID table (Note: Used only if IATMØS = 2, see NHUMID).
RHUMID(1) . . . RHUMID(N)	% RH . . . % RH		Each entry in the table defines the % relative humidity for the altitude defined by the corresponding entry in the RALT table (Note: Used only if IATMØS = 2, see NHUMID).
CTEMP	^{o}K (^{o}R)		Temperature of homogeneous atmosphere defined by user. (Note: Used only if IATMØS = 4).
CPRES	ATM (lb/in^2)		Pressure of homogeneous atmosphere defined by user (Note: Used only if IATMØS = 4).
CRHUMD	% RH		Relative humidity of homogeneous atmosphere defined by user (Note: Used only if IATMØS = 4).
IEGA		0	Specifies whether corrections for extra ground attenuation are to be applied while extrapolating the noise level from the airplane to the observer. Set equal to: 0 if EGA 1 if no EGA.
IAIR		0	Specifies whether the air absorption coefficients are calculated by the program or defined by the user. Set equal to: 0 if program calculates 1 if user defines (see UAIRAB) -1 to retain coefficients from previous case.
UAIRAB(1) . . . UAIRAB(N)	dB/KM (dB/1000 ft) . . . dB/KM (dB/1000 ft)		User defined air absorption coefficient for first octave (or 1/3 octave) band (Note: Used only if IAIR = 1). User defined air absorption coefficient for Nth O.B.; N = 8 for 1/1 O.B.; N = 24 for 1/3 O.B.

A.5 DIAGNOSTICS

The following is a list of the diagnostic messages which are printed when various error conditions are detected by the program. The number at the left of the message indicates the error number in the argument to the error routine.

1. CALCULATION FOR MACH NUMBER OF FLOW IN SECONDARY DUCT AFT OF FAN STAGE DOES NOT CONVERGE.

2. TOO MANY TARGET FREQUENCIES SPECIFIED FOR INLET LINING. ONLY FIRST TEN ARE USED.

3. TOO MANY TARGET FREQUENCIES SPECIFIED FOR AFT LINING. ONLY FIRST TEN ARE USED.

4. CALCULATED MACH NUMBER OF FLOW IN SECONDARY DUCT IS NOT WITHIN PROPER RANGE.

5. MUST SPECIFY THE DIAMETER OF DOMINANT NOISE ROTOR STAGE.

6. TOO MANY WALLS SPECIFIED IN INLET LINING. ONLY FIRST TEN ARE USED.

7. TOO MANY WALLS SPECIFIED IN AFT FAN LINING. ONLY FIRST TEN ARE USED.

8. NO WALLS HAVE BEEN DEFINED FOR INLET LINING.

9. NO WALLS HAVE BEEN DEFINED FOR AFT FAN LINING.

10. TOO MANY ENTRIES IN ALTITUDE VS TEMPERATURE TABLE. MAXIMUM ALLOWED IS FIFTY. ISA ATMOSPHERE IS ASSUMED.

11. TOO MANY ENTRIES IN ALTITUDE VS PRESSURE TABLE. MAXIMUM ALLOWED IS FIFTY. ISA ATMOSPHERE IS ASSUMED.

12. TOO MANY ENTRIES IN ALTITUDE VS RELATIVE HUMIDITY TABLE. MAXIMUM ALLOWED IS FIFTY. ISA ATMOSPHERE IS ASSUMED.

13. ALTITUDE VS TEMPERATURE TABLE IS UNDEFINED. MUST HAVE AT LEAST TWO ENTRIES. ISA ATMOSPHERE IS ASSUMED.

14. ALTITUDE VS PRESSURE TABLE IS UNDEFINED. MUST HAVE AT LEAST TWO ENTRIES. ISA ATMOSPHERE IS ASSUMED.

15. ALTITUDE VS RELATIVE HUMIDITY TABLE IS UNDEFINED. MUST HAVE AT LEAST TWO ENTRIES. ISA ATMOSPHERE IS ASSUMED.

16. TOO MANY OBSERVERS SPECIFIED. ONLY FIRST TEN ARE USED.

17. BAD INPUT OF RANGE DATA FOR PNL TO EPNL TRANSFER CURVE.

A.6 MACHINE REQUIREMENTS

This program is available in both an IBM 360 version and a CDC 6600 version. Requirements to run the program are basically the same on either machine. If the 360 version is used, approximately 200K decimal bytes are needed for field length; for the CDC 6600 version, a field length of 105K octal is needed. Data input for both versions is through cards; output is on the printer. Should the optional file of noise data versus engine pressure ratio, off-axis range, and elevation angle be desired, files (tape 20 and 21) and punch file (tape 22) must be available for use by the program.

A.7 OPERATING SYSTEM

An IBM 360 version runs under the MVT operating system on the 360-75W and a CDC 6600 version runs under the KRONOS 3.1 operating system on the CDC 6600 computer.

A.8 RESOURCE ESTIMATES

The central processor (CP) time required to process a job depends upon which program options are used. The major factors influencing the time are:

1. Type of jet engine
2. 1/1 or 1/3 octave bands for predicted noise spectra
3. Number of observer stations
4. Type of atmospheric conditions

The sample cases shown in Sec A.11 and A.12 required 3.45 CP seconds of execution time on the IBM 360-75W. For more lengthy jobs, the following equation may be used to estimate the number of CP seconds required to process a job containing "n" cases

$$T = 1.5 + \sum_{i=1}^{n} [S_i T_i (1.5 + 0.3 N_i) + A_i]$$

where $S_i = \begin{cases} 1 \text{ for } 1/3 \text{ octaves} \\ 0.5 \text{ for full octaves} \end{cases}$

$T_i = \begin{cases} 1 \text{ for turbofan engine} \\ 0.66 \text{ for turbojet engine} \end{cases}$

N_i = number of observer stations

$A_i = \begin{cases} 0 \text{ .... homogeneous atmosphere} \\ \text{largest of} \\ 0.014\ (C|T_N - T_1| + |RH_N - RH_1|) \text{ or } 0.15 \text{ .. nonhomogeneous atmosphere} \end{cases}$

where T and RH are temperatures and relative humidities at the aircraft altitude and ground level. If T is in ^{o}K, C=1.8; or C=1 for T given in ^{o}R.

The number of pages of printed output also depends upon which program options are used. The following equation may be used to estimate the total number of pages for a job of "n" cases.

$$P = \sum_{i=1}^{n} (4 + 4L_i + 2N_i)$$

where

L = 0 if engine does not have linings or configuration corrections
= 1 if engine has linings or configuration corrections

N = number of observer stations

Should the optional file of noise data versus engine pressure ratio, off-axis range, and elevation angle be generated, one record (80 col) per case will be generated on a file (TAPE20). This file may be punched on cards or written to tape or disc for additional processing by the postprocessor part of the source noise prediction program. This data is then compatible with the Noise Contour Program.

A.9 PROGRAM RESTRICTIONS

1. Maximum number of observers along the sideline is 10.
2. When defining the linings geometrically, the maximum number of walls is 10.
3. If the program calculates the lining attenuation, the maximum number of target frequencies that may be specified is 10.
4. When defining the EPNL transfer curve, the maximum number of points is 10.
5. When the user defines the nonhomogeneous atmospheric tables, the minimum number of entries per table is 2 and the maximum number is 50.

A.10 CONTROL CARDS

IBM job control language constructions are listed below to run the noise source estimation program on an IBM 360/67 or IBM 360-75W machine.

```
Col
1
//JOBNAME       (format per installation)
//EXEC PGM = IE BG ENER
//SYSPRINT   DD  SYSØUT = A
//SYSIN      DD  DUMMY
//SYSUT2     DD  UNIT = SYSDA, DSN = & CARDS, SPACE = (TRK, (5, 1)),
//DCB = (LRECL=80, RECFM=FB, BLKSIZE=400), DISP=(NEW, PASS)
//SYSUT1     DD  *
   {input DATA }
   {to TEE187C }
/*
//EXEC PGM=IEBGENER                    {this step prints out the  }
//SYSPRINT   DD  SYSØUT=A              {input Data to TEE187C     }
//SYSIN      DD  DUMMY
//SYSUT2     DD  SYSØUT=A, DCB=BLKSIZE=400
//SYSUT1     DD  DSN=& CARDS, DISP=(ØLD, PASS)
//EXEC FØRTGLG,TIME=4,REGIØN=200K
//LKED.SYSIN DD *
    {Binary   Approx 2 card boxes}
    {Deck     for TEE187C        }
/*
//GØ.FT20F001  DD UNIT=SYSDA,DSN=&&TAPE20, DISP=(,PASS),
//SPACE=(400,(80,800)),DCB=(LRECL=80,BLKSIZE=400,RECFM=FB)
    {The above JCL card needed if optional level versus engine pressure }
    {ratio, off-axis range, and elevation angle data is generated.     }
//GØ.SYSIN DD  DSN = & CARDS, DISP = (ØLD,DELETE)
/*
```

{The following control cards are needed only if the optional noise level versus engine pressure ratio, off-axis range, and elevation angle data is generated. This data is precompiled as a data array subroutine for the Noise Contour program, TEE227, and punched out as a source (EBCDIC) deck to be run on either the IBM 360 version or the real time SIGMA VII version of TEE227.}

```
Col
1
//EXEC FØRTGLG,TIME=1,REGIØN=110K
//LKED.SYSIN DD *
   {Binary   TEE187C       }
   {Deck     Postprocessor }
```

```
/*
//GØ.FT20F001  DD DSN=&&TAPE20,DISP=(ØLD,DELETE)
//GØFT21F001  DD UNIT=SYSDA,DSN=&&TAPE21,DISP=(,DELETE),
//SPACE=(400,(80,80)),DCB=(LRECL=80,BLKSIZE=400,RECFM=FB)
//GØFT22F001  DD  UNIT=SYSDA,DSN=&&TAPE22, DISP(NEW, PASS),
//SPACE=(400,(80,80)), DCB=(LRECL=80, BLKSIZE=400, RECFM=FB)
//EXEC PGM=IEBGENER (Punches the data routine generated for real time TEE 227)
//SYSPRINT DD SYSØUT=A
//SYSIN       DD DUMMY
//SYSUT2      DD SYSØUT=B,DCB=(LRECL=90,BLKSIZE=400,RECFM=FB)
//SYSUT1      DD  UNIT=SYSDA,DSN=&&TAPE22,DISP=(ØLD,PASS)
//EXEC PGM=IEBGENER (Listing of the data routine generated for TEE 227)
//SYSPRINT DD SYSØUT=A
//SYSIN       DD  DUMMY
//SYSUT2      DD  SYSØUT=A,DCB=(LRECL=80,BLKSIZE=400,RECFM=FB)
//SYSUT1      DD  UNIT=SYSDA,DSN=&&TAPE22,DISP=(ØLD,PASS)
//EXEC FØRTGC,PRAM.FØRT='MAP,DECK',TIME=1,REGIØN=110K
//FØRT.SYSIN  DD  DSN=&&TAPE22,DISP=(ØLD,DELETE)
/*    { The last job step produced a binary deck of a data routine }
      { for the 360/version of TEE 227.                            }
```

A.10.1 Sample TSS Input Data for the IBM 360/67 Computer

```
  LOGON FSAEJJ35,     ...
GETNEWS *UPDATE
DDEF FT20F001,VS,DSNAME=JJTAPE20
CALL MAIN$$
 CONCORDE OL593 NOISE (PRELIM. CYCLE DATA, 15 OCT 68)  M.K.S. UNITS
 &PARAM IUNIT=0,ELEV=0,ALT=121.92,SLOPE=.287,DELTAE=16,ENG=4,AMACH=.3,
        NOBS=1,SLDIST(1)=457.2,IATMOS=1,DTEMP=10,ITENG=1,IPARM=0,
        IFLTGD=1,ISPTRM=1,IDOPLR=1,D=1.2141,B=40,VTO=392.58,PT1PSO=3.46,
        TT1=1166.7,A1=.49518,IDMP=1,NLOPT=1,
   IDMP = 0,
     &END
 G.E. TF800 NOISE (PRELIM. CYCLE DATA, 14 OCT 68)
 &PARAM ALT=152.4,SLOPE=.203,DELTAE=10,AMACH=.264,ITENG=0,IOPTS=2,IND=1,
        IGV=1,IATNFI=1,IATNFA=1,D=1.6891,B=44,S=55,VTO=465.61,
        PTFPTO=1.95,AF=1.0684,A1=.63081,A2=1.0359,AI=1.6723,PT1PSO=1.98,
        PT2PSO=2.44,TT1=1033.3,TT2=1930.6,GAMMA2=1.3,ELOHI=6,EDHI=.25786,
        ELOHA=6,EDHA=.2838, &END
 SAME EXCEPT LINING GEOMETRY IS SPECIFIED
 &PARAM LGMINF=1,NWLINF=3,RINF(1)=.25786,.51572,.77358,TLINF(1)=.77358,
        .77358,.77358,LGMAFT=1,NWLAFF=2,RAFF(1)=.44806,.73152,TLAFF(1)=
        1.7038,1.7038, &END
 MEASURED INPUT SAMPLE CASE
 &PARAM IATMOS=2,NTEMP=2,TALT(1)=0,304.8,TEMP(1)=288.89,277.78,NPRES=2,
        PALT(1)=0,304.8,PRES(1)=1.0207,.95264,NHUMID=2,RALT(1)=0,304.8,
        RHUMID(1)=70,60,IEGA=1,UAIRAB(1)=0,3.2808,6.5617,9.8425,13.123,
        16.404,19.685,22.966,26.247,IAIR=1,IPARM=1,IGV=0,ICORE=1,IEXTR=1,
        IEXQD=1,IPJSPT=1,ISJSPT=1,IIFSPT=1,IBZSPT=1,IAFSPT=1,IRJSPT=1,
        IATNPJ=1,IATNSJ=1,IATNFI=1,IATNBZ=1,IATNRJ=1,IATNCR=1,IATNEX=1.
        IATNFA=1,DAITJ=55,DAETJ=125,AX1=.6336,AX2=1.0814,VJX1=612.28,
        VJX2=945.25,W1=152.41,W2=225.62,ILASPT=1,IAASPT=1,PJCDEL=10,
        PJSDEL(4)=10,SJCDEL=10,SJSDEL(4)=10,FICDEL=10,FISDEL(4)=10,
        BZCDEL=10,BZSDEL(4)=10,RJCDEL=10,RJSDEL(4)=10,FACDEL=10,
        FASDEL(4)=10,EXCDEL=10,EXSDEL(4)=10,CRCDEL=10,CRSDEL(4)=10,
        PJSPEC(1)=8*100,SJSPEC(1)=8*100,FISPEC(1)=8*100,BZSPEC(1)=8*100,
        RJSPEC(1)=8*100,FASPEC(1)=8*100,CRSPEC(1)=8*100,EXSPEC(1)=8*100,
        AICDEL=10,AISDEL(3)=-10,5,-10,AACDEL=10,AASDEL(3)=-10,5,-10,
        APSPEC(5)=10,ASSPEC(5)=10,AISPEC(5)=10,ABSPEC(5)=10,ARSPEC(5)=10,
        AASPEC(5)=10,ACSPEC(5)=10,AESPEC(5)=10,NTCP=3,RO(1)=.3048,304.8,
        609.6,DEPNL(1)=-10,10,-10, &END
%END
PUNCH JJTAPE20, ERASE=N
  LOGOFF
```

A.11 SAMPLE INPUT DATA

```
SAMPLE NO.1  TURBOJET (UNSUPPRESSED)  MKS UNITS
&PARAM ALT=121.92,SLOPE=.287,DELTAE=16,ENG=4,AMACH=.3,NOBS=1,
       SLDIST(1)=457.2,IATMOS=1,DTEMP=10,ITENG=1,IFLTGD=1,ISPTRM=1,
       IDOPLR=1,D=1.2141,B=40,VTO=392.58,PT1PSO=3.46,TT1=1166.7,
       A1=.49518,NLOPT=1,AI=.9725, &END
SAMPLE NO.2  SAME EXCEPT SUPPRESSED
&PARAM IATNPJ=1,IATNFI=1,LGMINF=1,NWLINF=3,RINF(1)=.2428,.4623,.607,
       TLINF(1)= .8,1.0,1.2,APSPEC(1)=6,6.5,7,7.5,6,5,4.3,3.5, &END
SAMPLE NO.3  TURBOFAN (SUPPRESSED)  MKS UNITS
&PARAM NTFINF=0,ALT=152.4,SLOPE=.203,DELTAE=10,AMACH=.264,ITENG=0,
       IOPTS=2,IND=1,IGV=1,IATNFA=1,D=1.6891,B=44,S=55,VTO=465.61,
       PTFPTO=1.95,AF=1.3,A1=0.631,A2=1.036,AI=1.7,PT1PSO=1.98,
       PT2PSO=2.44,TT1=1033.3,TT2=1930.6,GAMMA2=1.3,LGMINF=0,ELOHI=6,
       EDHI=.258,ELOHA=6,EDHA=.284,IATNSJ=1,ASSPEC(1)=5,6,7,8,6,5,4,4, &END
SAMPLE NO.4  ALL MEASURED INPUT
&PARAM IATMOS=2,NTEMP=2,TALT(1)=0,304.8,TEMP(1)=288.9,277.8,NPRES=2,
       PALT(1)=0,304.8,PRES(1)=1.021,.953,NHUMID=2,RALT(1)=0,304.8,
       RHUMID(1)=70,60,IEGA=1,UAIRAB(1)=0,3.3,6.6,9.8,13.1,16.4,19.7,
       23,26.2,IAIR=1,IGV=0,ICORE=1,IEXTR=1,IEXQD=1,IPJSPT=1,ISJSPT=1,
       IIFSPT=1,IBZSPT=1,IAFSPT=1,IRJSPT=1,IATNBZ=1,IATNRJ=1,IATNCR=1,
       IATNEX=1,DAITF=65,DAETF=120,ILASPT=1,IAASPT=1,PJSPEC(1)=8*100,
       SJSPEC(1)=8*100,FISPEC(1)=8*100,BZSPEC(1)=8*100,RJSPEC(1)=8*100,
       FASPEC(1)=8*100,CRSPEC(1)=8*100,EXSPEC(1)=8*100,APSPEC(1)=2*0,
       -10,5,-10,3*0,ASSPEC(1)=2*0,-10,5,-10,3*0,AISPEC(3)=-10,5,-10,
       ABSPEC(3)=-10,5,-10,ARSPEC(3)=-10,5,-10,AASPEC(3)=-10,5,-10,
       ACSPEC(3)=-10,5,-10,AESPEC(3)=-10,5,-10,NTCP=3,RO(1)=152.4,
       304.8,609.6,DEPNL(1)=-10,10,-10, &END
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A.12 SAMPLE OUTPUT DATA

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                              NOISE PREDICTION FROM JET ENGINE PARAMETERS                         PAGE   1
                                        (PROGRAM TEE187C)

SAMPLE NO.1  TURBOJET (UNSUPPRESSED)  MKS UNITS

INPUT OR ASSUMED VALUES

   FLIGHT PATH PARAMETERS

      GROUND ELEVATION FROM SEA LEVEL . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .      0.0   M
      ALTITUDE OF AIRPLANE ABOVE GROUND WHEN AT Y=0 . . . . . . . . . . . . . . . . . . . . . . . . . .    121.920 M
      CLIMB GRADIENT. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .      0.287
      ANGLE BETWEEN ENGINE AXIS AND HORIZONTAL. . . . . . . . . . . . . . . . . . . . . . . . . . . . .     16.000 DEG
      NUMBER OF ENGINES . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .      4.0
      MACH NUMBER OF AIRCRAFT . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .      0.300
      NUMBER OF OBSERVERS . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .      1
      SIDELINE DISTANCE OF OBSERVERS (M )
              457.2

   ATMOSPHERIC CONDITIONS

      INTERNATIONAL STANDARD ATMOSPHERE PLUS    10.000 DEG K,     0.0   S. ATM. , AND     0.0   PERCENT RELATIVE HUMIDITY
      EXTRA GROUND ATTENUATION

   TURBOJET ENGINE PERFORMANCE PARAMETERS

      FLIGHT SPECTRUM CURVE USED IN JET NOISE CALCULATIONS
      PRIMARY JET OASPL CALCULATED BY USING EXHAUST VELOCITY RELATIVE TO AMBIENT AIR AND CURVE NO.  1
      TURBOMACHINERY NOISE FLIGHT EFFECTS ARE APPLIED DURING EXTRAPOLATION
      DIRECTIVITY ANGLE OF INLET QUADRANT . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .     70.000 DEG
      DIRECTIVITY ANGLE OF EXIT QUADRANT. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .    130.000 DEG
      MECHANICAL TIP SPEED OF DOMINATE-NOISE ROTOR STAGE. . . . . . . . . . . . . . . . . . . . . . . .    392.579 M /SEC
      NUMBER OF BLADES ON DOMINATE-NOISE ROTOR STAGE. . . . . . . . . . . . . . . . . . . . . . . . . .     40.000
      DIAMETER OF DOMINATE-NOISE ROTOR STAGE. . . . . . . . . . . . . . . . . . . . . . . . . . . . . .      1.214 M
      RATIO OF SPECIFIC HEATS FOR AMBIENT AIR . . . . . . . . . . . . . . . . . . . . . . . . . . . . .      1.400
      ENGINE PRESSURE RATIO   . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .      3.251
      RATIO OF SPECIFIC HEATS FOR PRIMARY FLOW. . . . . . . . . . . . . . . . . . . . . . . . . . . . .      1.300
      PRIMARY NOZZLE PRESSURE RATIO . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .      3.460
      TOTAL TEMPERATURE AT PRIMARY EXIT . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .   1166.699 DEG K
      EXIT AREA FOR PRIMARY NOZZLE. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .      0.495 SQ M
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SAMPLE NO.1 TURBOJET (UNSUPPRESSED) MKS UNITS

CALCULATED VALUES

STATIC TEMPERATURE AT AIRPLANE ALTITUDE	296.971 DEG K
STATIC TEMPERATURE AT GROUND LEVEL	298.160 DEG K
RELATIVE HUMIDITY AT AIRPLANE ALTITUDE	69.207 PERCENT
RELATIVE HUMIDITY AT GROUND LEVEL	70.000 PERCENT
STATIC PRESSURE AT AIRPLANE ALTITUDE	0.986 S. ATM.
SPEED OF SOUND AT AIRPLANE ALTITUDE	345.457 M /SEC
AVERAGE SPEED OF SOUND PROPOGATION FROM AIRPLANE TO OBSERVERS ON GROUND	345.802 M /SEC
VELOCITY OF AIRPLANE	103.637 M /SEC
VELOCITY OF PRIMARY EXHAUST RELATIVE TO AMBIENT AIR	746.603 M /SEC
VELOCITY OF PRIMARY EXHAUST RELATIVE TO NOZZLE	850.240 M /SEC
FULLY EXPANDED PRIMARY NOZZLE EXIT AREA	0.584 SQ M
DENSITY OF PRIMARY FLOW	0.39725 KG/CU M
MASS FLOW THROUGH PRIMARY NOZZLE	197.359 KG/SEC
MACH NUMBER OF FLOW AT PRIMARY EXIT	1.487
TOTAL THRUST	147352.4 N
FUNDAMENTAL BLADE PASSAGE FREQUENCY	4117.0 HZ

AVERAGE AIR ABSORPTION COEFFICIENTS (DB/KM)

0.36	0.72	1.44	2.88	5.82	11.89	24.88	38.86

BAND CENTER FREQUENCIES (HZ)

63.0	125.0	250.0	500.0	1000.0	2000.0	4000.0	8000.0

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                         NOISE PREDICTION FROM JET ENGINE PARAMETERS                                   PAGE    3
                                      (PROGRAM TEE187C)

 SAMPLE NO.1  TURBOJET (UNSUPPRESSED)  MKS UNITS

BARE ENGINE SPECTRA ( 61 M  OFF-AXIS, 1 ENG, INDEX, DB RE. 20 MICRO-N/SQ M)

          INLET QUADRANT NOISE (DIRECTIVITY ANGLE =   70.0 DEG)

             COMPRESSOR (PREDICTED)                    OVERALL SPL =  112.5 DB
               SPL SPECTRUM (DB)
                    87.6      89.6      91.7      93.8      96.0     102.3     109.2     108.3

          EXIT QUADRANT NOISE (DIRECTIVITY ANGLE =  130.0 DEG)

             JET (PREDICTED)                           OVERALL SPL =  136.0 DB     10 * LOG10(AX/AR *(RHO/RHOR)**2) =     -24.1 DB
               SPL SPECTRUM (DB)
                   121.4     127.6     130.4     130.2     128.1     124.9     121.1     117.7
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                         NOISE PREDICTION FROM JET ENGINE PARAMETERS                                   PAGE    4
                                      (PROGRAM TEE187C)

 SAMPLE NO.1  TURBOJET (UNSUPPRESSED)  MKS UNITS

EXTRAPOLATED SPECTRA (4. ENGINE OPERATION, DB RE. 20 MICRO-N/SQ M)
     SIDELINE POSITION OF OBSERVER =     457.2 M       OFF-AXIS RANGE =     472.0 M , EPNL =  123.3 EPNDB

          INLET QUADRANT NOISE (DIRECTIVITY ANGLE =   70.0 DEG)
          TIME HEARD =     -0.529 SEC (RELATIVE TO TIME WHEN A/C IS AT Y = 0)
          POSITION OF AIRPLANE (Y,Z) = (    -197.4,      65.3) M

             COMPRESSOR                    OVERALL SPL =    86.3 DB      PNL =    99.2 PNDB      TONE CORRECTED PNL = ****** PNDB
               SPL SPECTRUM (DB)
                    75.0      76.0      76.9      77.1      76.8      79.6      79.9      73.4

          EXIT QUADRANT NOISE (DIRECTIVITY ANGLE =  130.0 DEG)
          TIME HEARD =      5.279 SEC (RELATIVE TO TIME WHEN A/C IS AT Y = 0)
          POSITION OF AIRPLANE (Y,Z) = (     348.4,     221.9) M

             JET                           OVERALL SPL =  118.2 DB      PNL =  123.3 PNDB      TONE CORRECTED PNL = ****** PNDB
               SPL SPECTRUM (DB)
                   106.8     112.1     113.9     111.7     106.9     100.6      88.8      76.8

             COMPOSITE                     OVERALL SPL =  118.2 DB      PNL =  123.3 PNDB      TONE CORRECTED PNL = ****** PNDB
               SPL SPECTRUM (DB)
                   106.8     112.1     113.9     111.7     106.9     100.6      88.8      76.8
```

SAMPLE NO.2 SAME EXCEPT SUPPRESSED

INPUT OR ASSUMED VALUES

FLIGHT PATH PARAMETERS

GROUND ELEVATION FROM SEA LEVEL	0.0 M
ALTITUDE OF AIRPLANE ABOVE GROUND WHEN AT Y=0	121.920 M
CLIMB GRADIENT.	0.287
ANGLE BETWEEN ENGINE AXIS AND HORIZONTAL.	16.000 DEG
NUMBER OF ENGINES	4.0
MACH NUMBER OF AIRCRAFT	0.300
NUMBER OF OBSERVERS	1
SIDELINE DISTANCE OF OBSERVERS (M)	
457.2	

ATMOSPHERIC CONDITIONS

INTERNATIONAL STANDARD ATMOSPHERE PLUS 10.000 DEG K, 0.0 S. ATM. , AND 0.0 PERCENT RELATIVE HUMIDITY
EXTRA GROUND ATTENUATION

TURBOJET ENGINE PERFORMANCE PARAMETERS

FLIGHT SPECTRUM CURVE USED IN JET NOISE CALCULATIONS
PRIMARY JET OASPL CALCULATED BY USING EXHAUST VELOCITY RELATIVE TO AMBIENT AIR AND CURVE NO. 1
TURBOMACHINERY NOISE FLIGHT EFFECTS ARE APPLIED DURING EXTRAPOLATION

DIRECTIVITY ANGLE OF INLET QUADRANT	70.000 DEG
DIRECTIVITY ANGLE OF EXIT QUADRANT.	130.000 DEG
MECHANICAL TIP SPEED OF DOMINATE-NOISE ROTOR STAGE.	392.579 M /SEC
NUMBER OF BLADES ON DOMINATE-NOISE ROTOR STAGE.	40.000
DIAMETER OF DOMINATE-NOISE ROTOR STAGE.	1.214 M
RATIO OF SPECIFIC HEATS FOR AMBIENT AIR	1.400
ENGINE PRESSURE RATIO	3.251
RATIO OF SPECIFIC HEATS FOR PRIMARY FLOW.	1.300
PRIMARY NOZZLE PRESSURE RATIO	3.460
TOTAL TEMPERATURE AT PRIMARY EXIT	1166.699 DEG K
INLET AREA.	0.973 SQ M
EXIT AREA FOR PRIMARY NOZZLE.	0.495 SQ M
MACH NUMBER IN THE INLET DUCT	0.576

SAMPLE NO.2 SAME EXCEPT SUPPRESSED

CALCULATED VALUES

STATIC TEMPERATURE AT AIRPLANE ALTITUDE	296.971 DEG K
STATIC TEMPERATURE AT GROUND LEVEL	298.160 DEG K
RELATIVE HUMIDITY AT AIRPLANE ALTITUDE	69.207 PERCENT
RELATIVE HUMIDITY AT GROUND LEVEL	70.000 PERCENT
STATIC PRESSURE AT AIRPLANE ALTITUDE	0.986 S. ATM.
SPEED OF SOUND AT AIRPLANE ALTITUDE	345.457 M /SEC
AVERAGE SPEED OF SOUND PROPOGATION FROM AIRPLANE TO OBSERVERS ON GROUND	345.802 M /SEC
VELOCITY OF AIRPLANE	103.637 M /SEC
VELOCITY OF PRIMARY EXHAUST RELATIVE TO AMBIENT AIR	746.603 M /SEC
VELOCITY OF PRIMARY EXHAUST RELATIVE TO NOZZLE	850.240 M /SEC
FULLY EXPANDED PRIMARY NOZZLE EXIT AREA	0.584 SQ M
DENSITY OF PRIMARY FLOW	0.39725 KG/CU M
MASS FLOW THROUGH PRIMARY NOZZLE	197.359 KG/SEC
MACH NUMBER OF FLOW AT PRIMARY EXIT	1.487
TOTAL THRUST	147352.4 N
FUNDAMENTAL BLADE PASSAGE FREQUENCY	4117.0 HZ

AVERAGE AIR ABSORPTION COEFFICIENTS (DB/KM)

0.36	0.72	1.44	2.88	5.82	11.89	24.88	38.86

BAND CENTER FREQUENCIES (HZ)

63.0	125.0	250.0	500.0	1000.0	2000.0	4000.0	8000.0

```
SAMPLE NO.2  SAME EXCEPT SUPPRESSED

BARE ENGINE SPECTRA ( 61 M  OFF-AXIS, 1 ENG, INDEX, DB RE. 20 MICRO-N/SQ M)

          INLET QUADRANT NOISE (DIRECTIVITY ANGLE =   70.0 DEG)

             COMPRESSOR (PREDICTED)                      OVERALL SPL =  112.5 DB
               SPL SPECTRUM (DB)
                    87.6      89.6      91.7      93.8      96.0     102.3     109.2     108.3

          EXIT QUADRANT NOISE (DIRECTIVITY ANGLE =  130.0 DEG)

             JET (PREDICTED)                             OVERALL SPL =  136.0 DB      10 * LOG10(AX/AR *(RHO/RHOR)**2) =      -24.1 DB
               SPL SPECTRUM (DB)
                   121.4     127.6     130.4     130.2     128.1     124.9     121.1     117.7
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```
SAMPLE NO.2  SAME EXCEPT SUPPRESSED

CONFIGURATION EFFECTS

    LINING TREATMENT

        INLET
            TARGET FREQUENCIES (HZ)
                 4117.023

            PERCENTAGE OF LINING TREATED FOR THE ABOVE TARGET FREQUENCIES
                  100.000
            MULTIPLE DESIGN POINT OPTION USED

            DIRECTIVITY ANGLE . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .    70.000 DEG
            INLET DUCT MACH NUMBER. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .    -0.576
            SPEED OF SOUND IN INLET DUCT. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .   337.526 M /SEC

            RADII OF WALLS IN LINING  (M .   -   OUTERMOST WALL FIRST)
                    0.607    0.462    0.243

            TREATMENT LENGTH OF WALLS (M .   -   OUTERMOST WALL FIRST)
                    1.200    1.000    0.800

            LINING ATTENUATION (PREDICTED - DB)
                 0.3      0.6      1.0      1.7      3.8      8.7      15.0      9.3

    CORRECTIONS

        EXIT

            PRIMARY JET (MEASURED - DB)
                 6.0      6.5      7.0      7.5      6.0      5.0      4.3      3.5
```

SAMPLE-NO.2 SAME EXCEPT SUPPRESSED

SUPPRESSED ENGINE SPECTRA (61 M OFF-AXIS, 1 ENG, INDEX, DB RE. 20 MICRO-N/SQ M)

INLET QUADRANT NOISE (DIRECTIVITY ANGLE = 70.0 DEG)

COMPRESSOR OVERALL SPL = 102.7 DB
SPL SPECTRUM (DB)

87.3	89.0	90.7	92.1	92.2	93.5	94.1	99.0

EXIT QUADRANT NOISE (DIRECTIVITY ANGLE = 130.0 DEG)

JET OVERALL SPL = 129.6 DB
SPL SPECTRUM (DB)

115.4	121.1	123.4	122.7	122.1	119.9	116.8	114.2

```
SAMPLE NO.2  SAME EXCEPT SUPPRESSED

EXTRAPOLATED SPECTRA (4. ENGINE OPERATION, DB RE. 20 MICRO-N/SQ M)
     SIDELINE POSITION OF OBSERVER =     457.2 M      OFF-AXIS RANGE =      472.0 M , EPNL =  116.9 EPNDB

          INLET QUADRANT NOISE (DIRECTIVITY ANGLE =   70.0 DEG)
          TIME HEARD =    -0.529 SEC (RELATIVE TO TIME WHEN A/C IS AT Y = 0)
          POSITION OF AIRPLANE (Y,Z) = (   -197.4,     65.3) M

             COMPRESSOR                    OVERALL SPL =   82.7 DB     PNL =   91.1 PNDB     TONE CORRECTED PNL = ****** PNDB
               SPL SPECTRUM (DB)
                    74.7      75.5      76.0      75.6      73.4      71.8      65.3      63.2

          EXIT QUADRANT NOISE (DIRECTIVITY ANGLE =  130.0 DEG)
          TIME HEARD =     5.279 SEC (RELATIVE TO TIME WHEN A/C IS AT Y = 0)
          POSITION OF AIRPLANE (Y,Z) = (    348.4,    221.9) M

             JET                           OVERALL SPL =  111.4 DB     PNL =  116.9 PNDB     TONE CORRECTED PNL = ****** PNDB
               SPL SPECTRUM (DB)
                   100.8     105.6     106.9     104.2     100.9      95.6      84.5      73.3

             COMPOSITE                     OVERALL SPL =  111.4 DB     PNL =  116.9 PNDB     TONE CORRECTED PNL = ****** PNDB
               SPL SPECTRUM (DB)
                   100.8     105.6     106.9     104.2     100.9      95.6      84.5      73.3
```

SAMPLE NO.3 TURBOFAN (SUPPRESSED) MKS UNITS

INPUT OR ASSUMED VALUES

FLIGHT PATH PARAMETERS

GROUND ELEVATION FROM SEA LEVEL	0.0 M
ALTITUDE OF AIRPLANE ABOVE GROUND WHEN AT Y=0	152.400 M
CLIMB GRADIENT	0.203
ANGLE BETWEEN ENGINE AXIS AND HORIZONTAL	10.000 DEG
NUMBER OF ENGINES	4.0
MACH NUMBER OF AIRCRAFT	0.264
NUMBER OF OBSERVERS	1

SIDELINE DISTANCE OF OBSERVERS (M)
457.2

ATMOSPHERIC CONDITIONS

INTERNATIONAL STANDARD ATMOSPHERE PLUS 10.000 DEG K, 0.0 S. ATM. , AND 0.0 PERCENT RELATIVE HUMIDITY
EXTRA GROUND ATTENUATION

TURBOFAN ENGINE PERFORMANCE PARAMETERS

FLIGHT SPECTRUM CURVE USED IN JET NOISE CALCULATIONS
ENGINE HAS INLET GUIDE VANES
PRIMARY JET OASPL CALCULATED BY USING EXHAUST VELOCITY RELATIVE TO AMBIENT AIR AND CURVE NO. 1
SECONDARY JET OASPL CALCULATED BY USING EXHAUST VELOCITY RELATIVE TO AMBIENT AIR AND CURVE NO. 3
FAN OASPL CALCULATED BY USING SINGLE STAGE FAN PRESSURE RATIO
TURBOMACHINERY NOISE FLIGHT EFFECTS ARE APPLIED DURING EXTRAPOLATION

DIRECTIVITY ANGLE OF INLET QUADRANT	60.000 DEG
DIRECTIVITY ANGLE OF EXIT QUADRANT	110.000 DEG
MECHANICAL TIP SPEED OF DOMINATE-NOISE ROTOR STAGE	465.609 M /SEC
NUMBER OF BLADES ON DOMINATE-NOISE ROTOR STAGE	44.000
DIAMETER OF DOMINATE-NOISE ROTOR STAGE	1.689 M
MINIMUM ROTOR-VANE SPACING IN PERCENT OF ROTOR BLADE AXIAL PROJECTED CHORD LENGTH	55.000 PERCENT
RATIO OF SPECIFIC HEATS FOR PRIMARY FLOW	1.300
RATIO OF SPECIFIC HEATS FOR SECONDARY FLOW	1.300
ENGINE PRESSURE RATIO	1.886
PRIMARY NOZZLE PRESSURE RATIO	1.980
SECONDARY NOZZLE PRESSURE RATIO	2.440
FAN PRESSURE RATIO	1.950
TOTAL TEMPERATURE AT PRIMARY EXIT	1033.299 DEG K
TOTAL TEMPERATURE AT SECONDARY EXIT	1930.599 DEG K
TOTAL TEMPERATURE AT FAN STAGE	300.806 DEG K
EXIT AREA FOR PRIMARY NOZZLE	0.631 SQ M
EXIT AREA FOR SECONDARY NOZZLE	1.036 SQ M
INLET AREA	1.700 SQ M
FAN DISCHARGE AREA	1.300 SQ M

SAMPLE NO.3 TURBOFAN (SUPPRESSED) MKS UNITS

CALCULATED VALUES

STATIC TEMPERATURE AT AIRPLANE ALTITUDE	296.674	DEG K
STATIC TEMPERATURE AT GROUND LEVEL	298.160	DEG K
RELATIVE HUMIDITY AT AIRPLANE ALTITUDE	69.009	PERCENT
RELATIVE HUMIDITY AT GROUND LEVEL	70.000	PERCENT
STATIC PRESSURE AT AIRPLANE ALTITUDE	0.982	S. ATM.
SPEED OF SOUND AT AIRPLANE ALTITUDE	345.284	M /SEC
AVERAGE SPEED OF SOUND PROPOGATION FROM AIRPLANE TO OBSERVERS ON GROUND	345.716	M /SEC
VELOCITY OF AIRPLANE	91.155	M /SEC
VELOCITY OF PRIMARY EXHAUST RELATIVE TO AMBIENT AIR	521.161	M /SEC
VELOCITY OF PRIMARY EXHAUST RELATIVE TO NOZZLE	612.281	M /SEC
VELOCITY OF SECONDARY EXHAUST RELATIVE TO AMBIENT AIR	854.135	M /SEC
VELOCITY OF SECONDARY EXHAUST RELATIVE TO NOZZLE	945.257	M /SEC
FULLY EXPANDED PRIMARY NOZZLE EXIT AREA	0.633	SQ M
FULLY EXPANDED SECONDARY NOZZLE EXIT AREA	1.081	SQ M
DENSITY OF PRIMARY FLOW	0.39292	KG/CU M
DENSITY OF SECONDARY FLOW	0.22068	KG/CU M
MASS FLOW THROUGH PRIMARY NOZZLE	152.381	KG/SEC
MASS FLOW THROUGH SECONDARY NOZZLE	225.555	KG/SEC
MACH NUMBER OF FLOW AT PRIMARY EXIT	1.067	
MACH NUMBER OF FLOW AT SECONDARY EXIT	1.234	
THRUST FROM PRIMARY JET EXHAUST	79416.1	N
THRUST FROM SECONDARY JET EXHAUST	192658.3	N
TOTAL THRUST	272074.4	N
FUNDAMENTAL BLADE PASSAGE FREQUENCY	3860.7	HZ
FUNDAMENTAL BUZZ-SAW FREQUENCY	1286.9	HZ

AVERAGE AIR ABSORPTION COEFFICIENTS (DB/KM)

0.36	0.72	1.43	2.87	5.80	11.86	24.80	38.92

BAND CENTER FREQUENCIES (HZ)

63.0	125.0	250.0	500.0	1000.0	2000.0	4000.0	8000.0

SAMPLE NO.3 TURBOFAN (SUPPRESSED) MKS UNITS

BARE ENGINE SPECTRA (61 M OFF-AXIS, 1 ENG, INDEX, DB RE. 20 MICRO-N/SQ M)

INLET QUADRANT NOISE (DIRECTIVITY ANGLE = 60.0 DEG)

FAN (PREDICTED) — OVERALL SPL = 109.5 DB
SPL SPECTRUM (DB)

87.6	88.7	90.7	92.8	95.1	99.7	106.1	104.9

RESIDUAL JET (PREDICTED) — OVERALL SPL = 127.2 DB
SPL SPECTRUM (DB)

116.7	121.0	121.8	120.4	117.5	113.6	109.5	105.9

TOTAL INLET — OVERALL SPL = 127.3 DB
SPL SPECTRUM (DB)

116.7	121.0	121.8	120.4	117.5	113.8	111.1	108.5

EXIT QUADRANT NOISE (DIRECTIVITY ANGLE = 110.0 DEG)

TURBOMACHINERY (PREDICTED) — OVERALL SPL = 123.1 DB
SPL SPECTRUM (DB)

101.2	102.3	104.3	106.4	108.7	113.3	119.7	118.5

PRIMARY JET (PREDICTED) — OVERALL SPL = 124.1 DB — 10 * LOG10(AX/AR *(RHO/RHOR)**2) = -23.9 DB
SPL SPECTRUM (DB)

113.6	117.8	118.7	117.3	114.4	110.5	106.4	102.8

SECONDARY JET (PREDICTED) — OVERALL SPL = 137.0 DB — 10 * LOG10(AX/AR *(RHO/RHOR)**2) = -26.6 DB
SPL SPECTRUM (DB)

126.5	130.7	131.6	130.2	127.2	123.4	119.3	115.7

TOTAL JET — OVERALL SPL = 137.2 DB
SPL SPECTRUM (DB)

126.7	131.0	131.8	130.4	127.5	123.6	119.5	115.9

TOTAL EXIT — OVERALL SPL = 137.4 DB
SPL SPECTRUM (DB)

126.7	131.0	131.8	130.4	127.5	124.0	122.6	120.4

```
SAMPLE NO.3  TURBOFAN (SUPPRESSED)  MKS UNITS

CONFIGURATION EFFECTS

     LINING TREATMENT

          INLET
               TARGET FREQUENCIES (HZ)
                     3860.732

               PERCENTAGE OF LINING TREATED FOR THE ABOVE TARGET FREQUENCIES
                       100.000
               MULTIPLE DESIGN POINT OPTION USED

               DIRECTIVITY ANGLE . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .    60.000 DEG
               INLET DUCT MACH NUMBER. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .    -0.699
               SPEED OF SOUND IN INLET DUCT. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .   331.850 M /SEC
               RATIO OF TREATMENT LENGTH TO EFFECTIVE DUCT HEIGHT. . . . . . . . . . . . . . . . . . . . .     6.000
               EFFECTIVE DUCT HEIGHT . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .     0.258 M

               LINING ATTENUATION (PREDICTED - DB)
                     0.4      0.6      1.0      1.8      4.1      9.3     14.7      8.6

          EXIT
               TARGET FREQUENCIES (HZ)
                     3860.732

               PERCENTAGE OF LINING TREATED FOR THE ABOVE TARGET FREQUENCIES
                       100.000
               MULTIPLE DESIGN POINT OPTION USED

               DIRECTIVITY ANGLE . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .   110.000 DEG
               BYPASS DUCT MACH NUMBER . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .     0.226
               SPEED OF SOUND IN BYPASS DUCT . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .   333.757 M /SEC
               RATIO OF TREATMENT LENGTH TO EFFECTIVE DUCT HEIGHT. . . . . . . . . . . . . . . . . . . . .     6.000
               EFFECTIVE DUCT HEIGHT . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .     0.284 M

               LINING ATTENUATION (PREDICTED - DB)
                     0.4      0.6      1.0      1.9      4.2      9.6     15.2      8.9

     CORRECTIONS

          EXIT

               PRIMARY JET (MEASURED - DB)
                     6.0      6.5      7.0      7.5      6.0      5.0      4.3      3.5

               SECONDARY JET (MEASURED - DB)
                     5.0      6.0      7.0      8.0      6.0      5.0      4.0      4.0
```

SAMPLE NO.3 TURBOFAN (SUPPRESSED) MKS UNITS

SUPPRESSED ENGINE SPECTRA (61 M OFF-AXIS, 1 ENG, INDEX, DB RE. 20 MICRO-N/SQ M)

INLET QUADRANT NOISE (DIRECTIVITY ANGLE = 60.0 DEG)

FAN — OVERALL SPL = 100.6 DB
SPL SPECTRUM (DB)

87.2	88.1	89.7	91.0	91.0	90.4	91.4	96.3

RESIDUAL JET — OVERALL SPL = 127.2 DB
SPL SPECTRUM (DB)

116.7	121.0	121.8	120.4	117.5	113.6	109.5	105.9

TOTAL INLET — OVERALL SPL = 127.2 DB
SPL SPECTRUM (DB)

116.7	121.0	121.8	120.4	117.5	113.6	109.5	106.4

EXIT QUADRANT NOISE (DIRECTIVITY ANGLE = 110.0 DEG)

TURBOMACHINERY — OVERALL SPL = 114.0 DB
SPL SPECTRUM (DB)

100.8	101.6	103.3	104.6	104.5	103.7	104.6	109.6

PRIMARY JET — OVERALL SPL = 117.5 DB
SPL SPECTRUM (DB)

107.6	111.3	111.7	109.8	108.4	105.5	102.1	99.3

SECONDARY JET — OVERALL SPL = 130.6 DB
SPL SPECTRUM (DB)

121.5	124.7	124.6	122.2	121.2	118.4	115.3	111.7

TOTAL JET — OVERALL SPL = 130.8 DB
SPL SPECTRUM (DB)

121.7	124.9	124.8	122.4	121.5	118.6	115.5	111.9

TOTAL EXIT — OVERALL SPL = 130.9 DB
SPL SPECTRUM (DB)

121.7	125.0	124.8	122.5	121.5	118.7	115.3	114.0

SAMPLE NO.3 TURBOFAN (SUPPRESSED) MKS UNITS

EXTRAPOLATED SPECTRA (4. ENGINE OPERATION, DB RE. 20 MICRO-N/SQ M)
SIDELINE POSITION OF OBSERVER = 457.2 M OFF-AXIS RANGE = 481.0 M , EPNL = 119.4 EPNDB

INLET QUADRANT NOISE (DIRECTIVITY ANGLE = 60.0 DEG)
TIME HEARD = -1.725 SEC (RELATIVE TO TIME WHEN A/C IS AT Y = 0)
POSITION OF AIRPLANE (Y,Z) = (-297.0, 92.1) M

FAN OVERALL SPL = 82.2 DB PNL = 89.3 PNDB TONE CORRECTED PNL = ****** PNDB
SPL SPECTRUM (DB)
75.5 75.3 75.6 75.1 72.6 69.2 61.9 59.1

RESIDUAL JET OVERALL SPL = 110.6 DB PNL = 114.7 PNDB TONE CORRECTED PNL = ****** PNDB
SPL SPECTRUM (DB)
102.7 105.9 105.6 102.1 96.5 89.7 78.4 67.0

TOTAL INLET OVERALL SPL = 110.6 DB PNL = 114.7 PNDB TONE CORRECTED PNL = ****** PNDB
SPL SPECTRUM (DB)
102.7 105.9 105.6 102.1 96.5 89.7 78.5 67.7

EXIT QUADRANT NOISE (DIRECTIVITY ANGLE = 110.0 DEG)
TIME HEARD = 3.121 SEC (RELATIVE TO TIME WHEN A/C IS AT Y = 0)
POSITION OF AIRPLANE (Y,Z) = (146.2, 182.1) M

TURBOMACHINERY OVERALL SPL = 92.8 DB PNL = 100.5 PNDB TONE CORRECTED PNL = ****** PNDB
SPL SPECTRUM (DB)
85.4 85.7 86.4 85.8 83.4 80.0 74.6 72.6

PRIMARY JET OVERALL SPL = 101.4 DB PNL = 106.1 PNDB TONE CORRECTED PNL = ****** PNDB
SPL SPECTRUM (DB)
93.6 96.7 96.2 92.5 88.8 83.4 73.3 63.3

SECONDARY JET OVERALL SPL = 114.6 DB PNL = 119.1 PNDB TONE CORRECTED PNL = ****** PNDB
SPL SPECTRUM (DB)
107.6 110.1 109.1 104.9 101.7 96.2 86.5 75.7

TOTAL JET OVERALL SPL = 114.8 DB PNL = 119.3 PNDB TONE CORRECTED PNL = ****** PNDB
SPL SPECTRUM (DB)
107.7 110.3 109.3 105.2 101.9 96.5 86.7 75.9

TOTAL EXIT OVERALL SPL = 114.8 DB PNL = 119.4 PNDB TONE CORRECTED PNL = ****** PNDB
SPL SPECTRUM (DB)
107.8 110.3 109.3 105.2 101.9 96.6 86.9 77.6

COMPOSITE OVERALL SPL = 114.8 DB PNL = 119.4 PNDB TONE CORRECTED PNL = ****** PNDB
SPL SPECTRUM (DB)
107.8 110.3 109.3 105.2 101.9 96.6 86.9 77.6

SAMPLE NO.4 ALL MEASURED INPUT

INPUT OR ASSUMED VALUES

FLIGHT PATH PARAMETERS

GROUND ELEVATION FROM SEA LEVEL . . . . 0.0 M
ALTITUDE OF AIRPLANE ABOVE GROUND WHEN AT Y=0 . . . . 152.400 M
CLIMB GRADIENT. 0.203
ANGLE BETWEEN ENGINE AXIS AND HORIZONTAL. . . . . 10.000 DEG
NUMBER OF ENGINES 4.0
MACH NUMBER OF AIRCRAFT 0.264
NUMBER OF OBSERVERS 1
SIDELINE DISTANCE OF OBSERVERS (M)
457.2

ATMOSPHERIC CONDITIONS

(ALTITUDE - M , TEMPERATURE - DEG K)
(0.0, 288.9) , (304.8, 277.8) , (

(ALTITUDE - M , PRESSURE - S.ATM)
(0.0, 1.0) , (304.8, 1.0) , (

(ALTITUDE - M , PERCENT RELATIVE HUMIDITY)
(0.0, 70.0) , (304.8, 60.0) , (
NO EXTRA GROUND ATTENUATION

TURBOFAN ENGINE PERFORMANCE PARAMETERS

ENGINE DOES NOT HAVE INLET GUIDE VANES
DIRECTIVITY ANGLE OF INLET QUADRANT . . . . 65.000 DEG
DIRECTIVITY ANGLE OF EXIT QUADRANT. . . . . 120.000 DEG
RATIO OF SPECIFIC HEATS FOR SECONDARY FLOW. 1.300
ENGINE PRESSURE RATIO 1.886
PRIMARY NOZZLE PRESSURE RATIO 1.980

C2

SAMPLE NO.4 ALL MEASURED INPUT

CALCULATED VALUES

STATIC TEMPERATURE AT AIRPLANE ALTITUDE	283.349 DEG K
STATIC TEMPERATURE AT GROUND LEVEL.	288.900 DEG K
RELATIVE HUMIDITY AT AIRPLANE ALTITUDE.	65.000 PERCENT
RELATIVE HUMIDITY AT GROUND LEVEL	70.000 PERCENT
STATIC PRESSURE AT AIRPLANE ALTITUDE.	0.987 S. ATM.
SPEED OF SOUND AT AIRPLANE ALTITUDE	337.441 M /SEC
AVERAGE SPEED OF SOUND PROPOGATION FROM AIRPLANE TO OBSERVERS ON GROUND	339.086 M /SEC
VELOCITY OF AIRPLANE.	89.084 M /SEC

AVERAGE AIR ABSORPTION COEFFICIENTS (DB/KM)

0.0 3.30 6.60 9.80 13.10 16.40 19.70 23.00

BAND CENTER FREQUENCIES (HZ)

63.0 125.0 250.0 500.0 1000.0 2000.0 4000.0 8000.0

SAMPLE NO.4 ALL MEASURED INPUT

BARE ENGINE SPECTRA (61 M OFF-AXIS, 1 ENG, INDEX, DB RE. 20 MICRO-N/SQ M)

INLET QUADRANT NOISE (DIRECTIVITY ANGLE = 65.0 DEG)

FAN (MEASURED) OVERALL SPL = 109.0 DB
SPL SPECTRUM (DB)

100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

BUZZ-SAW (MEASURED) OVERALL SPL = 109.0 DB
SPL SPECTRUM (DB)

100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

TOTAL TURBOMACHINERY OVERALL SPL = 112.0 DB
SPL SPECTRUM (DB)

103.0	103.0	103.0	103.0	103.0	103.0	103.0	103.0

RESIDUAL JET (MEASURED) OVERALL SPL = 109.0 DB
SPL SPECTRUM (DB)

100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

TOTAL INLET OVERALL SPL = 113.8 DB
SPL SPECTRUM (DB)

104.8	104.8	104.8	104.8	104.8	104.8	104.8	104.8

EXIT QUADRANT NOISE (DIRECTIVITY ANGLE = 120.0 DEG)

TURBOMACHINERY (MEASURED) OVERALL SPL = 109.0 DB
SPL SPECTRUM (DB)

100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

CORE (MEASURED) OVERALL SPL = 109.0 DB
SPL SPECTRUM (DB)

100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

PRIMARY JET (MEASURED) OVERALL SPL = 109.0 DB
SPL SPECTRUM (DB)

100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

SECONDARY JET (MEASURED) OVERALL SPL = 109.0 DB
SPL SPECTRUM (DB)

100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

TOTAL JET OVERALL SPL = 112.0 DB
SPL SPECTRUM (DB)

103.0	103.0	103.0	103.0	103.0	103.0	103.0	103.0

EXTRANEOUS (MEASURED) OVERALL SPL = 109.0 DB
SPL SPECTRUM (DB)

100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

SAMPLE NO.4 ALL MEASURED INPUT

TOTAL EXIT   OVERALL SPL = 116.0 DB
SPL SPECTRUM (DB)

107.0	107.0	107.0	107.0	107.0	107.0	107.0	107.0

```
 SAMPLE NO.4  ALL MEASURED INPUT

CONFIGURATION EFFECTS

     LINING TREATMENT

          INLET

               LINING ATTENUATION (MEASURED - DB)
                     0.0       0.0     -10.0        5.0    -10.0        0.0       0.0       0.0

          EXIT

               LINING ATTENUATION (MEASURED - DB)
                     0.0       0.0     -10.0        5.0    -10.0        0.0       0.0       0.0

     CORRECTIONS

          INLET

               BUZZ-SAW ATTENUATION (MEASURED - DB)
                     0.0       0.0     -10.0        5.0    -10.0        0.0       0.0       0.0

               RESIDUAL JET (MEASURED - DB)
                     0.0       0.0     -10.0        5.0    -10.0        0.0       0.0       0.0

          EXIT

               PRIMARY JET (MEASURED - DB)
                     0.0       0.0     -10.0        5.0    -10.0        0.0       0.0       0.0

               SECONDARY JET (MEASURED - DB)
                     0.0       0.0     -10.0        5.0    -10.0        0.0       0.0       0.0

               CORE (MEASURED - DB)
                     0.0       0.0     -10.0        5.0    -10.0        0.0       0.0       0.0

               EXTRANEOUS (MEASURED - DB)
                     0.0       0.0     -10.0        5.0    -10.0        0.0       0.0       0.0
```

SAMPLE NO.4 ALL MEASURED INPUT

SUPPRESSED ENGINE SPECTRA (61 M OFF-AXIS, 1 ENG, INDEX, DB RE. 20 MICRO-N/SQ M)

INLET QUADRANT NOISE (DIRECTIVITY ANGLE = 65.0 DEG)

FAN — OVERALL SPL = 114.0 DB
SPL SPECTRUM (DB)

100.0	100.0	110.0	95.0	110.0	100.0	100.0	100.0

BUZZ-SAW — OVERALL SPL = 123.1 DB
SPL SPECTRUM (DB)

100.0	100.0	120.0	90.0	120.0	100.0	100.0	100.0

TOTAL TURBOMACHINERY — OVERALL SPL = 123.6 DB
SPL SPECTRUM (DB)

103.0	103.0	120.4	96.2	120.4	103.0	103.0	103.0

RESIDUAL JET — OVERALL SPL = 114.0 DB
SPL SPECTRUM (DB)

100.0	100.0	110.0	95.0	110.0	100.0	100.0	100.0

TOTAL INLET — OVERALL SPL = 124.1 DB
SPL SPECTRUM (DB)

104.8	104.8	120.8	98.6	120.8	104.8	104.8	104.8

EXIT QUADRANT NOISE (DIRECTIVITY ANGLE = 120.0 DEG)

TURBOMACHINERY — OVERALL SPL = 114.0 DB
SPL SPECTRUM (DB)

100.0	100.0	110.0	95.0	110.0	100.0	100.0	100.0

CORE — OVERALL SPL = 114.0 DB
SPL SPECTRUM (DB)

100.0	100.0	110.0	95.0	110.0	100.0	100.0	100.0

PRIMARY JET — OVERALL SPL = 114.0 DB
SPL SPECTRUM (DB)

100.0	100.0	110.0	95.0	110.0	100.0	100.0	100.0

SECONDARY JET — OVERALL SPL = 114.0 DB
SPL SPECTRUM (DB)

100.0	100.0	110.0	95.0	110.0	100.0	100.0	100.0

TOTAL JET — OVERALL SPL = 117.0 DB
SPL SPECTRUM (DB)

103.0	103.0	113.0	98.0	113.0	103.0	103.0	103.0

EXTRANEOUS — OVERALL SPL = 114.0 DB
SPL SPECTRUM (DB)

100.0	100.0	110.0	95.0	110.0	100.0	100.0	100.0

SAMPLE NO.4 ALL MEASURED INPUT

TOTAL EXIT OVERALL SPL = 121.0 DB
SPL SPECTRUM (DB)

107.0	107.0	117.0	102.0	117.0	107.0	107.0	107.0

SAMPLE NO.4 ALL MEASURED INPUT

EXTRAPOLATED SPECTRA (4. ENGINE OPERATION, DB RE. 20 MICRO-N/SQ M)
SIDELINE POSITION OF OBSERVER = 457.2 M OFF-AXIS RANGE = 481.0 M , EPNL = 110.5 EPNDB

INLET QUADRANT NOISE (DIRECTIVITY ANGLE = 65.0 DEG)
TIME HEARD = -1.247 SEC (RELATIVE TO TIME WHEN A/C IS AT Y = 0)
POSITION OF AIRPLANE (Y,Z) = (-245.0, 102.7) M

FAN OVERALL SPL = 99.0 DB PNL = 105.5 PNDB TONE CORRECTED PNL = ****** PNDB
SPL SPECTRUM (DB)
90.7 87.2 96.3 79.9 92.0 82.0 79.3 77.5

BUZZ-SAW OVERALL SPL = 107.7 DB PNL = 111.9 PNDB TONE CORRECTED PNL = ****** PNDB
SPL SPECTRUM (DB)
91.6 86.5 106.3 75.3 101.2 83.0 79.3 77.5

TOTAL TURBOMACHINERY OVERALL SPL = 108.2 DB PNL = 113.2 PNDB TONE CORRECTED PNL = ****** PNDB
SPL SPECTRUM (DB)
94.2 89.9 106.7 81.2 101.7 85.5 82.3 80.5

RESIDUAL JET OVERALL SPL = 97.0 DB PNL = 103.4 PNDB TONE CORRECTED PNL = ****** PNDB
SPL SPECTRUM (DB)
87.7 85.9 94.2 77.5 90.7 79.0 77.2 75.5

TOTAL INLET OVERALL SPL = 108.5 DB PNL = 113.7 PNDB TONE CORRECTED PNL = ****** PNDB
SPL SPECTRUM (DB)
95.1 91.4 107.0 82.8 102.0 86.4 83.5 81.7

EXIT QUADRANT NOISE (DIRECTIVITY ANGLE = 120.0 DEG)
TIME HEARD = 4.482 SEC (RELATIVE TO TIME WHEN A/C IS AT Y = 0)
POSITION OF AIRPLANE (Y,Z) = (247.6, 202.7) M

TURBOMACHINERY OVERALL SPL = 92.0 DB PNL = 98.5 PNDB TONE CORRECTED PNL = ****** PNDB
SPL SPECTRUM (DB)
84.0 86.6 86.1 78.8 84.9 75.6 73.7 71.9

CORE OVERALL SPL = 96.0 DB PNL = 102.4 PNDB TONE CORRECTED PNL = ****** PNDB
SPL SPECTRUM (DB)
86.9 85.1 93.2 76.4 89.6 77.8 75.9 74.1

PRIMARY JET OVERALL SPL = 96.0 DB PNL = 102.4 PNDB TONE CORRECTED PNL = ****** PNDB
SPL SPECTRUM (DB)
86.9 85.1 93.2 76.4 89.6 77.8 75.9 74.1

SECONDARY JET OVERALL SPL = 96.0 DB PNL = 102.4 PNDB TONE CORRECTED PNL = ****** PNDB
SPL SPECTRUM (DB)
86.9 85.1 93.2 76.4 89.6 77.8 75.9 74.1

TOTAL JET OVERALL SPL = 99.0 DB PNL = 105.4 PNDB TONE CORRECTED PNL = ****** PNDB
SPL SPECTRUM (DB)
89.9 88.1 96.2 79.5 92.6 80.8 78.9 77.1

SAMPLE NO.4 ALL MEASURED INPUT

EXTRANEOUS OVERALL SPL = 96.0 DB PNL = 102.4 PNDB TONE CORRECTED PNL = ****** PNDB
SPL SPECTRUM (DB)

86.9	85.1	93.2	76.4	89.6	77.8	75.9	74.1

TOTAL EXIT OVERALL SPL = 102.4 DB PNL = 108.9 PNDB TONE CORRECTED PNL = ****** PNDB
SPL SPECTRUM (DB)

93.5	92.4	99.5	84.0	96.0	84.4	82.6	80.7

COMPOSITE OVERALL SPL = 108.6 DB PNL = 113.8 PNDB TONE CORRECTED PNL = ****** PNDB
SPL SPECTRUM (DB)

95.1	92.4	107.0	84.0	102.0	86.4	83.5	81.7

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APPENDIX B
NOISE CONTOUR COMPUTER PROGRAMS
USER'S GUIDE

INTRODUCTION

Two Fortran IV programs are provided to compute noise contours based on the procedures defined in section 5.2 of this report: an IBM 360 version for "batch" processing and a SIGMA VII version for "real time" processing with the NASA-Ames flight simulator. The computation procedures for the two programs are the same—only the input-output controls differ. The SIGMA VII version has been written to conform to the flight simulator requirements and is used by means of a subroutine call. During the initialization stage of the flight simulator, the program needs no input other than the acoustic data routine generated by the noise source computer program (appendix A) or an equivalent set of data. In this stage, tables for the acoustic data functions are generated in the core of the SIGMA VII computer. During the flight simulation stage, input to and output from the program is by a list of arguments in the subroutine call. Printing or plotting of input/output variables is handled by the calling program.

The IBM 360 version has been written to function in a stand-alone manner. The acoustic data is input in the same manner as the SIGMA VII version via a data routine (appendix A). Additional input variables for initializing and defining aero/propulsion parameters during an aircraft's flight are specified on cards. The output from the program is a printed listing of the results and optional magnetic tape(s) for CALCØMP plotting. Sample cases are given in sections B.7 and B.8.

B.1 USAGE OF THE SIGMA VII NOISE CONTOUR PROGRAM

The use of the program is made by a subroutine call as shown below. The acoustic data routine generated by the noise source computer program (appendix A) or its equivalent must be included as part of the contour program during compilation and loading into the SIGMA VII system. For best results these data should correspond to the conditions outlined in table 3.

CALL VALUES (IMØDE, NLS, NLF, XF, YF, Z, SCI, DE, EPR, SD, X1, X2, Y1, Y2,
SUM, SLNL, IEC)

The input arguments are:

IMØDE — Indicator to denote the state of the simulator
IMØDE = -1 for initialization state
= 0 for hold state
= 1 for flight simulation processing state.

NLS, NLF — Indices denoting the noise levels for the first and last noise contour. The user has the option of selecting up to five noise levels: 85, 90, 95, 100, and 105. These levels are set internally in the program through a DATA statement in subroutine DATAIN for the variable array ANS. The variables NLS and NLF act as pointers in the ANS array, and the output arrays (X1, X2, Y1, Y2, SUM, IEC). For example, if NLS = 2, and NLF = 4, the noise contours having values of 90, 95, and 100 will be computed. RESTRICTION: $1 \leq NLS \leq NLF \leq 5$.

XF, YF, Z	Aircraft coordinates (X, Y, Z) in figure 17. The units for distance must be the same as those used to form the acoustic data in the noise source computer program.
SCI	Directivity angle in degrees for maximum passby noise (see ψ in figure 17).
DE	Engine attitude angle in degrees relative to horizon. (see δ_E in figure 17).
EPR	Engine pressure ratio.
SD	Sideline[2] distances for U in figure 17 for maximum passby noise estimates. The number of values for SD is counted by the contour program with the restriction: $1 \leq SD \leq 10\,000$.

The output arguments are:

X1, Y1	Coordinates[1] for each contour on the positive side of flight track.
X2, Y2	Coordinates[1] for each contour on the negative side of flight track.
SUM	Accumulated area[1] inside each contour.
SLNL	Maximum[2] passby noise level estimates at the sideline distances U = SD (see above and figure 17).
IEC	Error Code[1] Array = -1 indicates no error = 0 indicates present contour has closed = 1 indicates directivity cone does not intersect ground plane at predicted distance, hence no solution possible.

---

[1]These variables must be dimensioned (length = 5) in the calling routine. The results are stored consecutively from the NLS element to the NLF element of each array.

[2] These arrays must be dimensioned (length = 3) in the calling routine.

B.2 USAGE OF THE IBM 360 NOISE CONTOUR PROGRAM

The deck stacking instructions for using the IBM 360 noise contour program are listed below. The acoustic data routine generated by the noise source computer program (appendix A) or its equivalent must be included as part of the contour program during compilation and loading into the IBM 360 system.

B.2.1 Initialization Parameters

Card No. 1 Normally the first 3 columns of this card are blank; the remainder may be used for comment. However, if the user wishes to check his output before using the CALCØMP plotter, he should run his job with the program option IPLØT = -1. This option directs the program to save the output on a data tape, file TAPE 2, to be used later in preparing a plot tape. The user may then check his printout and resubmit the job to the IBM 360 with a "-1" punched in columns 2 and 3 of this card. The only additional input needed will be the three cards (No. A, B, and C) defining the plotting options (see page 109).

If the first 3 columns of card No. 1 are blank, the following Namelist &DIGINT parameters are required for initialization of the program variables. The same procedure for Fortran Namelist as specified in appendix A is to be used except the Namelist name is &DIGINT instead of &PARAM.

Variable Name	Units	Default Value	Description
NL		5	The maximum number of noise contours to be calculated for each flight path. RESTRICTION: $1 \leq NL \leq 5$.
ANL(1)	EPNdB (PNdB)	85	The noise levels applying to each contour.
ANL(2)	" "	90	
ANL(3)	" "	95	
ANL(4)	" "	100	
ANL(5)	EPNdB (PNdB)	105	
IUNIT		0	Specifies the units for distance input and output IUNIT = 0 for MKS units = 1 for English units.
IPNDB		0	Specifies the units for noise levels input and output IPNDB = 0 for EPNdB = 1 for PNdB.

Variable Name	Units	Default Value	Description
IPLØT		0	Specifies if tapes are to be prepared for CALCØMP plotting IPLØT = -1 for preparing contour point data tape = 0 for printout only = 1 for preparing complete plot tape.

B.2.2 Aero/Propulsion Parameters

If the first 3 columns of card No. 1 are blank, the following set of data cards are required immediately after the Namelist &DIGINT parameters. For multiple flight paths, this data set is to be repeated.

Title Card	Format (18A4)
Variable Name	Description
TITLE	Title card for each flight path case. NOTE: The maximum number of characters is 72.

After the title card, the following Namelist &DIGSIM parameters are to be specified. The same procedure for Fortran Namelist as shown in appendix A is to be used except the Namelist name is &DIGSIM instead of &PARAM.

Variable Name	Units	Default Value	Description
DSCI	degrees	110	Directivity angle for maximum passby noise.
SD(1)	m(ft)	1.0	Sideline distance U in figure 17 for maximum
SD(2)	m(ft)	152.4	passby noise estimate.
SD(3)	m(ft)	463.3	RESTRICTION: $1 \leq SD \leq 10\,000$.
NSL		3	Number of sideline distance values. RESTRICTION: $1 \leq NSL \leq 3$

If the user does not wish to have all (NL) contours specified in section B.2.1 calculated for this flight path, he is able to specify the subset of the ANL array to be used:

Variable Name	Default Value	Description
NLS NLF	1 NL	Indices denoting the noise levels for the first and last noise contour to be calculated for this flight path. The variables (NLS, NLF) act as pointers in the ANS array specified in section B.2.1. RESTRICTION: $1 \leq NLS \leq NLF \leq NL$. EXAMPLE: Suppose the values for ANL are 80, 90, 100, 110 with NL = 4, and we want only the 90, 100 EPNdB contours for this flight path. Then the values to be specified for NLS and NLF are NLS = 2, NLF = 3.

The program permits the user to specify the aero/propulsion parameters in two ways. The first method lets the user define the parameters in a tabular function form and the increment at which noise levels are to be computed. The second lets the user define the discrete points along the flight path where contour points are to be calculated.

Method 1

Variable Name	Units	Default Value	Description
NFPP		25	Number of points along the flight track where noise contour points are to be calculated. RESTRICTION: $2 \leq NFPP \leq 100$.
DS	m (ft)		Step size along flight track for computing contour points, i.e., distance between flight path points (X_i, Y_i) and (X_{i-1},Y_{i-1}) shown in figure 17. These coordinates are obtained by linear interpolation on the prescribed flight path.
ND			Number of points defining the flight path. RESTRICTION: $2 \leq ND \leq 20$.
DDX(1)	m (ft)		Array of X coordinates (figure 17) for flight path.
...	...		
DDX(ND)	m (ft)		
DDY(1)	m (ft)		Array of Y coordinates (figure 17) for flight path, corresponding to DDX values.
. . .	. . .		

Variable Name	Units	Default Value	Description
DDY(ND)	m (ft)		
DDZ(1) . . . DDZ(ND)	m (ft) . . . m (ft)		Array of Z coordinates (figure 17) for flight path, corresponding to DDX, DDY values.
DDDE(1) . . . DDDE(ND)	degrees . . . degrees		Array of engine attitude angles for defined positions along flight path.
DDEPR(1) . . . DDEPR(ND)			Array of engine pressure ratios for defined positions along flight path.
<u>Method 2</u>			
NFPP			Number of points along the flight track where noise contour points are to be calculated. RESTRICTION: $2 \leq$ NFPP ≤ 100.
DX(1) . . . DX(NFPP)	m (ft) . . . m (ft)		Array of X coordinates (figure 17) for flight path.
DY(1) . . . DY(NFPP)	m (ft) . . . m (ft)		Array of Y coordinates (figure 17) for flight path.
DZ(1) . . . DZ(NFPP)	m (ft) . . . m (ft)		Array of Z coordinates (figure 17) for flight path.
DDE(1) . . . DDE(NFPP)	degrees . . . degrees		Array of engine attitude angles for points along flight path.
DEPR(1) . . . DEPR(NFPP)			Array of engine pressure ratios for points along flight path.
ISTØP		0	An indicator to denote if this is the last flight path to be considered. ISTØP = 0 denotes to do another case = 1 denotes that this is the last case.

NOTE: This completes the list of &DIGSIM parameters. For multiple flight paths, the title card and the &DIGSIM parameter input are to be repeated.

Optional Cards A, B, C

These cards will be inserted after the last set of &DIGSIM cards if IPLØT = +1, or if a contour point data tape has been previously prepared for plotting (see card No. 1 information).

Card A Format (3F10.0, 3X, A2, 5X, A4, 5X, 2A4)

Variable Name	Column No.	Description
SCALV	1-10	Desired scale in units of distance per centimeter. If omitted, the scale will be computed to plot contours within the specified plot dimensions below.
XLENM	11-20	Maximum size of the plot along the width (shortest side) of the paper. NOTE: The units for XLENM are specified by the variable DUNITS and the size of the plot must be less than or equal to the width of the plotter. The X direction shown in figure 17 corresponds to this dimension.
YLENM	21-30	Same as XLENM except along the length (longest side) of the paper. NOTE: This dimension must be less than or equal to the length of the plotter. The Y direction shown in figure 17 corresponds to this dimension.
DUNITS	34-35	Units used to specify XLENM and YLENM. Input "IN" for inches or "CM" for centimeters.
AXUNIT	41-44	A four-character label for the units of the plotted distances X and Y.
NLABEL	50-57	An eight-character label for the units of noise level. The character string should be left-adjusted in the eight-character positions.

Card B Format (10A4)

LABELX		Label for the X axis of the contour plot. The character string should be left-adjusted in the 40-character positions.

Card C Format (10A4)

LABELY		Same as LABELX on card B, except it applies to the Y axis.

B.3 MACHINE REQUIREMENTS

The IBM 360 version of the noise contour program requires 110 K decimal bytes for field length. Program input is done by the card reader. The output is a listing done by the printer. If the plot option IPLØT = ±1, a file TAPE 2 is written containing the noise contour data. If IPLØT = 1, a complete plot file TAPE is prepared for offline processing on the CALCØMP plotter.

The SIGMA VII version of the noise contour program requires approximately 8 K decimal (32 bit) computer words for field length. Input/output is done through a list of arguments in the subroutine calling sequence. Any printing, plotting, or display of results is to be done by the NASA-Ames flight simulator.

B.4 OPERATING SYSTEM(S)

One version of the noise contour program is designed to operate on the IBM 360/67 or IBM 360-75W computer systems. A second version of the program has been prepared to operate on the SIGMA VII computer system of the NASA-Ames flight simulator.

B.5 RESOURCE ESTIMATES

B.5.1 IBM 360 System

The control processor time required to process a job depends upon the following:

1. Number of flight paths on which to calculate contours.
2. Number of points along each flight path.
3. Number of noise levels per point on which to calculate contours.

B.5.2 SIGMA VII System

Since the "real time" system is concerned with only one aircraft position at a time, the critical time path is the time needed to calculate the contour points for up to 5 noise levels for a given aircraft position. Approximate measurements running in a non-real-time background mode indicate a 0.06 sec per noise level contour point.

B.6 PROGRAM RESTRICTIONS

There is only one additional restriction to be added to those mentioned in sections B.2.1 and B.2.2 for program usage. The maximum number of acoustic data points generated by the noise source computer program is 324. See section 5.2.1 and table 3 of this report for further details.

B.7 CONTROL CARDS

IBM 360 control cards under ∅S operating system.

```
//JOBNAME    (per installation)
//EXEC       PGM = IEBGENER
//SYSPRINT   DD SYS∅UT = A
//SYSIN      DD DUMMY
//SYSUTZ     DD UNIT = SYSDA, DSN = & CARDS, SPACE = TRK, (5,1)),
//DCB = (LRECL = 80, RECFM = FB, BLKSIZE = 400), DISP = (NEW, PASS)
//SYSUTI     DD *
     input DATA
     to Noise Contour Program

/*
//EXEC       PGM = IEBGENER
//SYSPRINT   DD SYS∅UT = A
//SYSIN      DD DUMMY
//SYSUTZ     DD SYS∅UT = A, DCB = BLKSIZE = 400
//SYSUTI     DD DSN = & CARDS, DISP = (∅LD, PASS)
//EXEC F∅RTGLG, TIME = 4, REGI∅N = 110K
//LKED.SYSLIB DD
//           DD
//           DD
//           DD DSNAME = SYS1.NP5, DISP = SHR
//LKED.SYSIN DD *
```

Binary deck of Noise Contour program which must include a new subroutine TEE227 generated by the Noise Source Program for each new engine configuration.

```
/*
//G∅.SYSIN    DD DSN = & CARDS, DISP = (∅LD, DELETE)
//G∅.FT15F001 DD UNIT = SYSDA, SPACE = (1729, (7))
//G∅.CALC∅MP DD DSN = DNAME, UNIT = 2400-2,
//LABEL = (,SL), DISP = (,KEEP), V∅L = SER = XXXXXX
//G∅.FT02F001 DD UNIT = SYSDA, DSN = && TAPE02, DISP = (DELETE),
//SPACE = (400, (80,80)), DCB = (LRECL = 80, BLKSIZE = 400, RECFM = FB)
//
```

B.7.1 Sample TSS Input Data for the IBM 360/67 Computer

Sample No. 1

```
*****   TO PLOT FROM DATA PREVIOUSLY SAVED ON FILF   *****

..RJSTART RMT05
  LOGON FSAFJJ08,PLOTCASE,  ...
GEINEWS *UPDATE
DEFAULT  RUNFREE=Y
AMES CCPLOT
DDFF FT02F001,VS,DSNAME=JJTAPE02
CALL TEX227$$
 -1       PROGRAM NFEDS  THIS CARD  TO PLOT A SAVED TAPE PUT -1 IN COL 2&3
 &DIGINT NL=3,ANL=80.,90.,100.,IPNDB=0,        IPLOT=1, &END
         0       10.        15.    IN      M          EPNDB
LATERAL DISTANCE FROM RUNWAY (M)
DISTANCE ALONG RUNWAY (M)
%END
  LOGOFF
..CONTINUE
```

Sample No. 2

```
*****   TO COMPUTE AND SAVE ON FILE, BUT NOT PLOT    *****

..RJSTART RMT05
  LOGON FSAE JJ08,TESTCASE,  ...
GETNEWS *UPDATE
DEFAULT  RUNFREE=Y
AMES CCPLOT
DDEF FT02F001,VS,DSNAME=JJTAPE02
CALL TEX227$$
 . STARTING IN COLUMN 4, THIS CAN BE USED AS DECK IDENTIFICATION, ETC...........
 &DIGINT NL=3,ANL=80.,90.,100.,IPNDB=0,        IPLOT=-1 &END
          THIS IS CASE 1  TAKEOFF
 &DIGS!M DSCI=120.,NEPP=36,DS=500.,ND=12,DDX=5*0.,75.,200.,640.,1220.,
   1900.,2700.,3520.,DDY= 0.,1400., 1600.,6000.,7000.,7500.,7980.,8880.,9700.,
   10400.,11010.,11560.,DDZ=0.,0.,10.,450.,500.,5 7.,533.,567.,600.,633.,
   667.,700.,DDDE=2*0.,2*20.,8*10.,DDEPR=4*2.0,1.5,7*1.4,
NLS=1,NLF=3, &END
       THIS IS CASE @   APPROACH
&DIGSIM  ND=8,DDX=8*0.0,DDY=-15000.,-10000.,-6500.,-1800.,0.,150.,300.,600.,
DDZ=1250.,728.,360.,113.,15.,3*0.0,DDDE=7.,8.,10.,2*10.,5.,0.,0.,DDEPR=2*1.4,
3*1.25,1.1,2*1.0,&END
             THIS IS CASE THREE    TOUCH AND GO
&DIGSIM  NFPP=72,ND=13,DDX=13*0.0,DDY(8)=1400.,1600.,6000.,7000.,10000.,13000.,
DDZ(9)=10.,450.,500.,600.,700.,DDDE(9)=2*20.,3*10.,DDEPR(8)=3*2.0,1.5,2*1.4,
 ISTOP=1,  &END
%END
PUNCH JJTAPE02, ERASE=N
 LOGOFF
..CONTINUE
```

Sample No. 3

```
*****   TO COMPUTE, WRITE ON FILE, AND PLOT    *****

..RJSTART RMT05
  LOGON FSAEJJ08,TESTPLOT,  ...
GETNEWS *UPDATE
DEFAULT  RUNFREE=Y
AMES CCPLOT
DDEF FT02F001,VS,DSNAME=JJTAPE02
CALL  TFX227$$
   STARTING IN COLUMN 4, THIS CAN BE USED AS DECK IDENTIFICATION, ETC...........
 &DIGINT NL=3,ANL=80.,90.,100.,IPNDB=0,        IPLOT= 1 &END
          THIS IS CASE 1  TAKEOFF
 &DIGSIM DSCI=120.,NFPP=36,DS=500.,ND=12,DDX=5*0.,75.,200.,640.,1220.,
   1900.,2700.,3520.,DDY= 0.,1400., 1600.,6000.,7000.,7500.,7980.,8880.,9700.,
   10400.,11010.,11560.,DDZ=0.,0.,10.,450.,500.,517.,533.,567.,600.,633.,
   667.,700.,DDDE=2*0.,2*20.,8*10.,DDEPR=4*2.0,1.5,7*1.4,
 NLS=1,NLF=3, &END
       THIS IS CASE 2   APPROACH
&DIGSIM  ND=8,DDX=8*0.0,DDY=-15000.,-10000.,-6500.,-1800.,0.,150.,300.,600.,
DDZ=1250.,728.,360.,113.,15.,3*0.0,DDDE=7.,8.,10.,2*10.,5.,0.,0.,DDEPR=2*1.4,
3*1.25,1.1,2*1.0,&END
             THIS IS CASE THREE    TOUCH AND GO
&DIGSIM  NFPP=72,ND=13,DDX=13*0.0,DDY(8)=1400.,1600.,6000.,7000.,10000.,13000.,
DDZ(9)=10.,450.,500.,600.,700.,DDDE(9)=2*20.,3*10.,DDEPR(8)=3*2.0,1.5,2*1.4,
 ISTOP=1,  &END
        0       10.        15.    IN      M          EPNDB
LATERAL DISTANCE FROM RUNWAY (M)
DISTANCE ALONG RUNWAY (M)
%END
 LOGOFF
..CONTINUE
```

B.8 IBM 360 SAMPLE INPUT DATA

```
          PROGRAM NEEDS THIS CARD  TO PLOT A SAVED TAPE PUT -1 IN COL 2+3
 &DIGINT NL=3,ANL=80.,90.,100.,IPNDB=0,          IPLOT=1, &END
             THIS IS CASE 1  TAKEOFF
 &DIGSIM DSCI=120.,NFPP=36,DS=500.,ND=12,DDX=5*0.,75.,200.,640.,1220.,
   1900.,2700.,3520.,DDY= 0.,1400., 1600.,6000.,7000.,7500.,7980.,8880.,9700.,
   10400.,11010.,11560.,DDZ=0.,0.,10.,450.,500.,517.,533.,567.,600.,633.,
   667.,700.,DDDE=2*0.,2*20.,8*10.,DDEPR=4*2.0,1.5,7*1.4,
  NLS=1,NLF=3,ISTOP=1,&END
     1000        10.        15.    IN      M           FPNDB
LATERAL DISTANCE FROM RUNWAY (M)
DISTANCE ALONG RUNWAY (M)
```

ACOUSTIC DATA FUNCTION
NOISE LEVEL VALUES

AT ENGINE PRESSURE RATIO = 1.000E 00

LOGIC (OFF AXIS RANGE)

ELEVATION ANGLE (DEGREES)	1.699E 00	2.000E 00	2.301E 00	2.602E 00	2.903E 00	3.204E 00	3.505E 00	3.806E 00	4.107E 00
0.0	7.503E 01	7.299E 01	6.901E 01	6.370E 01	5.787E 01	5.190E 01	4.589E 01	3.938E 01	3.386E 01
7.181E 00	7.857E 01	7.653E 01	7.255E 01	6.723E 01	6.141E 01	5.544E 01	4.943E 01	4.341E 01	3.739E 01
1.448E 01	8.003E 01	7.799E 01	7.401E 01	6.870E 01	6.287E 01	5.690E 01	5.089E 01	4.488E 01	3.886E 01
3.000E 01	8.210E 01	8.006E 01	7.608E 01	7.077E 01	6.494E 01	5.897E 01	5.296E 01	4.695E 01	4.093E 01
4.500E 01	8.344E 01	8.140E 01	7.742E 01	7.210E 01	6.628E 01	6.031E 01	5.430E 01	4.828E 01	4.226E 01
9.000E 01	8.503E 01	8.299E 01	7.901E 01	7.370E 01	6.787E 01	6.190E 01	5.589E 01	4.988E 01	4.386E 01

ACOUSTIC DATA FUNCTION
NOISE LEVEL VALUES

AT ENGINE PRESSURE RATIO = 1.200E 00

LOG10 (OFF AXIS RANGE)

ELEVATION ANGLE (DEGREES)	1.699E 00	2.000E 00	2.301E 00	2.602E 00	2.903E 00	3.204E 00	3.505E 00	3.806E 00	4.107E 00
0.0	8.943E 01	8.739E 01	8.341E 01	7.810E 01	7.227E 01	6.630E 01	6.029E 01	5.428E 01	4.826E 01
7.181E 00	9.297E 01	9.093E 01	8.695E 01	8.163E 01	7.581E 01	6.984E 01	6.383E 01	5.781E 01	5.179E 01
1.448E 01	9.443E 01	9.239E 01	8.841E 01	8.310E 01	7.727E 01	7.130E 01	6.529E 01	5.928E 01	5.326E 01
3.000E 01	9.650E 01	9.446E 01	9.048E 01	8.517E 01	7.934E 01	7.337E 01	6.736E 01	6.135E 01	5.533E 01
4.500E 01	9.784E 01	9.580E 01	9.182E 01	8.650E 01	8.068E 01	7.471E 01	6.870E 01	6.268E 01	5.666E 01
9.000E 01	9.943E 01	9.739E 01	9.341E 01	8.810E 01	8.227E 01	7.630E 01	7.029E 01	6.428E 01	5.826E 01

ACOUSTIC DATA FUNCTION
NOISE LEVEL VALUES

AT ENGINE PRESSURE RATIO = 1.400E 00

LOG10 (OFF AXIS RANGE)

ELEVATION ANGLE (DEGREES)	1.699E 00	2.000E 00	2.301E 00	2.602E 00	2.903E 00	3.204E 00	3.505E 00	3.806E 00	4.107E 00
0.0	1.006E 02	9.859E 01	9.461E 01	8.930E 01	8.347E 01	7.750E 01	7.149E 01	6.548E 01	5.946E 01
7.181E 00	1.042E 02	1.021E 02	9.815E 01	9.283E 01	8.701E 01	8.104E 01	7.503E 01	6.901E 01	6.299E 01
1.448E 01	1.056E 02	1.036E 02	9.961E 01	9.430E 01	8.847E 01	8.250E 01	7.649E 01	7.048E 01	6.446E 01
3.000E 01	1.077E 02	1.057E 02	1.017E 02	9.637E 01	9.054E 01	8.457E 01	7.856E 01	7.255E 01	6.653E 01
4.500E 01	1.090E 02	1.070E 02	1.030E 02	9.770E 01	9.188E 01	8.591E 01	7.990E 01	7.388E 01	6.786E 01
9.000E 01	1.106E 02	1.086E 02	1.046E 02	9.930E 01	9.347E 01	8.750E 01	8.149E 01	7.548E 01	6.946E 01

ACOUSTIC DATA FUNCTION
NOISE LEVEL VALUES

AT ENGINE PRESSURE RATIO = 1.600E 00

LOG10 (OFF AXIS RANGE)

ELEVATION ANGLE (DEGREES)	1.699E 00	2.000E 00	2.301E 00	2.602E 00	2.903E 00	3.204E 00	3.505E 00	3.806E 00	4.107E 00
0.0	1.086E 02	1.066E 02	1.026E 02	9.730E 01	9.147E 01	8.550E 01	7.949E 01	7.348E 01	6.746E 01
7.181E 00	1.122E 02	1.101E 02	1.061E 02	1.008E 02	9.501E 01	8.904E 01	8.303E 01	7.701E 01	7.099E 01
1.448E 01	1.136E 02	1.116E 02	1.076E 02	1.023E 02	9.647E 01	9.050E 01	8.449E 01	7.848E 01	7.246E 01
3.000E 01	1.157E 02	1.137E 02	1.097E 02	1.044E 02	9.854E 01	9.257E 01	8.656E 01	8.055E 01	7.453E 01
4.500E 01	1.170E 02	1.150E 02	1.110E 02	1.057E 02	9.988E 01	9.391E 01	8.790E 01	8.188E 01	7.586E 01
9.000E 01	1.186E 02	1.166E 02	1.126E 02	1.073E 02	1.015E 02	9.550E 01	8.949E 01	8.348E 01	7.746E 01

ACOUSTIC DATA FUNCTION
NOISE LEVEL VALUES

AT ENGINE PRESSURE RATIO = 1.800E 00

LOG10 (OFF AXIS RANGE)

ELEVATION ANGLE (DEGREES)	1.699E 00	2.000E 00	2.301E 00	2.602E 00	2.903E 00	3.204E 00	3.505E 00	3.806E 00	4.107E 00
0.0	1.134E 02	1.114E 02	1.074E 02	1.021E 02	9.627E 01	9.030E 01	8.429E 01	7.828E 01	7.226E 01
7.181E 00	1.170E 02	1.149E 02	1.109E 02	1.056E 02	9.981E 01	9.384E 01	8.783E 01	8.181E 01	7.579E 01
1.448E 01	1.184E 02	1.164E 02	1.124E 02	1.071E 02	1.013E 02	9.530E 01	8.929E 01	8.328E 01	7.726E 01
3.000E 01	1.205E 02	1.185E 02	1.145E 02	1.092E 02	1.033E 02	9.737E 01	9.136E 01	8.535E 01	7.933E 01
4.500E 01	1.218E 02	1.198E 02	1.158E 02	1.105E 02	1.047E 02	9.871E 01	9.270E 01	8.668E 01	8.066E 01
9.000E 01	1.234E 02	1.214E 02	1.174E 02	1.121E 02	1.063E 02	1.003E 02	9.429E 01	8.828E 01	8.226E 01

ACOUSTIC DATA FUNCTION
NOISE LEVEL VALUES

AT ENGINE PRESSURE RATIO = 2.000E 00

LOG10 (OFF AXIS RANGE)

ELEVATION ANGLE (DEGREES)	1.699E 00	2.000E 00	2.301E 00	2.602E 00	2.903E 00	3.204E 00	3.505E 00	3.806E 00	4.107E 00
0.0	1.150E 02	1.130E 02	1.090E 02	1.037E 02	9.787E 01	9.190E 01	8.589E 01	7.988E 01	7.386E 01
7.181E 00	1.186E 02	1.165E 02	1.125E 02	1.072E 02	1.014E 02	9.544E 01	8.943E 01	8.341E 01	7.739E 01
1.448E 01	1.200E 02	1.180E 02	1.140E 02	1.087E 02	1.029E 02	9.690E 01	9.089E 01	8.488E 01	7.886E 01
3.000E 01	1.221E 02	1.201E 02	1.161F 02	1.108E 02	1.049E 02	9.897E 01	9.296E 01	8.695E 01	8.093E 01
4.500E 01	1.234E 02	1.214E 02	1.174E 02	1.121E 02	1.063E 02	1.003E 02	9.430E 01	8.828E 01	8.226E 01
9.000E 01	1.250E 02	1.230E 02	1.190E 02	1.137E 02	1.079E 02	1.019E 02	9.589E 01	8.988E 01	8.386E 01

B.9 IBM 360 SAMPLE OUTPUT DATA

TABLE OF DEVELOPED VALUES OF LOG10 OFF AXIS RANGE
BASED ON THE PRECEDING INPUT ACOUSTIC DATA

VALUES FOR NOISE LEVEL OF 80.0 DB

ELEVATION ANGLE (DEGREES)	ENGINE PRESSURE RATIO 1.000	1.200	1.400	1.600	1.800	2.000
(0.0)	9.657E-01	2.494E 00	3.078E 00	3.479E 00	3.720E 00	3.800E 00
(7.181E 00)	1.488E 00	2.686E 00	3.256E 00	3.656E 00	3.896E 00	3.976E 00
(1.448E 01)	1.703E 00	2.762E 00	3.329E 00	3.730E 00	3.970E 00	4.050E 00
(3.000E 01)	2.005E 00	2.869E 00	3.433E 00	3.833E 00	4.073E 00	4.153E 00
(4.500E 01)	2.106E 00	2.937E 00	3.500E 00	3.900E 00	4.140E 00	4.220E 00
(9.000E 01)	2.226E 00	3.017E 00	3.580E 00	3.980E 00	4.220E 00	4.300E 00

VALUES FOR NOISE LEVEL OF 90.0 DB

ELEVATION ANGLE (DEGREES)	ENGINE PRESSURE RATIO 1.000	1.200	1.400	1.600	1.800	2.000
(0.0)	-5.098E-01	1.615E 00	2.562E 00	2.977E 00	3.219E 00	3.299E 00
(7.181E 00)	1.250E-02	2.070E 00	2.748E 00	3.156E 00	3.396E 00	3.476E 00
(1.448E 01)	2.279E-01	2.181E 00	2.824E 00	3.229E 00	3.469E 00	3.550E 00
(3.000E 01)	5.334E-01	2.328E 00	2.930E 00	3.333E 00	3.573E 00	3.653E 00
(4.500E 01)	7.311E-01	2.404E 00	2.998E 00	3.400E 00	3.640E 00	3.720E 00
(9.000E 01)	9.657E-01	2.494E 00	3.078E 00	3.479E 00	3.720E 00	3.800E 00

VALUES FOR NOISE LEVEL OF 100.0 DB

ELEVATION ANGLE (DEGREES)	ENGINE PRESSURE RATIO 1.000	1.200	1.400	1.600	1.800	2.000
(0.0)	-1.985E 00	1.394E-01	1.789E 00	2.449E 00	2.710E 00	2.793E 00
(7.181E 00)	-1.463E 00	6.617E-01	2.160E 00	2.644E 00	2.893E 00	2.974E 00
(1.448E 01)	-1.248E 00	6.771E-01	2.272E 00	2.721E 00	2.968E 00	3.048E 00
(3.000E 01)	-9.421E-01	1.183E 00	2.397E 00	2.828E 00	3.071E 00	3.152E 00
(4.500E 01)	-7.444E-01	1.380E 00	2.471E 00	2.897E 00	3.139E 00	3.219E 00
(9.000E 01)	-5.098E-01	1.615E 00	2.562E 00	2.978E 00	3.219E 00	3.299E 00

THIS IS CASE 1 TAKEOFF

AIRCRAFT COORDINATES(X,Y,Z) IN M. (0.0 , 0.0 , 0.0)

DISTANCE ALONG FLIGHT TRACK = 0.0 M.

ENGINE ATTITUDE ANGLE = 0.0 (DEGREES) , DIRECTIVITY ANGLE = 1.20E 02 (DEGREES)

ENGINE PRESSURE RATIO = 2.00E 00

NOISE LEVEL IN EPNDB = 1.263E 02 AT A SIDELINE DISTANCE 1.00E 00 M.
NOISE LEVEL IN EPNDB = 1.106E 02 AT A SIDELINE DISTANCE 1.52E 02 M.
NOISE LEVEL IN EPNDB = 1.025E 02 AT A SIDELINE DISTANCE 4.63E 02 M.

CONTOUR POINTS

NOISE LEVEL (EPNDB)	LEFT CONTOUR POINT (M.)	(M.)	RIGHT CONTOUR POINT (M.)	(M.)	ACCUMULATED AREA (SQUARE M.)	ERROR CODE
8.000E 01	6.309E 03	-3.643E 03	-6.309E 03	-3.643E 03	0.0	-1
9.000E 01	1.991E 03	-1.150E 03	-1.991E 03	-1.150E 03	0.0	-1
1.000E 02	6.209E 02	-3.585E 02	-6.209E 02	-3.585E 02	0.0	-1

AIRCRAFT COORDINATES(X,Y,Z) IN M. (0.0 , 5.000E 02, 0.0)

DISTANCE ALONG FLIGHT TRACK = 5.000E 02 M.

ENGINE ATTITUDE ANGLE = 0.0 (DEGREES) , DIRECTIVITY ANGLE = 1.20E 02 (DEGREES)

ENGINE PRESSURE RATIO = 2.00E 00

NOISE LEVEL IN EPNDB = 1.263E 02 AT A SIDELINE DISTANCE 1.00E 00 M.
NOISE LEVEL IN EPNDB = 1.106E 02 AT A SIDELINE DISTANCE 1.52E 02 M.
NOISE LEVEL IN EPNDB = 1.025E 02 AT A SIDELINE DISTANCE 4.63E 02 M.

CONTOUR POINTS

NOISE LEVEL (EPNDB)	LEFT CONTOUR POINT (M.)	(M.)	RIGHT CONTOUR POINT (M.)	(M.)	ACCUMULATED AREA (SQUARE M.)	ERROR CODE
8.000E 01	6.309E 03	-3.143E 03	-6.309E 03	-3.143E 03	6.309E 06	-1
9.000E 01	1.991E 03	-6.497E 02	-1.991E 03	-6.497E 02	1.991E 06	-1
1.000E 02	6.209E 02	1.415E 02	-6.209E 02	1.415E 02	6.209E 05	-1

THIS IS CASE 1 TAKEOFF

AIRCRAFT COORDINATES(X,Y,Z) IN M. (0.0 , 1.000E 03, 0.0)

DISTANCE ALONG FLIGHT TRACK = 1.000E 03 M.

ENGINE ATTITUDE ANGLE = 0.0 (DEGREES) , DIRECTIVITY ANGLE = 1.20E 02 (DEGREES)

ENGINE PRESSURE RATIO = 2.00E 00

NOISE LEVEL IN EPNDB = 1.263E 02 AT A SIDELINE DISTANCE 1.00E 00 M.
NOISE LEVEL IN EPNDB = 1.106E 02 AT A SIDELINE DISTANCE 1.52E 02 M.
NOISE LEVEL IN EPNDB = 1.025E 02 AT A SIDELINE DISTANCE 4.63E 02 M.

CONTOUR POINTS

NOISE LEVEL (EPNDB)	LEFT CONTOUR POINT (M.)	(M.)	RIGHT CONTOUR POINT (M.)	(M.)	ACCUMULATED AREA (SQUARE M.)	ERROR CODE
8.000E 01	6.309E 03	-2.643E 03	-6.309E 03	-2.643E 03	1.262E 07	-1
9.000E 01	1.991E 03	-1.497E 02	-1.991E 03	-1.497E 02	3.983E 06	-1
1.000E 02	6.209E 02	6.415E 02	-6.209E 02	6.415E 02	1.242E 06	-1

AIRCRAFT COORDINATES(X,Y,Z) IN M. (0.0 , 1.500E 03, 5.000E 00)

DISTANCE ALONG FLIGHT TRACK = 1.500E 03 M.

ENGINE ATTITUDE ANGLE = 1.00E 01 (DEGREES) , DIRECTIVITY ANGLE = 1.20E 02 (DEGREES)

ENGINE PRESSURE RATIO = 2.00E 00

NOISE LEVEL IN EPNDB = 1.312E 02 AT A SIDELINE DISTANCE 1.00E 00 M.
NOISE LEVEL IN EPNDB = 1.115E 02 AT A SIDELINE DISTANCE 1.52E 02 M.
NOISE LEVEL IN EPNDB = 1.028E 02 AT A SIDELINE DISTANCE 4.63E 02 M.

CONTOUR POINTS

NOISE LEVEL (EPNDB)	LEFT CONTOUR POINT (M.)	(M.)	RIGHT CONTOUR POINT (M.)	(M.)	ACCUMULATED AREA (SQUARE M.)	ERROR CODE
8.000E 01	6.325E 03	-2.226E 03	-6.325E 03	-2.226E 03	1.788E 07	-1
9.000E 01	2.007E 03	3.182E 02	-2.007E 03	3.182E 02	5.354E 06	-1
1.000E 02	6.370E 02	1.126E 03	-6.370E 02	1.126E 03	1.851E 06	-1

THIS IS CASE 1 TAKEOFF

AIRCRAFT COORDINATES(X,Y,Z) IN M. (0.0 , 2.000E 03, 5.000E 01)

DISTANCE ALONG FLIGHT TRACK = 2.000E 03 M.

ENGINE ATTITUDE ANGLE = 2.00E 01 (DEGREES) , DIRECTIVITY ANGLE = 1.20E 02 (DEGREES)

ENGINE PRESSURE RATIO = 2.00E 00

NOISE LEVEL IN EPNDB = 1.251E 02 AT A SIDELINE DISTANCE 1.00E 00 M.
NOISE LEVEL IN EPNDB = 1.157E 02 AT A SIDELINE DISTANCE 1.52E 02 M.
NOISE LEVEL IN EPNDB = 1.052E 02 AT A SIDELINE DISTANCE 4.63E 02 M.

CONTOUR POINTS

NOISE LEVEL (EPNDB)	LEFT CONTOUR POINT (M.)	(M.)	RIGHT CONTOUR POINT (M.)	(M.)	ACCUMULATED AREA (SQUARE M.)	ERROR CODE
8.000E 01	6.460E 03	-2.034E 03	-6.460E 03	-2.034E 03	2.034E 07	-1
9.000E 01	2.139E 03	6.810E 02	-2.139E 03	6.810E 02	7.358E 06	-1
1.000E 02	7.603E 02	1.546E 03	-7.603E 02	1.546E 03	2.439E 06	-1

AIRCRAFT COORDINATES(X,Y,Z) IN M. (0.0 , 2.500E 03, 1.000E 02)

DISTANCE ALONG FLIGHT TRACK = 2.500E 03 M.

ENGINE ATTITUDE ANGLE = 2.00E 01 (DEGREES) , DIRECTIVITY ANGLE = 1.20E 02 (DEGREES)

ENGINE PRESSURE RATIO = 2.00E 00

NOISE LEVEL IN EPNDB = 1.232E 02 AT A SIDELINE DISTANCE 1.00E 00 M.
NOISE LEVEL IN EPNDB = 1.169E 02 AT A SIDELINE DISTANCE 1.52E 02 M.
NOISE LEVEL IN EPNDB = 1.067E 02 AT A SIDELINE DISTANCE 4.63E 02 M.

CONTOUR POINTS

NOISE LEVEL (EPNDB)	LEFT CONTOUR POINT (M.)	(M.)	RIGHT CONTOUR POINT (M.)	(M.)	ACCUMULATED AREA (SQUARE M.)	ERROR CODE
8.000E 01	6.606E 03	-1.601E 03	-6.606E 03	-1.601E 03	2.599E 07	-1
9.000E 01	2.276E 03	1.119E 03	-2.276E 03	1.119E 03	9.291E 06	-1
1.000E 02	8.769E 02	1.995E 03	-8.769E 02	1.995E 03	3.174E 06	-1

THIS IS CASE 1 TAKEOFF

AIRCRAFT COORDINATES(X,Y,Z) IN M. (0.0 , 3.000E 03, 1.500E 02)

DISTANCE ALONG FLIGHT TRACK = 3.000E 03 M.

ENGINE ATTITUDE ANGLE = 2.00E 01 (DEGREES) , DIRECTIVITY ANGLE = 1.20E 02 (DEGREES)

ENGINE PRESSURE RATIO = 2.00E 00

NOISE LEVEL IN EPNDB = 1.210E 02 AT A SIDELINE DISTANCE 1.00E 00 M.
NOISE LEVEL IN EPNDB = 1.169E 02 AT A SIDELINE DISTANCE 1.52E 02 M.
NOISE LEVEL IN EPNDB = 1.074E 02 AT A SIDELINE DISTANCE 4.63E 02 M.

CONTOUR POINTS

NOISE LEVEL (EPNDB)	LEFT CONTOUR POINT (M.)	(M.)	RIGHT CONTOUR POINT (M.)	(M.)	ACCUMULATED AREA (SQUARE M.)	ERROR CODE
8.000E 01	6.750E 03	-1.167E 03	-6.750E 03	-1.167E 03	3.179E 07	-1
9.000E 01	2.405E 03	1.561E 03	-2.405E 03	1.561E 03	1.136E 07	-1
1.000E 02	9.576E 02	2.466E 03	-9.576E 02	2.466E 03	4.037E 06	-1

AIRCRAFT COORDINATES(X,Y,Z) IN M. (0.0 , 3.500E 03, 2.000E 02)

DISTANCE ALONG FLIGHT TRACK = 3.500E 03 M.

ENGINE ATTITUDE ANGLE = 2.00E 01 (DEGREES) , DIRECTIVITY ANGLE = 1.20E 02 (DEGREES)

ENGINE PRESSURE RATIO = 2.00E 00

NOISE LEVEL IN EPNDB = 1.193E 02 AT A SIDELINE DISTANCE 1.00E 00 M.
NOISE LEVEL IN EPNDB = 1.162E 02 AT A SIDELINE DISTANCE 1.52E 02 M.
NOISE LEVEL IN EPNDB = 1.078E 02 AT A SIDELINE DISTANCE 4.63E 02 M.

CONTOUR POINTS

NOISE LEVEL (EPNDB)	LEFT CONTOUR POINT (M.)	(M.)	RIGHT CONTOUR POINT (M.)	(M.)	ACCUMULATED AREA (SQUARE M.)	ERROR CODE
8.000E 01	6.890E 03	-7.307E 02	-6.890E 03	-7.307E 02	3.774E 07	-1
9.000E 01	2.528E 03	2.007E 03	-2.528E 03	2.007E 03	1.356E 07	-1
1.000E 02	1.003E 03	2.957E 03	-1.003E 03	2.957E 03	4.999E 06	-1

THIS IS CASE 1 TAKEOFF

AIRCRAFT COORDINATES(X,Y,Z) IN M. (0.0 , 4.000E 03, 2.500E 02)

DISTANCE ALONG FLIGHT TRACK = 4.000E 03 M.

ENGINE ATTITUDE ANGLE = 2.00E 01 (DEGREES) , DIRECTIVITY ANGLE = 1.20E 02 (DEGREES)

ENGINE PRESSURE RATIO = 2.00E 00

NOISE LEVEL IN EPNDB = 1.178E 02 AT A SIDELINE DISTANCE 1.00E 00 M.
NOISE LEVEL IN EPNDB = 1.153E 02 AT A SIDELINE DISTANCE 1.52E 02 M.
NOISE LEVEL IN EPNDB = 1.082E 02 AT A SIDELINE DISTANCE 4.63E 02 M.

CONTOUR POINTS

NOISE LEVEL (EPNDB)	LEFT CONTOUR POINT (M.)	(M.)	RIGHT CONTOUR POINT (M.)	(M.)	ACCUMULATED AREA (SQUARE M.)	ERROR CODE
8.000E 01	7.028E 03	-2.928E 02	-7.028E 03	-2.928E 02	4.384E 07	-1
9.000E 01	2.646E 03	2.456E 03	-2.646E 03	2.456E 03	1.588E 07	-1
1.000E 02	1.045E 03	3.448E 03	-1.045E 03	3.448E 03	6.006E 06	-1

AIRCRAFT COORDINATES(X,Y,Z) IN M. (0.0 , 4.500E 03, 3.000E 02)

DISTANCE ALONG FLIGHT TRACK = 4.500E 03 M.

ENGINE ATTITUDE ANGLE = 2.00E 01 (DEGREES) , DIRECTIVITY ANGLE = 1.20E 02 (DEGREES)

ENGINE PRESSURE RATIO = 2.00E 00

NOISE LEVEL IN EPNDB = 1.164E 02 AT A SIDELINE DISTANCE 1.00E 00 M.
NOISE LEVEL IN EPNDB = 1.144E 02 AT A SIDELINE DISTANCE 1.52E 02 M.
NOISE LEVEL IN EPNDB = 1.083E 02 AT A SIDELINE DISTANCE 4.63E 02 M.

CONTOUR POINTS

NOISE LEVEL (EPNDB)	LEFT CONTOUR POINT (M.)	(M.)	RIGHT CONTOUR POINT (M.)	(M.)	ACCUMULATED AREA (SQUARE M.)	ERROR CODE
8.000E 01	7.163E 03	1.464E 02	-7.163E 03	1.464E 02	5.007E 07	-1
9.000E 01	2.758E 03	2.907E 03	-2.758E 03	2.907E 03	1.332E 07	-1
1.000E 02	1.084E 03	3.941E 03	-1.084E 03	3.941E 03	7.055E 06	-1

THIS IS CASE 1 TAKEOFF

AIRCRAFT COORDINATES(X,Y,Z) IN M. (0.0 , 5.000E 03, 3.500E 02)

DISTANCE ALONG FLIGHT TRACK = 5.000E 03 M.

ENGINE ATTITUDE ANGLE = 2.00E 01 (DEGREES) , DIRECTIVITY ANGLE = 1.20E 02 (DEGREES)

ENGINE PRESSURE RATIO = 2.00E 00

NOISE LEVEL IN EPNDB = 1.152E 02 AT A SIDELINE DISTANCE 1.00E 00 M.
NOISE LEVEL IN EPNDB = 1.136E 02 AT A SIDELINE DISTANCE 1.52E 02 M.
NOISE LEVEL IN EPNDB = 1.083E 02 AT A SIDELINE DISTANCE 4.63E 02 M.

CONTOUR POINTS

NOISE LEVEL (EPNDB)	LEFT CONTOUR POINT (M.)	(M.)	RIGHT CONTOUR POINT (M.)	(M.)	ACCUMULATED AREA (SQUARE M.)	ERROR CODE
8.000E 01	7.295E 03	5.870E 02	-7.295E 03	5.870E 02	5.644E 07	-1
9.000E 01	2.867E 03	3.360E 03	-2.867E 03	3.360E 03	2.087E 07	-1
1.000E 02	1.106E 03	4.442E 03	-1.106E 03	4.442E 03	8.153E 06	-1

AIRCRAFT COORDINATES(X,Y,Z) IN M. (0.0 , 5.500E 03, 4.000E 02)

DISTANCE ALONG FLIGHT TRACK = 5.500E 03 M.

ENGINE ATTITUDE ANGLE = 2.00E 01 (DEGREES) , DIRECTIVITY ANGLE = 1.20E 02 (DEGREES)

ENGINE PRESSURE RATIO = 2.00E 00

NOISE LEVEL IN EPNDB = 1.142E 02 AT A SIDELINE DISTANCE 1.00E 00 M.
NOISE LEVEL IN EPNDB = 1.128E 02 AT A SIDELINE DISTANCE 1.52E 02 M.
NOISE LEVEL IN EPNDB = 1.082E 02 AT A SIDELINE DISTANCE 4.63E 02 M.

CONTOUR POINTS

NOISE LEVEL (EPNDB)	LEFT CONTOUR POINT (M.)	(M.)	RIGHT CONTOUR POINT (M.)	(M.)	ACCUMULATED AREA (SQUARE M.)	ERROR CODE
8.000E 01	7.425E 03	1.029E 03	-7.425E 03	1.029E 03	6.295E 07	-1
9.000E 01	2.973E 03	3.815E 03	-2.973E 03	3.815E 03	2.353E 07	-1
1.000E 02	1.127E 03	4.944E 03	-1.127E 03	4.944E 03	9.272E 06	-1

THIS IS CASE 1 TAKEOFF

AIRCRAFT COORDINATES(X,Y,Z) IN M. (0.0 , 6.000E 03, 4.500E 02)

DISTANCE ALONG FLIGHT TRACK = 6.000E 03 M.

ENGINE ATTITUDE ANGLE = 2.00E 01 (DEGREES) , DIRECTIVITY ANGLE = 1.20E 02 (DEGREES)

ENGINE PRESSURE RATIO = 2.00E 00

NOISE LEVEL IN EPNDB = 1.132E 02 AT A SIDELINE DISTANCE 1.00E 00 M.
NOISE LEVEL IN EPNDB = 1.120E 02 AT A SIDELINE DISTANCE 1.52E 02 M.
NOISE LEVEL IN EPNDB = 1.081E 02 AT A SIDELINE DISTANCE 4.63E 02 M.

CONTOUR POINTS

NOISE LEVEL (EPNDB)	LEFT CONTOUR POINT (M.)	(M.)	RIGHT CONTOUR POINT (M.)	(M.)	ACCUMULATED AREA (SQUARE M.)	ERROR CODE
8.000E 01	7.553E 03	1.472E 03	-7.553E 03	1.472E 03	6.958E 07	-1
9.000E 01	3.021E 03	4.305E 03	-3.021E 03	4.305E 03	2.646E 07	-1
1.000E 02	1.146E 03	5.446E 03	-1.146E 03	5.446E 03	1.041E 07	-1

AIRCRAFT COORDINATES(X,Y,Z) IN M. (0.0 , 6.500E 03, 4.750E 02)

DISTANCE ALONG FLIGHT TRACK = 6.500E 03 M.

ENGINE ATTITUDE ANGLE = 1.50E 01 (DEGREES) , DIRECTIVITY ANGLE = 1.20E 02 (DEGREES)

ENGINE PRESSURE RATIO = 1.75E 00

NOISE LEVEL IN EPNDB = 1.097E 02 AT A SIDELINE DISTANCE 1.00E 00 M.
NOISE LEVEL IN EPNDB = 1.087E 02 AT A SIDELINE DISTANCE 1.52E 02 M.
NOISE LEVEL IN EPNDB = 1.052E 02 AT A SIDELINE DISTANCE 4.63E 02 M.

CONTOUR POINTS

NOISE LEVEL (EPNDB)	LEFT CONTOUR POINT (M.)	(M.)	RIGHT CONTOUR POINT (M.)	(M.)	ACCUMULATED AREA (SQUARE M.)	ERROR CODE
8.000E 01	5.866E 03	3.112E 03	-5.866E 03	3.112E 03	9.159E 07	-1
9.000E 01	2.330E 03	5.232E 03	-2.330E 03	5.232E 03	3.143E 07	-1
1.000E 02	8.689E 02	6.068E 03	-8.689E 02	6.068E 03	1.167E 07	-1

THIS IS CASE 1 TAKEOFF

AIRCRAFT COORDINATES(X,Y,Z) IN M. (0.0 , 7.000E 03, 5.000E 02)

DISTANCE ALONG FLIGHT TRACK = 7.000E 03 M.

ENGINE ATTITUDE ANGLE = 1.00E 01 (DEGREES) , DIRECTIVITY ANGLE = 1.20E 02 (DEGREES)

ENGINE PRESSURE RATIO = 1.50E 00

NOISE LEVEL IN EPNDB = 1.016E 02 AT A SIDELINE DISTANCE 1.00E 00 M.
NOISE LEVEL IN EPNDB = 1.006E 02 AT A SIDELINE DISTANCE 1.52E 02 M.
NOISE LEVEL IN EPNDB = 9.735E 01 AT A SIDELINE DISTANCE 4.63E 02 M.

CONTOUR POINTS

NOISE LEVEL (EPNDB)	LEFT CONTOUR POINT (M.)	(M.)	RIGHT CONTOUR POINT (M.)	(M.)	ACCUMULATED AREA (SQUARE M.)	ERROR CODE
8.000E 01	2.969E 03	5.344E 03	-2.969E 03	5.344E 03	1.113E 08	-1
9.000E 01	1.116E 03	6.396E 03	-1.116E 03	6.396E 03	3.544E 07	-1
1.000E 02	0.0	6.854E 03	0.0	6.854E 03	1.235E 07	0

AIRCRAFT COORDINATES(X,Y,Z) IN M. (7.417E 01, 7.494E 03, 5.168E 02)

DISTANCE ALONG FLIGHT TRACK = 7.500E 03 M.

ENGINE ATTITUDE ANGLE = 1.00E 01 (DEGREES) , DIRECTIVITY ANGLE = 1.20E 02 (DEGREES)

ENGINE PRESSURE RATIO = 1.40E 00

NOISE LEVEL IN EPNDB = 9.731E 01 AT A SIDELINE DISTANCE 1.00E 00 M.
NOISE LEVEL IN EPNDB = 9.636E 01 AT A SIDELINE DISTANCE 1.52E 02 M.
NOISE LEVEL IN EPNDB = 9.328E 01 AT A SIDELINE DISTANCE 4.63E 02 M.

CONTOUR POINTS

NOISE LEVEL (EPNDB)	LEFT CONTOUR POINT (M.)	(M.)	RIGHT CONTOUR POINT (M.)	(M.)	ACCUMULATED AREA (SQUARE M.)	ERROR CODE
8.000E 01	1.937E 03	6.076E 03	-2.123E 03	6.685E 03	1.165E 08	-1
9.000E 01	7.395E 02	6.980E 03	-7.128E 02	7.198E 03	3.572E 07	-1
1.000E 02	6.096E 01	7.406E 03	6.096E 01	7.406E 03	1.235E 07	0

THIS IS CASE 1 TAKEOFF

AIRCRAFT COORDINATES(X,Y,Z) IN M. (1.996E 02, 7.978E 03, 5.329E 02)

DISTANCE ALONG FLIGHT TRACK = 8.000E 03 M.

ENGINE ATTITUDE ANGLE = 1.00E 01 (DEGREES) , DIRECTIVITY ANGLE = 1.20E 02 (DEGREES)

ENGINE PRESSURE RATIO = 1.40E 00

NOISE LEVEL IN EPNDB = 9.701E 01 AT A SIDELINE DISTANCE 1.00E 00 M.
NOISE LEVEL IN EPNDB = 9.610E 01 AT A SIDELINE DISTANCE 1.52E 02 M.
NOISE LEVEL IN EPNDB = 9.312E 01 AT A SIDELINE DISTANCE 4.63E 02 M.

CONTOUR POINTS

NOISE LEVEL (EPNDB)	LEFT CONTOUR POINT (M.)	(M.)	RIGHT CONTOUR POINT (M.)	(M.)	ACCUMULATED AREA (SQUARE M.)	ERROR CODE
8.000E 01	1.910E 03	6.370E 03	-2.077E 03	7.403E 03	1.185E 08	-1
9.000E 01	8.064E 02	7.396E 03	-6.137E 02	7.764E 03	3.745E 07	-1
1.000E 02	1.774E 02	7.893E 03	1.774E 02	7.893E 03	1.235E 07	0

AIRCRAFT COORDINATES(X,Y,Z) IN M. (4.139E 02, 8.428E 03, 5.499E 02)

DISTANCE ALONG FLIGHT TRACK = 8.500E 03 M.

ENGINE ATTITUDE ANGLE = 1.00E 01 (DEGREES) , DIRECTIVITY ANGLE = 1.20E 02 (DEGREES)

ENGINE PRESSURE RATIO = 1.40E 00

NOISE LEVEL IN EPNDB = 9.675E 01 AT A SIDELINE DISTANCE 1.00E 00 M.
NOISE LEVEL IN EPNDB = 9.587E 01 AT A SIDELINE DISTANCE 1.52E 02 M.
NOISE LEVEL IN EPNDB = 9.301E 01 AT A SIDELINE DISTANCE 4.63E 02 M.

CONTOUR POINTS

NOISE LEVEL (EPNDB)	LEFT CONTOUR POINT (M.)	(M.)	RIGHT CONTOUR POINT (M.)	(M.)	ACCUMULATED AREA (SQUARE M.)	ERROR CODE
8.000E 01	1.782E 03	6.501E 03	-1.939E 03	8.317E 03	1.206E 08	-1
9.000E 01	8.955E 02	7.736E 03	-4.199E 02	8.378E 03	3.818E 07	-1
1.000E 02	3.801E 02	8.348E 03	3.801E 02	8.348E 03	1.235E 07	0

THIS IS CASE 1 TAKEOFF

AIRCRAFT COORDINATES(X,Y,Z) IN M. (6.385E 02, 8.877E 03, 5.669E 02)

DISTANCE ALONG FLIGHT TRACK = 9.000E 03 M.

ENGINE ATTITUDE ANGLE = 1.00E 01 (DEGREES) , DIRECTIVITY ANGLE = 1.20E 02 (DEGREES)

ENGINE PRESSURE RATIO = 1.40E 00

NOISE LEVEL IN EPNDB = 9.649E 01 AT A SIDELINE DISTANCE 1.00E 00 M.
NOISE LEVEL IN EPNDB = 9.565E 01 AT A SIDELINE DISTANCE 1.52E 02 M.
NOISE LEVEL IN EPNDB = 9.289E 01 AT A SIDELINE DISTANCE 4.63E 02 M.

CONTOUR POINTS

NOISE LEVEL (EPNDB)	LEFT CONTOUR POINT (M.)	(M.)	RIGHT CONTOUR POINT (M.)	(M.)	ACCUMULATED AREA (SQUARE M.)	ERROR CODE
8.000E 01	2.007E 03	6.943E 03	-1.728E 03	8.769E 03	1.226E 08	-1
9.000E 01	1.112E 03	8.184E 03	-1.993E 02	8.825E 03	3.891E 07	-1
1.000E 02	5.996E 02	8.797E 03	5.996E 02	8.797E 03	1.235E 07	0

AIRCRAFT COORDINATES(X,Y,Z) IN M. (9.268E 02, 9.285E 03, 5.833E 02)

DISTANCE ALONG FLIGHT TRACK = 9.500E 03 M.

ENGINE ATTITUDE ANGLE = 1.00E 01 (DEGREES) , DIRECTIVITY ANGLE = 1.20E 02 (DEGREES)

ENGINE PRESSURE RATIO = 1.40E 00

NOISE LEVEL IN EPNDB = 9.625E 01 AT A SIDELINE DISTANCE 1.00E 00 M.
NOISE LEVEL IN EPNDB = 9.544E 01 AT A SIDELINE DISTANCE 1.52E 02 M.
NOISE LEVEL IN EPNDB = 9.277E 01 AT A SIDELINE DISTANCE 4.63E 02 M.

CONTOUR POINTS

NOISE LEVEL (EPNDB)	LEFT CONTOUR POINT (M.)	(M.)	RIGHT CONTOUR POINT (M.)	(M.)	ACCUMULATED AREA (SQUARE M.)	ERROR CODE
8.000E 01	1.974E 03	7.151E 03	-1.436E 03	9.557E 03	1.247E 08	-1
9.000E 01	1.282E 03	8.526E 03	9.234E 01	9.366E 03	3.964E 07	-1
1.000E 02	8.757E 02	9.213E 03	8.757E 02	9.213E 03	1.235E 07	0

THIS IS CASE 1 TAKEOFF

AIRCRAFT COORDINATES(X,Y,Z) IN M. (1.216E 03, 9.694E 03, 5.997E 02)

DISTANCE ALONG FLIGHT TRACK = 1.000E 04 M.

ENGINE ATTITUDE ANGLE = 1.00E 01 (DEGREES) , DIRECTIVITY ANGLE = 1.20E 02 (DEGREES)

ENGINE PRESSURE RATIO = 1.40E 00

NOISE LEVEL IN EPNDB = 9.602E 01 AT A SIDELINE DISTANCE 1.00E 00 M.
NOISE LEVEL IN EPNDB = 9.524E 01 AT A SIDELINE DISTANCE 1.52E 02 M.
NOISE LEVEL IN EPNDB = 9.266E 01 AT A SIDELINE DISTANCE 4.63E 02 M.

CONTOUR POINTS

NOISE LEVEL (EPNDB)	LEFT CONTOUR POINT (M.)	(M.)	RIGHT CONTOUR POINT (M.)	(M.)	ACCUMULATED AREA (SQUARE M.)	ERROR CODE
8.000E 01	2.265E 03	7.551E 03	-1.155E 03	9.970E 03	1.268E 08	-1
9.000E 01	1.567E 03	8.934E 03	3.823E 02	9.772E 03	4.036E 07	-1
1.000E 02	1.164E 03	9.621E 03	1.164E 03	9.621E 03	1.235E 07	0

AIRCRAFT COORDINATES(X,Y,Z) IN M. (1.563E 03, 1.005E 04, 6.166E 02)

DISTANCE ALONG FLIGHT TRACK = 1.050E 04 M.

ENGINE ATTITUDE ANGLE = 1.00E 01 (DEGREES) , DIRECTIVITY ANGLE = 1.20E 02 (DEGREES)

ENGINE PRESSURE RATIO = 1.40E 00

NOISE LEVEL IN EPNDB = 9.578E 01 AT A SIDELINE DISTANCE 1.00E 00 M.
NOISE LEVEL IN EPNDB = 9.503E 01 AT A SIDELINE DISTANCE 1.52E 02 M.
NOISE LEVEL IN EPNDB = 9.254E 01 AT A SIDELINE DISTANCE 4.63E 02 M.

CONTOUR POINTS

NOISE LEVEL (EPNDB)	LEFT CONTOUR POINT (M.)	(M.)	RIGHT CONTOUR POINT (M.)	(M.)	ACCUMULATED AREA (SQUARE M.)	ERROR CODE
8.000E 01	2.277E 03	7.767E 03	-7.458E 02	1.069E 04	1.289E 08	-1
9.000E 01	1.792E 03	9.250E 03	7.524E 02	1.025E 04	4.109E 07	-1
1.000E 02	1.501E 03	9.989E 03	1.501E 03	9.989E 03	1.235E 07	0

THIS IS CASE 1 TAKEOFF

AIRCRAFT COORDINATES(X,Y,Z) IN M. (1.913E 03, 1.041E 04, 6.336E 02)

DISTANCE ALONG FLIGHT TRACK = 1.100E 04 M.

ENGINE ATTITUDE ANGLE = 1.00E 01 (DEGREES) , DIRECTIVITY ANGLE = 1.20E 02 (DEGREES)

ENGINE PRESSURE RATIO = 1.40E 00

NOISE LEVEL IN EPNDB = 9.556E 01 AT A SIDELINE DISTANCE 1.00E 00 M.
NOISE LEVEL IN EPNDB = 9.483E 01 AT A SIDELINE DISTANCE 1.52E 02 M.
NOISE LEVEL IN EPNDB = 9.242E 01 AT A SIDELINE DISTANCE 4.63E 02 M.

CONTOUR POINTS

NOISE LEVEL (EPNDB)	LEFT CONTOUR POINT (M.)	(M.)	RIGHT CONTOUR POINT (M.)	(M.)	ACCUMULATED AREA (SQUARE M.)	ERROR CODE
8.000E 01	2.614E 03	8.111E 03	-3.990E 02	1.107E 04	1.310E 08	-1
9.000E 01	2.133E 03	9.606E 03	1.105E 03	1.061E 04	4.180E 07	-1
1.000E 02	1.851E 03	1.035E 04	1.851E 03	1.035E 04	1.235E 07	0

AIRCRAFT COORDINATES(X,Y,Z) IN M. (2.311E 03, 1.071E 04, 6.504E 02)

DISTANCE ALONG FLIGHT TRACK = 1.150E 04 M.

ENGINE ATTITUDE ANGLE = 1.00E 01 (DEGREES) , DIRECTIVITY ANGLE = 1.20E 02 (DEGREES)

ENGINE PRESSURE RATIO = 1.40E 00

NOISE LEVEL IN EPNDB = 9.533E 01 AT A SIDELINE DISTANCE 1.00E 00 M.
NOISE LEVEL IN EPNDB = 9.463E 01 AT A SIDELINE DISTANCE 1.52E 02 M.
NOISE LEVEL IN EPNDB = 9.230E 01 AT A SIDELINE DISTANCE 4.63E 02 M.

CONTOUR POINTS

NOISE LEVEL (EPNDB)	LEFT CONTOUR POINT (M.)	(M.)	RIGHT CONTOUR POINT (M.)	(M.)	ACCUMULATED AREA (SQUARE M.)	ERROR CODE
8.000E 01	2.678E 03	8.329E 03	1.090E 02	1.170E 04	1.331E 08	-1
9.000E 01	2.410E 03	9.888E 03	1.541E 03	1.103E 04	4.252E 07	-1
1.000E 02	2.240E 03	1.066E 04	2.240E 03	1.066E 04	1.235E 07	0

THIS IS CASE 1 TAKEOFF

AIRCRAFT COORDINATES(X,Y,Z) IN M. (2.709E 03, 1.102E 04, 6.673E 02)

DISTANCE ALONG FLIGHT TRACK = 1.200E 04 M.

ENGINE ATTITUDE ANGLE = 1.00E 01 (DEGREES) , DIRECTIVITY ANGLE = 1.20E 02 (DEGREES)

ENGINE PRESSURE RATIO = 1.40E 00

NOISE LEVEL IN EPNDB = 9.512E 01 AT A SIDELINE DISTANCE 1.00E 00 M.
NOISE LEVEL IN EPNDB = 9.444E 01 AT A SIDELINE DISTANCE 1.52E 02 M.
NOISE LEVEL IN EPNDB = 9.218E 01 AT A SIDELINE DISTANCE 4.63E 02 M.

CONTOUR POINTS

NOISE LEVEL (EPNDB)	LEFT CONTOUR POINT (M.)	(M.)	RIGHT CONTOUR POINT (M.)	(M.)	ACCUMULATED AREA (SQUARE M.)	ERROR CODE
8.000E 01	3.074E 03	8.624E 03	5.010E 02	1.201E 04	1.352E 08	-1
9.000E 01	2.804E 03	1.019E 04	1.940E 03	1.133E 04	4.323E 07	-1
1.000E 02	2.638E 03	1.096E 04	2.638E 03	1.096E 04	1.235E 07	0

AIRCRAFT COORDINATES(X,Y,Z) IN M. (3.124E 03, 1.129E 04, 6.841E 02)

DISTANCE ALONG FLIGHT TRACK = 1.250E 04 M.

ENGINE ATTITUDE ANGLE = 1.00E 01 (DEGREES) , DIRECTIVITY ANGLE = 1.20E 02 (DEGREES)

ENGINE PRESSURE RATIO = 1.40E 00

NOISE LEVEL IN EPNDB = 9.491E 01 AT A SIDELINE DISTANCE 1.00E 00 M.
NOISE LEVEL IN EPNDB = 9.425E 01 AT A SIDELINE DISTANCE 1.52E 02 M.
NOISE LEVEL IN EPNDB = 9.206E 01 AT A SIDELINE DISTANCE 4.63E 02 M.

CONTOUR POINTS

NOISE LEVEL (EPNDB)	LEFT CONTOUR POINT (M.)	(M.)	RIGHT CONTOUR POINT (M.)	(M.)	ACCUMULATED AREA (SQUARE M.)	ERROR CODE
8.000E 01	3.348E 03	8.877E 03	9.722E 02	1.242E 04	1.373E 08	-1
9.000E 01	3.167E 03	1.047E 04	2.376E 03	1.165E 04	4.394E 07	-1
1.000E 02	3.050E 03	1.124E 04	3.050E 03	1.124E 04	1.235E 07	0

THIS IS CASE 1 TAKEOFF

AIRCRAFT COORDINATES(X,Y,Z) IN M. (3.539E 03, 1.157E 04, 7.008E 02)

DISTANCE ALONG FLIGHT TRACK = 1.300E 04 M.

ENGINE ATTITUDE ANGLE = 1.00E 01 (DEGREES) , DIRECTIVITY ANGLE = 1.20E 02 (DEGREES)

ENGINE PRESSURE RATIO = 1.40E 00

NOISE LEVEL IN EPNDB = 9.471E 01 AT A SIDELINE DISTANCE 1.00E 00 M.
NOISE LEVEL IN EPNDB = 9.407E 01 AT A SIDELINE DISTANCE 1.52E 02 M.
NOISE LEVEL IN EPNDB = 9.194E 01 AT A SIDELINE DISTANCE 4.63E 02 M.

CONTOUR POINTS

NOISE LEVEL (EPNDB)	LEFT CONTOUR POINT (M.)	(M.)	RIGHT CONTOUR POINT (M.)	(M.)	ACCUMULATED AREA (SQUARE M.)	ERROR CODE
8.000E 01	3.765E 03	9.147E 03	1.381E 03	1.270E 04	1.394E 08	-1
9.000E 01	3.579E 03	1.075E 04	2.793E 03	1.192E 04	4.465E 07	-1
1.000E 02	3.465E 03	1.152E 04	3.465E 03	1.152E 04	1.235E 07	0

AIRCRAFT COORDINATES(X,Y,Z) IN M. (3.954E 03, 1.185E 04, 7.175E 02)

DISTANCE ALONG FLIGHT TRACK = 1.350E 04 M.

ENGINE ATTITUDE ANGLE = 1.00E 01 (DEGREES) , DIRECTIVITY ANGLE = 1.20E 02 (DEGREES)

ENGINE PRESSURE RATIO = 1.40E 00

NOISE LEVEL IN EPNDB = 9.451E 01 AT A SIDELINE DISTANCE 1.00E 00 M.
NOISE LEVEL IN EPNDB = 9.389E 01 AT A SIDELINE DISTANCE 1.52E 02 M.
NOISE LEVEL IN EPNDB = 9.182E 01 AT A SIDELINE DISTANCE 4.63E 02 M.

CONTOUR POINTS

NOISE LEVEL (EPNDB)	LEFT CONTOUR POINT (M.)	(M.)	RIGHT CONTOUR POINT (M.)	(M.)	ACCUMULATED AREA (SQUARE M.)	ERROR CODE
8.000E 01	4.182E 03	9.418E 03	1.789E 03	1.298E 04	1.415E 08	-1
9.000E 01	3.990E 03	1.103E 04	3.209E 03	1.220E 04	4.535E 07	-1
1.000E 02	3.881E 03	1.180E 04	3.881E 03	1.180E 04	1.235E 07	0

THIS IS CASE 1 TAKEOFF

AIRCRAFT COORDINATES(X,Y,Z) IN M. (4.370E 03, 1.213E 04, 7.342E 02)

DISTANCE ALONG FLIGHT TRACK = 1.400E 04 M.

ENGINE ATTITUDE ANGLE = 1.00E 01 (DEGREES) , DIRECTIVITY ANGLE = 1.20E 02 (DEGREES)

ENGINE PRESSURE RATIO = 1.40E 00

NOISE LEVEL IN EPNDB = 9.432E 01 AT A SIDELINE DISTANCE 1.00E 00 M.
NOISE LEVEL IN EPNDB = 9.372E 01 AT A SIDELINE DISTANCE 1.52E 02 M.
NOISE LEVEL IN EPNDB = 9.170E 01 AT A SIDELINE DISTANCE 4.63E 02 M.

CONTOUR POINTS

NOISE LEVEL (EPNDB)	LEFT CONTOUR POINT (M.)	(M.)	RIGHT CONTOUR POINT (M.)	(M.)	ACCUMULATED AREA (SQUARE M.)	ERROR CODE
8.000E 01	4.598E 03	9.689E 03	2.198E 03	1.327E 04	1.437E 08	-1
9.000E 01	4.400E 03	1.132E 04	3.630E 03	1.247E 04	4.605E 07	-1
1.000E 02	4.296E 03	1.208E 04	4.296E 03	1.208E 04	1.235E 07	0

AIRCRAFT COORDINATES(X,Y,Z) IN M. (4.785E 03, 1.241E 04, 7.509E 02)

DISTANCE ALONG FLIGHT TRACK = 1.450E 04 M.

ENGINE ATTITUDE ANGLE = 1.00E 01 (DEGREES) , DIRECTIVITY ANGLE = 1.20E 02 (DEGREES)

ENGINE PRESSURE RATIO = 1.40E 00

NOISE LEVEL IN EPNDB = 9.413E 01 AT A SIDELINE DISTANCE 1.00E 00 M.
NOISE LEVEL IN EPNDB = 9.354E 01 AT A SIDELINE DISTANCE 1.52E 02 M.
NOISE LEVEL IN EPNDB = 9.159E 01 AT A SIDELINE DISTANCE 4.63E 02 M.

CONTOUR POINTS

NOISE LEVEL (EPNDB)	LEFT CONTOUR POINT (M.)	(M.)	RIGHT CONTOUR POINT (M.)	(M.)	ACCUMULATED AREA (SQUARE M.)	ERROR CODE
8.000E 01	5.014E 03	9.960E 03	2.607E 03	1.355E 04	1.458E 08	-1
9.000E 01	4.810E 03	1.161E 04	4.052E 03	1.274E 04	4.673E 07	-1
1.000E 02	4.711E 03	1.236E 04	4.711E 03	1.236E 04	1.235E 07	0

THIS IS CASE 1 TAKEOFF

AIRCRAFT COORDINATES(X,Y,Z) IN M. (5.200E 03, 1.269E 04, 7.676E 02)

DISTANCE ALONG FLIGHT TRACK = 1.500E 04 M.

ENGINE ATTITUDE ANGLE = 1.00E 01 (DEGREES) , DIRECTIVITY ANGLE = 1.20E 02 (DEGREES)

ENGINE PRESSURE RATIO = 1.40E 00

NOISE LEVEL IN EPNDB = 9.394E 01 AT A SIDELINE DISTANCE 1.00E 00 M.
NOISE LEVEL IN EPNDB = 9.337E 01 AT A SIDELINE DISTANCE 1.52E 02 M.
NOISE LEVEL IN EPNDB = 9.147E 01 AT A SIDELINE DISTANCE 4.63E 02 M.

CONTOUR POINTS

NOISE LEVEL (EPNDB)	LEFT CONTOUR POINT (M.)	(M.)	RIGHT CONTOUR POINT (M.)	(M.)	ACCUMULATED AREA (SQUARE M.)	ERROR CODE
8.000E 01	5.431E 03	1.023E 04	3.016E 03	1.383E 04	1.480E 08	-1
9.000E 01	5.220E 03	1.189E 04	4.475E 03	1.301E 04	4.741E 07	-1
1.000E 02	5.126E 03	1.264E 04	5.126E 03	1.264E 04	1.235E 07	0

AIRCRAFT COORDINATES(X,Y,Z) IN M. (5.615E 03, 1.297E 04, 7.843E 02)

DISTANCE ALONG FLIGHT TRACK = 1.550E 04 M.

ENGINE ATTITUDE ANGLE = 1.00E 01 (DEGREES) , DIRECTIVITY ANGLE = 1.20E 02 (DEGREES)

ENGINE PRESSURE RATIO = 1.40E 00

NOISE LEVEL IN EPNDB = 9.376E 01 AT A SIDELINE DISTANCE 1.00E 00 M.
NOISE LEVEL IN EPNDB = 9.321E 01 AT A SIDELINE DISTANCE 1.52E 02 M.
NOISE LEVEL IN EPNDB = 9.135E 01 AT A SIDELINE DISTANCE 4.63E 02 M.

CONTOUR POINTS

NOISE LEVEL (EPNDB)	LEFT CONTOUR POINT (M.)	(M.)	RIGHT CONTOUR POINT (M.)	(M.)	ACCUMULATED AREA (SQUARE M.)	ERROR CODE
8.000E 01	5.847E 03	1.050E 04	3.424E 03	1.411E 04	1.501E 08	-1
9.000E 01	5.629E 03	1.218E 04	4.397E 03	1.327E 04	4.307E 07	-1
1.000E 02	5.542E 03	1.292E 04	5.542E 03	1.292E 04	1.235E 07	0

THIS IS CASE 1 TAKEOFF

AIRCRAFT COORDINATES(X,Y,Z) IN M. (6.031E 03, 1.324E 04, 8.010E 02)

DISTANCE ALONG FLIGHT TRACK = 1.600E 04 M.

ENGINE ATTITUDE ANGLE = 1.00E 01 (DEGREES) , DIRECTIVITY ANGLE = 1.20E 02 (DEGREES)

ENGINE PRESSURE RATIO = 1.40E 00

NOISE LEVEL IN EPNDB = 9.358E 01 AT A SIDELINE DISTANCE 1.00E 00 M.
NOISE LEVEL IN EPNDB = 9.304E 01 AT A SIDELINE DISTANCE 1.52E 02 M.
NOISE LEVEL IN EPNDB = 9.124E 01 AT A SIDELINE DISTANCE 4.63E 02 M.

CONTOUR POINTS

NOISE LEVEL (EPNDB)	LEFT CONTOUR POINT (M.)	(M.)	RIGHT CONTOUR POINT (M.)	(M.)	ACCUMULATED AREA (SQUARE M.)	ERROR CODE
8.000E 01	6.263E 03	1.077E 04	3.833E 03	1.440E 04	1.523E 08	-1
9.000E 01	6.038E 03	1.247E 04	5.320E 03	1.354E 04	4.873E 07	-1
1.000E 02	5.957E 03	1.319E 04	5.957E 03	1.319E 04	1.235E 07	0

AIRCRAFT COORDINATES(X,Y,Z) IN M. (6.446E 03, 1.352E 04, 8.177E 02)

DISTANCE ALONG FLIGHT TRACK = 1.650E 04 M.

ENGINE ATTITUDE ANGLE = 1.00E 01 (DEGREES) , DIRECTIVITY ANGLE = 1.20E 02 (DEGREES)

ENGINE PRESSURE RATIO = 1.40E 00

NOISE LEVEL IN EPNDB = 9.341E 01 AT A SIDELINE DISTANCE 1.00E 00 M.
NOISE LEVEL IN EPNDB = 9.288E 01 AT A SIDELINE DISTANCE 1.52E 02 M.
NOISE LEVEL IN EPNDB = 9.112E 01 AT A SIDELINE DISTANCE 4.63E 02 M.

CONTOUR POINTS

NOISE LEVEL (EPNDB)	LEFT CONTOUR POINT (M.)	(M.)	RIGHT CONTOUR POINT (M.)	(M.)	ACCUMULATED AREA (SQUARE M.)	ERROR CODE
8.000E 01	6.680E 03	1.105E 04	4.243E 03	1.468E 04	1.545E 08	-1
9.000E 01	6.447E 03	1.276E 04	5.743E 03	1.381E 04	4.936E 07	-1
1.000E 02	6.372E 03	1.347E 04	6.372E 03	1.347E 04	1.235E 07	0

THIS IS CASE 1 TAKEOFF

AIRCRAFT COORDINATES(X,Y,Z) IN M. (6.861E 03, 1.380E 04, 8.345E 02)

DISTANCE ALONG FLIGHT TRACK = 1.700E 04 M.

ENGINE ATTITUDE ANGLE = 1.00E 01 (DEGREES) , DIRECTIVITY ANGLE = 1.20E 02 (DEGREES)

ENGINE PRESSURE RATIO = 1.40E 00

NOISE LEVEL IN EPNDB = 9.323E 01 AT A SIDELINE DISTANCE 1.00E 00 M.
NOISE LEVEL IN EPNDB = 9.272E 01 AT A SIDELINE DISTANCE 1.52E 02 M.
NOISE LEVEL IN EPNDB = 9.101E 01 AT A SIDELINE DISTANCE 4.63E 02 M.

CONTOUR POINTS

NOISE LEVEL (EPNDB)	LEFT CONTOUR POINT (M.)	(M.)	RIGHT CONTOUR POINT (M.)	(M.)	ACCUMULATED AREA (SQUARE M.)	ERROR CODE
8.000E 01	7.096E 03	1.132E 04	4.652E 03	1.496E 04	1.566E 08	-1
9.000E 01	6.855E 03	1.305E 04	6.166E 03	1.408E 04	4.999E 07	-1
1.000E 02	6.787E 03	1.375E 04	6.787E 03	1.375E 04	1.235E 07	0

AIRCRAFT COORDINATES(X,Y,Z) IN M. (7.276E 03, 1.408E 04, 8.512E 02)

DISTANCE ALONG FLIGHT TRACK = 1.750E 04 M.

ENGINE ATTITUDE ANGLE = 1.00E 01 (DEGREES) , DIRECTIVITY ANGLE = 1.20E 02 (DEGREES)

ENGINE PRESSURE RATIO = 1.40E 00

NOISE LEVEL IN EPNDB = 9.306E 01 AT A SIDELINE DISTANCE 1.00E 00 M.
NOISE LEVEL IN EPNDB = 9.256E 01 AT A SIDELINE DISTANCE 1.52E 02 M.
NOISE LEVEL IN EPNDB = 9.090E 01 AT A SIDELINE DISTANCE 4.63E 02 M.

CONTOUR POINTS

NOISE LEVEL (EPNDB)	LEFT CONTOUR POINT (M.)	(M.)	RIGHT CONTOUR POINT (M.)	(M.)	ACCUMULATED AREA (SQUARE M.)	ERROR CODE
8.000E 01	7.512E 03	1.159E 04	5.061E 03	1.524E 04	1.588E 08	-1
9.000E 01	7.263E 03	1.334E 04	6.589E 03	1.435E 04	5.060E 07	-1
1.000E 02	7.203E 03	1.403E 04	7.203E 03	1.403E 04	1.235E 07	0

THIS IS CASE 1 TAKEOFF

CONTOUR AT 80. EPNDB IN M

LEFT		RIGHT	
6.30937E 03	-3.14271E 03	-6.30937E 03	-3.14271E 03
6.30937E 03	-2.64271E 03	-6.30937E 03	-2.64271E 03
6.32528E 03	-2.22641E 03	-6.32528E 03	-2.22641E 03
6.45966E 03	-2.03423E 03	-6.45966E 03	-2.03423E 03
6.60616E 03	-1.60133E 03	-6.60616E 03	-1.60133E 03
6.74991E 03	-1.16695E 03	-6.74991E 03	-1.16695E 03
6.89023E 03	-7.30669E 02	-6.89023E 03	-7.30669E 02
7.02771E 03	-2.92829E 02	-7.02771E 03	-2.92829E 02
7.16257E 03	1.46438E 02	-7.16257E 03	1.46438E 02
7.29496E 03	5.87039E 02	-7.29496E 03	5.87039E 02
7.42508E 03	1.02889E 03	-7.42508E 03	1.02889E 03
7.55306E 03	1.47190E 03	-7.55306E 03	1.47190E 03
5.86592E 03	3.11222E 03	-5.86592E 03	3.11222E 03
2.96868E 03	5.34362E 03	-2.96868E 03	5.34362E 03
1.93714E 03	6.07616E 03	-2.12294E 03	6.68518E 03
1.90969E 03	6.36953E 03	-2.07669E 03	7.40262E 03
1.78232E 03	6.50087E 03	-1.93896E 03	8.31724E 03
2.00668E 03	6.94250E 03	-1.72839E 03	8.76853E 03
1.97428E 03	7.15062E 03	-1.43563E 03	9.55695E 03
2.26520E 03	7.55050E 03	-1.15488E 03	9.96957E 03
2.27744E 03	7.76712E 03	-7.45804E 02	1.06898E 04
2.61412E 03	8.11098E 03	-3.99050E 02	1.10665E 04
2.67751E 03	8.32935E 03	1.09020E 02	1.16979E 04
3.07444E 03	8.62355E 03	5.01013E 02	1.20073E 04
3.34846E 03	8.87666E 03	9.72211E 02	1.24194E 04
3.76501E 03	9.14736E 03	1.38077E 03	1.27021E 04
4.18159E 03	9.41817E 03	1.78934E 03	1.29847E 04
4.59808E 03	9.68907E 03	2.19799E 03	1.32673E 04
5.01446E 03	9.96008E 03	2.60678E 03	1.35498E 04
5.43086E 03	1.02312E 04	3.01560E 03	1.38322E 04
5.84720E 03	1.05024E 04	3.42450E 03	1.41144E 04
6.26349E 03	1.07737E 04	3.83347E 03	1.43966E 04
6.67971E 03	1.10451E 04	4.24251E 03	1.46788E 04
7.09588E 03	1.13167E 04	4.65164E 03	1.49608E 04
7.51202E 03	1.15883E 04	5.06081E 03	1.52428E 04

TOTAL AREA UNDER CONTOUR =1.588120E 08 SQ. M

THIS IS CASE 1 TAKEOFF

CONTOUR AT 90. EPNDB IN M

LEFT		RIGHT	
1.99138E 03	-6.49721E 02	-1.99138E 03	-6.49721E 02
1.99138E 03	-1.49721E 02	-1.99138E 03	-1.49721E 02
2.00734E 03	3.18223E 02	-2.00734E 03	3.18223E 02
2.13861E 03	6.80977E 02	-2.13861E 03	6.80977E 02
2.27586E 03	1.11891E 03	-2.27586E 03	1.11891E 03
2.40530E 03	1.56110E 03	-2.40530E 03	1.56110E 03
2.52825E 03	2.00683E 03	-2.52825E 03	2.00683E 03
2.64569E 03	2.45552E 03	-2.64569E 03	2.45552E 03
2.75839E 03	2.90674E 03	-2.75839E 03	2.90674E 03
2.86693E 03	3.36018E 03	-2.86693E 03	3.36018E 03
2.97317E 03	3.81471E 03	-2.97317E 03	3.81471E 03
3.02115E 03	4.30508E 03	-3.02115E 03	4.30508E 03
2.33013E 03	5.23232E 03	-2.33013E 03	5.23232E 03
1.11572E 03	6.39574E 03	-1.11572E 03	6.39574E 03
7.39484E 02	6.98004E 03	-7.12793E 02	7.19788E 03
8.06421E 02	7.39600E 03	-6.13732E 02	7.76405E 03
8.95500E 02	7.73563E 03	-4.19943E 02	8.37770E 03
1.11238E 03	8.18411E 03	-1.99291E 02	8.82537E 03
1.28189E 03	8.52610E 03	9.23440E 01	9.36555E 03
1.56711E 03	8.93418E 03	3.82302E 02	9.77221E 03
1.79192E 03	9.24977E 03	7.52410E 02	1.02547E 04
2.13300E 03	9.60602E 03	1.10500E 03	1.06143E 04
2.41019E 03	9.88767E 03	1.54100E 03	1.10276E 04
2.80386E 03	1.01921E 04	1.94033E 03	1.13276E 04
3.16677E 03	1.04687E 04	2.37630E 03	1.16472E 04
3.57856E 03	1.07498E 04	2.79258E 03	1.19216E 04
3.99031E 03	1.10305E 04	3.20853E 03	1.21960E 04
4.40043E 03	1.13183E 04	3.63038E 03	1.24663E 04
4.81027E 03	1.16063E 04	4.05241E 03	1.27362E 04
5.21984E 03	1.18947E 04	4.47466E 03	1.30057E 04
5.62911E 03	1.21835E 04	4.89713E 03	1.32748E 04
6.03805E 03	1.24727E 04	5.31984E 03	1.35435E 04
6.44666E 03	1.27623E 04	5.74280E 03	1.38116E 04
6.85493E 03	1.30523E 04	6.16602E 03	1.40794E 04
7.26236E 03	1.33427E 04	6.58950E 03	1.43466E 04

TOTAL AREA UNDER CONTOUR =5.060240E 07 SQ. M

THIS IS CASE 1 TAKEOFF

CONTOUR AT 100. EPNDB IN M

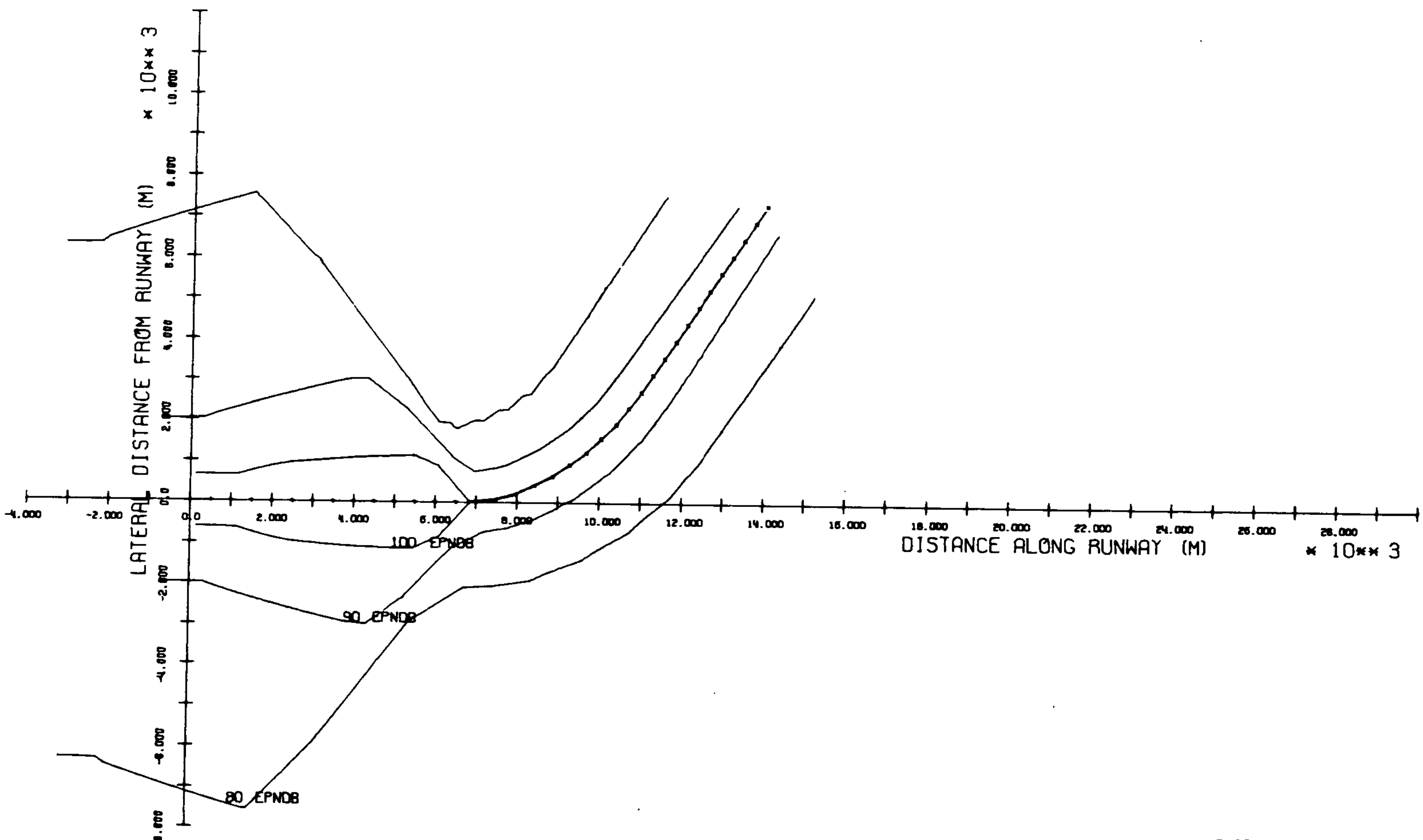
LEFT		RIGHT	
6.20905E 02	1.41521E 02	-6.20905E 02	1.41521E 02
6.20905E 02	6.41520E 02	-6.20905E 02	6.41520E 02
6.37010E 02	1.12577E 03	-6.37010E 02	1.12577E 03
7.60307E 02	1.54636E 03	-7.60307E 02	1.54636E 03
8.76936E 02	1.99545E 03	-8.76936E 02	1.99545E 03
9.57601E 02	2.46568E 03	-9.57601E 02	2.46568E 03
1.00289E 03	2.95662E 03	-1.00289E 03	2.95662E 03
1.04475E 03	3.44847E 03	-1.04475E 03	3.44847E 03
1.08358E 03	3.94110E 03	-1.08358E 03	3.94110E 03
1.10619E 03	4.44245E 03	-1.10619E 03	4.44245E 03
1.12677E 03	4.94395E 03	-1.12677E 03	4.94395E 03
1.14555E 03	5.44552E 03	-1.14555E 03	5.44552E 03
8.68895E 02	6.06803E 03	-8.68895E 02	6.06803E 03
0.0	6.85412E 03	0.0	6.85412E 03
6.09608E 01	7.40640E 03	6.09608E 01	7.40640E 03
1.77380E 02	7.89272E 03	1.77380E 02	7.89272E 03
3.80057E 02	8.34816E 03	3.80057E 02	8.34816E 03
5.99613E 02	8.79738E 03	5.99613E 02	8.79738E 03
8.75711E 02	9.21307E 03	8.75711E 02	9.21307E 03
1.16437E 03	9.62134E 03	1.16437E 03	9.62134E 03
1.50142E 03	9.98938E 03	1.50142E 03	9.98938E 03
1.85096E 03	1.03467E 04	1.85096E 03	1.03467E 04
2.24015E 03	1.06594E 04	2.24015E 03	1.06594E 04
2.63805E 03	1.09621E 04	2.63805E 03	1.09621E 04
3.05024E 03	1.12449E 04	3.05024E 03	1.12449E 04
3.46548E 03	1.15234E 04	3.46548E 03	1.15234E 04
3.88073E 03	1.18019E 04	3.88073E 03	1.18019E 04
4.29596E 03	1.20805E 04	4.29596E 03	1.20805E 04
4.71121E 03	1.23590E 04	4.71121E 03	1.23590E 04
5.12646E 03	1.26375E 04	5.12646E 03	1.26375E 04
5.54171E 03	1.29160E 04	5.54171E 03	1.29160E 04
5.95695E 03	1.31945E 04	5.95695E 03	1.31945E 04
6.37220E 03	1.34731E 04	6.37220E 03	1.34731E 04
6.78745E 03	1.37516E 04	6.78745E 03	1.37516E 04
7.20269E 03	1.40301E 04	7.20269E 03	1.40301E 04

TOTAL AREA UNDER CONTOUR =1.234910E 07 SQ. M

SIDELINE NOISE LEVELS

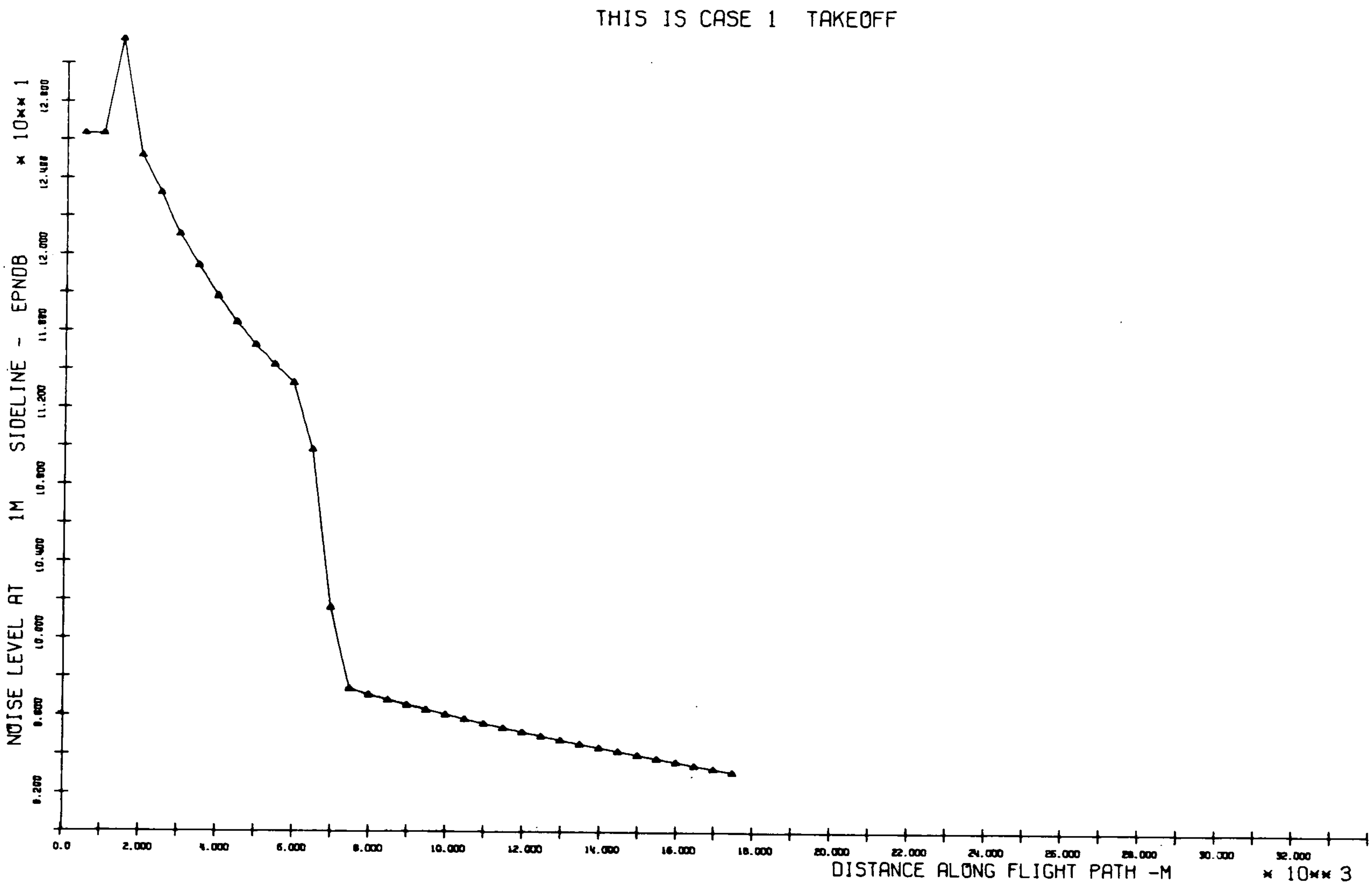
FLIGHT PATH DISTANCE (M)	NOISE LEVEL (EPNDB) 1(M)	152(M)	463(M)
5.000E 02	1.263E 02	1.106E 02	1.025E 02
1.000E 03	1.263E 02	1.106E 02	1.025E 02
1.500E 03	1.312E 02	1.115E 02	1.028E 02
2.000E 03	1.251E 02	1.157E 02	1.052E 02
2.500E 03	1.232E 02	1.169E 02	1.067E 02
3.000E 03	1.210E 02	1.169E 02	1.074E 02
3.500E 03	1.193E 02	1.162E 02	1.078E 02
4.000E 03	1.178E 02	1.153E 02	1.082E 02
4.500E 03	1.164E 02	1.144E 02	1.083E 02
5.000E 03	1.152E 02	1.136E 02	1.083E 02
5.500E 03	1.142E 02	1.128E 02	1.082E 02
6.000E 03	1.132E 02	1.120E 02	1.081E 02
6.500E 03	1.097E 02	1.087E 02	1.052E 02
7.000E 03	1.016E 02	1.006E 02	9.735E 01
7.500E 03	9.731E 01	9.636E 01	9.328E 01
8.000E 03	9.701E 01	9.610E 01	9.312E 01
8.500E 03	9.675E 01	9.587E 01	9.301E 01
9.000E 03	9.649E 01	9.565E 01	9.289E 01
9.500E 03	9.625E 01	9.544E 01	9.277E 01
1.000E 04	9.602E 01	9.524E 01	9.266E 01
1.050E 04	9.578E 01	9.503E 01	9.254E 01
1.100E 04	9.556E 01	9.483E 01	9.242E 01
1.150E 04	9.533E 01	9.463E 01	9.230E 01
1.200E 04	9.512E 01	9.444E 01	9.218E 01
1.250E 04	9.491E 01	9.425E 01	9.206E 01
1.300E 04	9.471E 01	9.407E 01	9.194E 01
1.350E 04	9.451E 01	9.389E 01	9.182E 01
1.400E 04	9.432E 01	9.372E 01	9.170E 01
1.450E 04	9.413E 01	9.354E 01	9.159E 01
1.500E 04	9.394E 01	9.337E 01	9.147E 01
1.550E 04	9.376E 01	9.321E 01	9.135E 01
1.600E 04	9.358E 01	9.304E 01	9.124E 01
1.650E 04	9.341E 01	9.288E 01	9.112E 01
1.700E 04	9.323E 01	9.272E 01	9.101E 01
1.750E 04	9.306E 01	9.256E 01	9.090E 01

THIS IS CASE 1 TAKEOFF

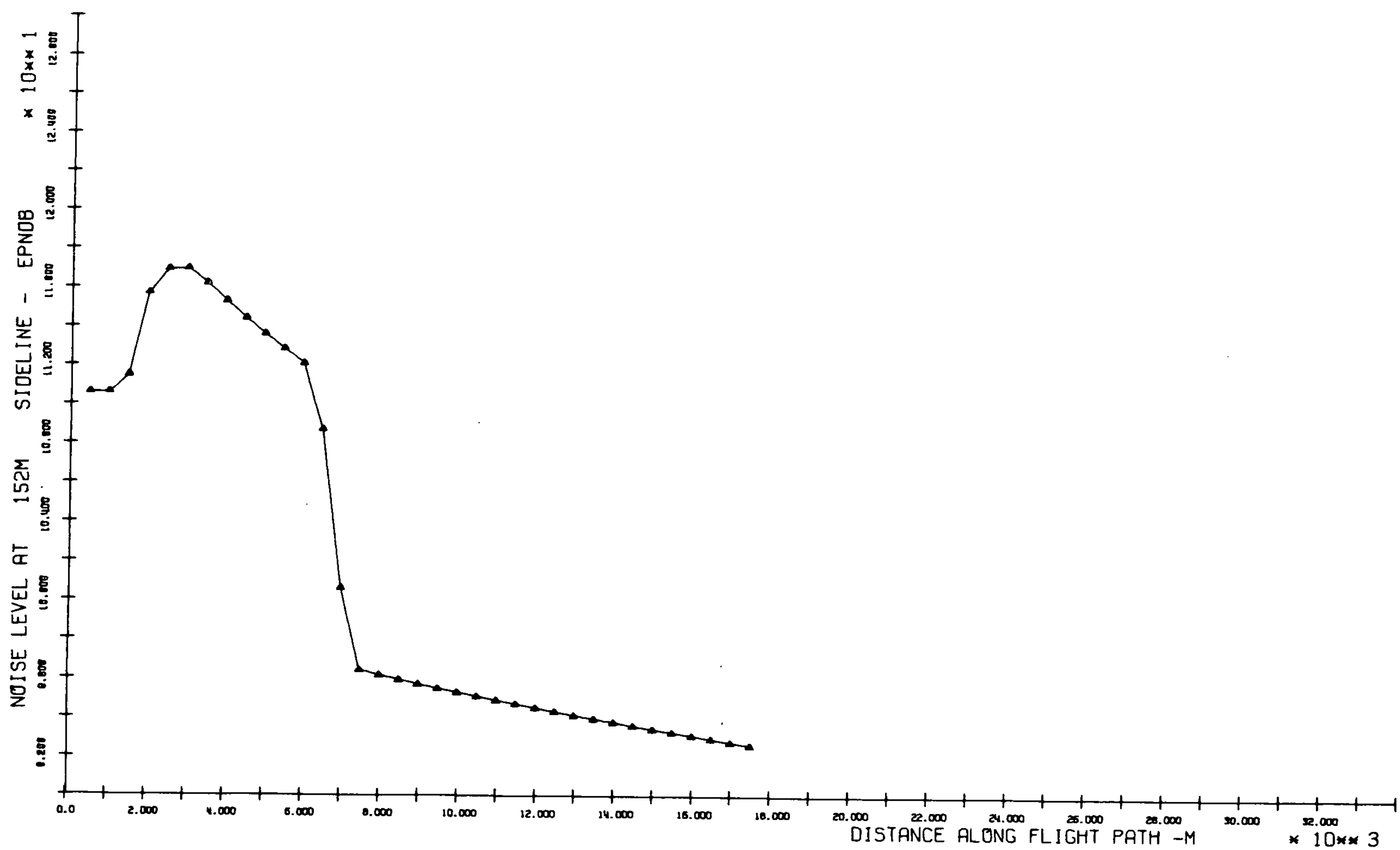


CONTOUR EPNDB	AREA SQ. M
80	1.588 E8
90	5.060 E7
100	1.235 E7

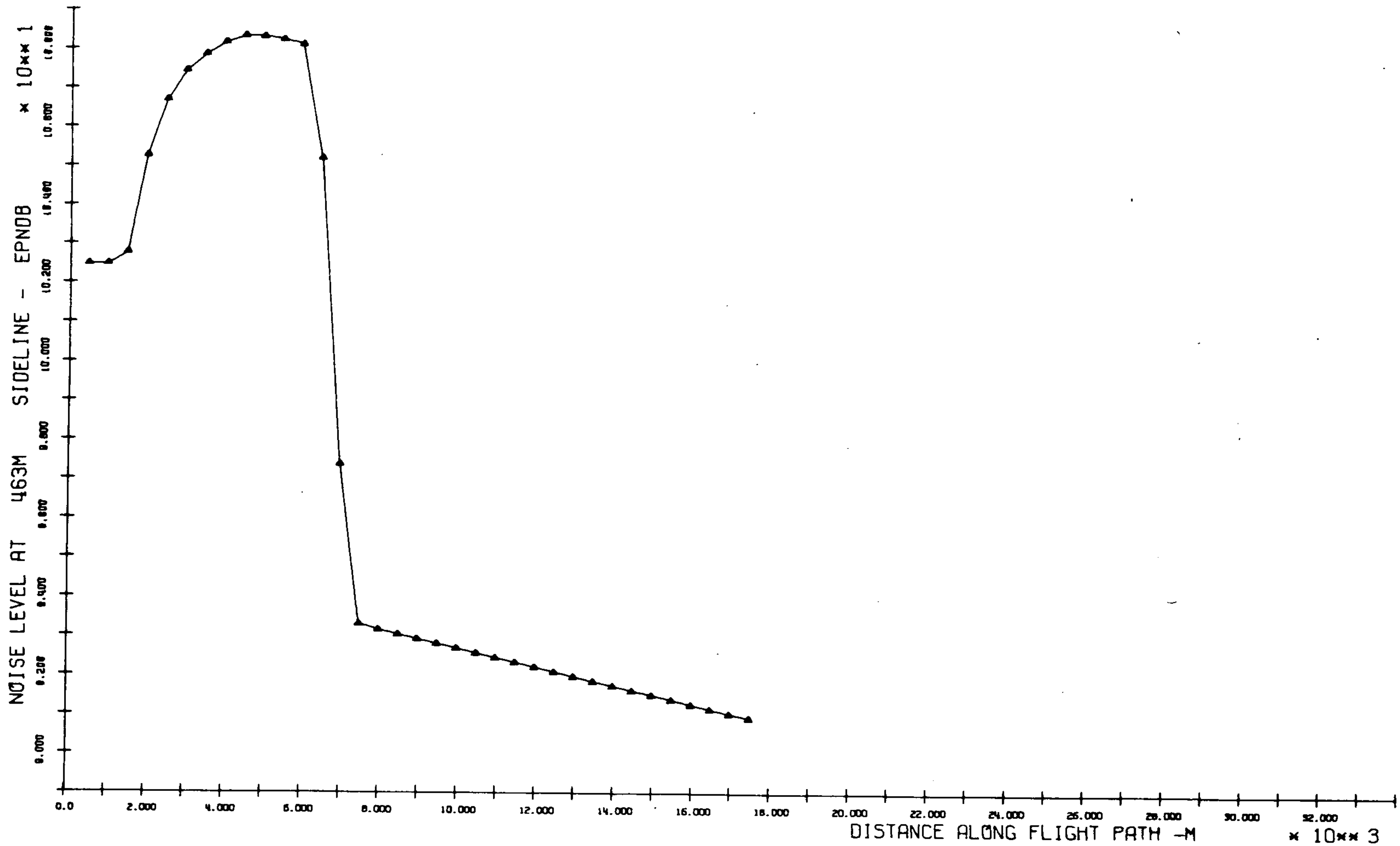
SCALE=1 CM/ 1000 M


THIS IS CASE 1 TAKEOFF
NOISE LEVEL AT 1M SIDELINE - EPNDB * 10** 1
0.0
2.000
4.000
6.000
8.000
10.000
12.000
14.000
16.000
18.000
20.000
22.000
24.000
26.000
28.000
30.000
32.000
DISTANCE ALONG FLIGHT PATH -M * 10** 3

THIS IS CASE 1 TAKEOFF



THIS IS CASE 1 TAKEOFF



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