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A Computer Program for the Prediction of Near-Field Noise of Aircraft in Cruising Flight -- User's Guide

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FOREWORD

This document is submitted in accordance with the requirements of NASA Contract NAS1-14946, Modification Number 3, Study of the Prediction of Cruise Noise and Laminar Flow Control Noise Criteria for Subsonic Air Transports.

The final technical reports of this program comprise three volumes. The first volume, CR-159104, describes the technical selection and development of cruise noise prediction and LFC noise criteria procedures. The second volume, CR-159105, is a Methods Manual for applying the cruise noise prediction procedures to actual aircraft designs. The final volume, this report, consists of a User's Guide for a computer program developed from the noise prediction procedures described in CR-159105.

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USERS GUIDE FOR NEAR-FIELD CRUISE NOISE PREDICTION PROGRAM

SUMMARY

A computer program for the prediction of near-field aircraft noise under cruise conditions has been developed. The total noise for free-field, lossless conditions at selected observer locations is obtained by summing the contributions from up to nine acoustic sources. These noise sources, selected by the user, include the: fan/compressor, turbine, core (combustion), jet, shock, and airframe (trailing-edges and turbulent boundary layers). The effects of acoustic suppression materials (e.g. engine inlet treatment) may also be included in the noise prediction. The program is available for use on the NASA/Langley Research Center CDC computer. This document provides detailed instructions for using this program, a program listing, and a sample case with output. A few comparisons of the programs predictions with measured data are given and some possible reasons for their lack of agreement presented.

INTRODUCTION

The overall objective of NASA Contract NAS1-14946 (A Study of the Prediction of Cruise Noise and Laminar Flow Control Noise Criteria for Subsonic Air Transports) was to develop procedures for identifying exterior surfaces on laminar flow control (LFC) aircraft which are subject to noise levels which would adversely affect the operation of LFC. Interest in the development of this technology was precipitated by the desire to develop LFC as one method for improving the fuel efficiency of commercial air transports. Two of the primary tasks required to accomplish this objective were (1) to develop from existing technology general procedures for the prediction of aircraft noise incident upon aircraft surfaces during subsonic cruising flight, and (2) to summarize and explicitly define all the prediction methods in a Cruise Noise Prediction Methods Manual. The results of this work are documented in References 1 and 2. This Users Guide represents work done under an extension to the basic contract to develop a Cruise Noise Prediction Computer Program from the Methods Manual procedures of Reference 2. It includes a sample of the comparisons made between noise levels measured on the NASA/Dryden JetStar aircraft and noise levels predicted by the program. Where possible, the prediction method was to have been modified and improved as a result of these comparisons. However, the program has not been modified as a result of these comparisons since those factors responsible for lack of agreement between measured and predicted noise levels have not been identified. This is discussed further with the presentation of the comparisons.

PREDICTION METHODS

The noise prediction methods employed in this program were selected or developed from currently available technology. They are believed to be the best available methods for application to aircraft noise prediction in the near field during cruising flight. It should be pointed out, however, that the term "near field" as applied here actually refers to the close-in acoustic far field[1]. Discussions of the aircraft noise sources considered and the selection and development of the prediction procedures used herein are contained in Reference 1. The details of the resulting computational procedures are given in Reference 2 in the form of a "Methods Manual." As noted in both References, no methods were found in the available literature which were directly applicable to near-field noise prediction in the cruise regime. In the case of prediction methods for propulsion system (or LFC suction system) noise sources, those methods available have typically been derived for the acoustic far field at sea level conditions with no forward speed or for the relatively slow speeds associated with takeoff or landing. This is especially true of the turbomachinery noise sources: fan/compressor, turbine, and core. For these sources, in particular, it is believed that the available methods will produce satisfactory predictions for the close-in far field since these sources are expected to behave essentially as acoustic point sources. Consequently, the basic far-field prediction procedures for the turbomachinery sources have been applied here with modifications as outlined below which attempt to adapt the methods to the cruise environment.

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[1]The acoustic near-field is generally considered to be the region within a couple of wavelengths of the noise source or the region where motion in the medium is strongly influenced by the source. The close-in far-field is used here to describe the region which lies just beyond the near-field and extending into the far field. This is the primary region of interest for cruise noise predictions. In this region, unlike the far-field, the physical dimensions or physical distribution of the noise source is important and must be considered. These effects are discussed in some detail in Reference 1.

The other propulsion system noise sources are the jet, jet shock, and shock screech. In the case of jet mixing noise, the procedure used is a near-field predictor but is strictly only applicable to a single circular nozzle under static conditions. It has been modified as suggested in the literature (see Reference 1) for application to coaxial jets and to account for forward-speed effects on noise source strength. The procedure employed for the prediction of jet shock-associated broadband noise is another far-field prediction method. This source is a distributed source, nevertheless the far-field procedure utilized is considered the best available for the present case. It has shown reasonable agreement with measured near-field data (see Reference 2). The method used to predict shock screech (discrete tone) noise is one developed partially from a near-field data base. See Reference 1. Finally, for the propulsion noise sources, the directivity indices of the basic prediction procedures have been extrapolated where necessary to cover the full range from 0° to 180° from the engine inlet.

The available airframe noise source prediction procedures were less well defined than those of the propulsion system sources. Consequently, for the airframe sources considered, it has been possible to develop the evolving prediction technologies into methods somewhat more applicable to the near-field case. Conversely, the prediction procedures are less general than the propulsion source predictions. The trailing-edge noise prediction procedure is a far-field predictor modified in the literature for predictions in the close-in far field. In this procedure, the observer location is restricted to a plane perpendicular to the trailing-edge at its midpoint. For this reason, most of the trailing-edge noise inputs are a function of observer location. Unfortunately, further development of this method to handle other observer locations was beyond the scope of the contracted effort. The other airframe source included in the present procedure is turbulent boundary layer noise. The prediction procedure was developed from methodologies available in the literature as described in Reference 1. This widely distributed noise source must be subdivided into smaller elements to adapt its prediction procedure to the close-in far field. As a result, considerable input may be required for this source prediction in the form of observer coordinates for each element as a function of observer location.

The prediction methods outlined above are applied to the high altitude, high forward speed case of the program presented here by accounting for the following effects:

- o Forward-speed propagation effects
  - (a) source emission angle } forward-speed
  - (b) sound propagation path length } transformation
  - (c) convective amplification
  - (d) dynamic amplification
- o Relative velocity/forward-speed effects on noise source strength
- o High altitude effects (acoustic impedance and atmospheric attenuation)

Forward-speed propagation effects are discussed in detail in Reference 1. Nonetheless, it is noted here that a Doppler frequency shift correction is not applied or required since the source and receiver move together. A convective amplification correction is applied to all sources except jet mixing noise, which has this effect built into its prediction model. A correction for dynamic amplification is included for jet mixing noise, shock broadband noise, and turbulent boundary layer noise.

Forward speed and/or relative velocity effects on source strength are included in the selected jet-mixing noise prediction procedure. Otherwise, a forward speed correction to sound power is not applied to the other propulsion sources. In the case of turbomachinery noise, forward speed is not expected to affect source strength since the noise generating mechanism occurs internal to the engine. Available data for shock broadband noise indicate no relative velocity effect on sound power for this source. Some recent data show a possible reduction of shock screech noise level with forward speed. However no correction is applied here since predictions developed from the measured data appear inconsistent. For the airframe noise sources, forward speed is, of course, a key factor in the basic prediction equations and no separate correction is required. Finally, it is noted that forward speed does impact all engine cycle parameters including those employed to predict propulsion system noise and thus its affect on sound power (and spectral content) is accounted for in this way.

The effects of high altitude have been accounted for in the form of a correction to the local acoustic impedance. A correction for atmospheric attentuation is not included in the program since its effect is estimated to be small. Neglecting this radiation effect will result in slightly conservative noise estimates. The prediction procedures are only applicable to free-field conditions. Surface effects such as reflection, or refraction or scattering effects such as in boundary layers, jet exhaust wakes, or airfoil wakes are not included in the procedures or methods of this program. Shielding effects are not included in the program although a method for their estimation was included in References 1 and 2. The reason for their omission is discussed with the presentation of the data comparisons.

Finally, the effects of acoustic sound suppression materials may be included in the noise analysis. Acoustic treatment can be accounted for in the form of duct liners and/or acoustic splitter rings in the engine inlet, or treated duct liners in a fan exhaust duct or the primary exhaust duct. Attenuation effects can thus be included in the fan/compressor, turbine, and/or core noise predictions. The method used is empirical and based on extensive test data. The result is a procedure which avoids details of the acoustic liner design. The liners, where used, are assumed to be acoustically optimized for maximum absorption at a specified design frequency. The effect of high Mach number inlets on forward-radiated fan noise and compressor noise can also be included.

SOURCE SELECTION GUIDELINES

The sources to be included in the noise prediction is a decision which rests primarily on the judgment of the user. Any number or combination of noise sources is permissible. Some guidelines and considerations for this source selection follow:

Fan/compressor: This source will normally be included if propulsion system noise is desired. To predict the compressor noise of a turbojet engine or the forward-radiated fan noise of a turbofan engine the user should specify SRC(1) = 1. The "compressor" noise prediction option (SRC(3)) is included with some reservations to provide an estimate of the noise radiated by the compressor of a turbofan engine. The prediction procedure used is identical to that of a first-stage fan with inlet guide vanes. Since the fan noise procedure does not account for any effect of sound propagation through upstream fan stages, the compressor noise predictions obtained here should be considered very preliminary. This stipulation is not expected to seriously limit program usefulness, however, since fan noise generally dominates the compressor noise of turbofan engines. If a compressor noise source is selected by the user, note that the combination tone noise component may be deleted from the prediction. This option was provided as an investigative tool since the literature indicate that combination tones may not propagate through an upstream rotor or stator vane array. Nevertheless, the method will compute combination tones for first-stage fans with or without inlet guide vanes. The fan noise prediction is not recommended for turbofan engines having more than two fan stages.

The selected method is based on a somewhat limited range of fan types. It is most applicable to single stage fans of relatively high bypass ratio and multiple (say three or more) low pressure turbine stages. This is consistent with the turbofan engines expected for the 1985-1990 time frame. Furthermore, the fan noise prediction method assumes aerodynamically clean, relatively short-duct nacelles with hard walls.

It should also be noted that this prediction procedure has been developed for cruising flight, and engine inflow turbulence is assumed to be low. Significant inflow turbulence, as might exist during ground static engine operation, can be expected to result in fan/compressor noise levels somewhat higher than will be predicted here. The source prediction method can be consulted for a suitable correction factor if desired.

Turbine noise: As with fan/compressor noise, this source would normally be included in predictions where engine noise is of interest. The method applied here is not recommended for engines whose low pressure turbines contain less than three stages. It may be useful to note that the turbine's blade passage frequency can normally be expected to fall beyond the frequency range of the predictions (11220 Hz). As a result, the turbine discrete tone and peak broadband level will not be included in the predicted spectra.

Core (combustion noise): The core noise source is recommended for all cases where engine noise may be important. The procedure is applicable to turbojets, turbofans, and turboprops. It includes transmission losses through the turbine stages.

Jet mixing noise: This source should normally be included where propulsion system noise is of interest. The program will handle single-flow circular exhaust or dual-flow coannular exhaust nozzles. Mixer nozzles are treated as single-flow exhaust where the flow parameters are those of the mixed exhaust flow. Some care is required when selecting observer locations. The program will terminate if the observer location is more than 30 nozzle diameters from the nozzle exit plane or from the engine centerline. The observer must also be located outside of the exhaust flow region defined by a 7.5° angle from the nozzle exit lip. Finally, the observer must be located forward of the engine inlet, if the computed source location (a function of frequency) relative to the engine centerline is greater than the actual observer distance from the engine centerline.

Shock broadband noise: The procedure is applicable to the shock broadband noise associated with the supersonically underexpanded jet exhaust of conical nozzles. With appropriate modifications to the prediction parameters, it is assumed to also apply to the annular jet exhaust of dual-flow nozzles. The method is not applicable to source emission angles of more than 150° relative to the engine inlet axis. If this source is specified for a jet with a subsonic flow exhaust, the shock noise component will be set to zero.

Shock discrete tone (screech) noise: This source, which is believed to result from a feedback mechanism between shocks in a jet exhaust and the nozzle lip, may be neglected for nozzle pressure ratios less than 2. If requested by the user at lower pressure ratios, the program will set the predicted levels to zero. The decision of whether or not to include this source will most likely be the most difficult. A most important aspect of "screech" noise is that it does not always appear to be present and no criteria are available to determine its presence (or absence). It appears that this source, if present, may be eliminated by a minor nozzle redesign. To be on the conservative side the user may desire to include this source in the predictions. If this is done, the noise levels predicted for screech should be considered as upper bounds for the true values. In any event, noise levels are predicted for only the fundamental and second harmonic discrete frequencies. For separate-flow nozzles, the procedure is applicable to either or both of the exhaust flows.

Trailing-edge noise: This source may be included if airframe noise is of interest to the user. The method is presumed to be applicable to "turbulent" or partially laminar-flow-controlled surfaces as long as the boundary layer at the trailing edge consists of fully developed turbulent flow. In its present form, the procedure used is somewhat cumbersome when applied to normal prediction situations. There is a restriction that the observer location must be located in a plane perpendicular to the trailing-edge of interest at its mid-point. As a result, the input for trailing-edge noise predictions is required at each observer location. This may frequently result in extensive input for this source. If the peak frequency is computed to fall beyond 11220 Hz, this source will be set to zero.

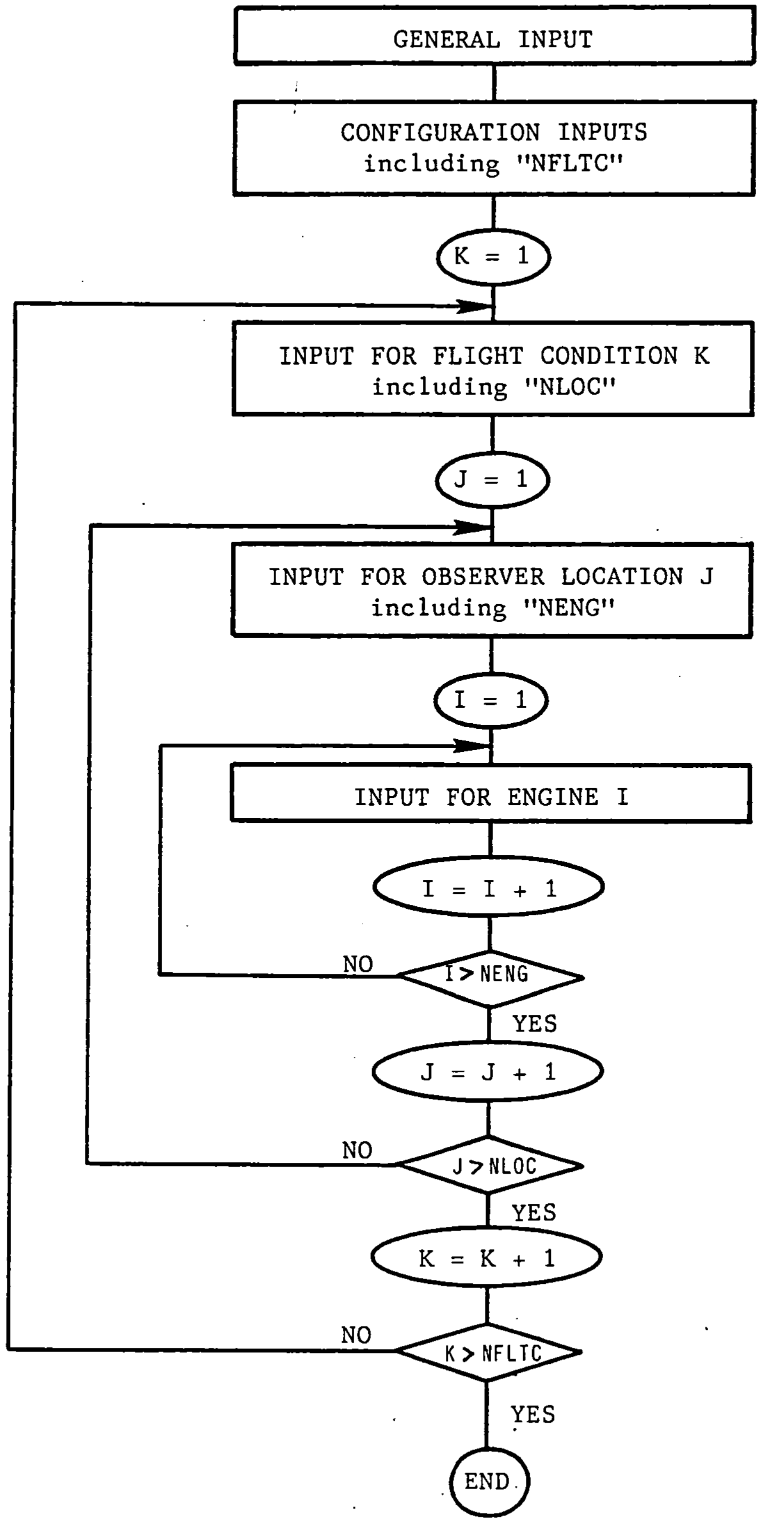
Turbulent boundary layer noise: The implementation of this method will normally involve approximating the surface of interest (say a portion of the fuselage) by one or more flat surfaces subdivided into several elemental areas. The center of each element is treated as a point noise source. The total noise is estimated by summing, on an energy basis, the noise contribution from each of these sub-areas. The noise contribution of an element whose peak frequency is greater than 11220 Hz will be set to zero. If the observer location lies on an element, that element's contribution will also be set to zero. In the close-in far field, the total radiated noise levels computed for a given surface will be dependent upon the number (and orientation) of these elemental areas. Unfortunately, no guidance is presently available as to a selection criteria which might relate the number and orientation of the representative elemental areas to the accuracy of the prediction procedure. Note, however, that for near-field estimates the more subdivisions made the more accurate will be the procedure (maximum dimension of the elemental area small compared to source-to-receiver distance), although fewer "elements" may give a conservative (high) estimate. For far-field estimates, one representative segment may be sufficient.

INPUT DESCRIPTION

The input data and format required by the Cruise Noise Prediction Program (LFCNO) are described in this section. A "bar chart" is used to indicate each line of input required. Not all lines are required; the actual input required will depend on the sources considered or the type of input selected for a given source. The "bar chart" begins in column one (1) for all input. The input can be specified in any consistent set of dimensional units. Format codes are given as Fa. or Ia. The "F" indicates a floating point value (real number with decimal such as 215.6 or 28.). "I" indicates an integer value (no decimal). The "a" indicates the field or number of columns within which the value must appear. It is important to note that integer input must appear in the right-most columns within its specified field. No spaces are allowed between the fields specified for a line of input. The input specification is broken down into four categories: (1) general input, (2) configuration inputs, (3) flight condition inputs, and (4) observer location inputs. See the input flowchart on the following page. The input in all categories except (1) is further broken down by noise source. The input specified under these source breakdowns is to be included if and only if that source has been specified as a source for the prediction. Many other lines of input, as indicated, contain conditional input. These lines of input must be omitted if the coded condition, a previous input, is not satisfied.

The control cards for running this program (LFCNO) must include a card to preset computer storage allocated for data arrays to zero (LDSET,PRESET=ZERO.). The line-by-line input description follows the input flowchart.

INPUT FLOWCHART



TITLE

1st 72 Columns

TITLE - Any title desired by user (2 lines).

GENERAL INPUT

SRC(I), I = 1, 12

I2	I2	I2	I2	——————→	I2

SRC(I), I = 1, 12 - Noise source code; determines noise sources to be included in noise prediction.

SRC(I) = 00 Do not include noise source I in the prediction.

= 01 Include noise source I in noise prediction.

Noise Source Code:

- I = 1 Forward-radiated fan noise
- = 2 Aft-radiated fan noise
- = 3 Compressor noise* (radiated from inlet)
- = 4 Turbine noise
- = 5 Core (combustion) noise
- = 6 Jet mixing noise
- = 7 Primary-jet shock-associated broadband noise
- = 8 Secondary-jet shock-associated broadband noise
- = 9 Primary-jet shock discrete tone (screech) noise
- = 10 Secondary-jet shock discrete tone (screech) noise
- = 11 Trailing-edge noise } *Airframe noise*
- = 12 Turbulent boundary layer noise } *Airframe noise*

Notes:

(1) Set SRC(3) = 02, if a combination tone noise component is to be computed for compressor noise.

(2) "Primary" jet exhaust means single-flow exhaust including mixed-flow exhaust nozzles, or the primary (or core) flow of a dual-flow exhaust. "Secondary jet" means the annular exhaust of a dual-flow exhaust, e.g. the fan exhaust of a short-duct turbofan.

**See remarks concerning compressor noise prediction on page* 8 .

TC1	TC2	TC3	TC4	TC5
I2	I2			I2

TC1, ... TC5 - Acoustic treatment code.
Set = 00 if no acoustic treatment suppression effects are to be included in the source noise prediction.

TC1 = 01, 02, or 03 - For engine inlet acoustic treatment effects on fan and/or compressor noise.

= 01 Engine inlet acoustic treatment only
= 02 High Mach number inlet for acoustic suppression
= 03 Both inlet treatment and high Mach number inlet

TC2 = 01 - For aft-radiated fan noise treatment effects.

TC3 = 01, 02, or 03 - For compressor noise treatment effects
= 01 Compressor inlet treatment effects only
= 02 Engine inlet treatment effects only
= 03 Both compressor inlet and engine inlet treatment effects to be applied

TC4 = 01 - For turbine noise suppression* effects.

TC5 = 01 - For core noise suppression* effects

*(Primary exhaust duct treatment)

RHOO	CO
F10.	F10.

RHOO - Sea level, standard day atmospheric density

CO - Sea level, standard day atmospheric speed of sound

P01	P02	P03
I2	I2	I2

P01, P02, P03 - Output codes =00 if the output as specified below is not desired.

P01 = 01 Output 1/3 octave-band sound pressure levels (SPL's) and overall sound pressure levels (OASPL's) for the total noise of each source and the total noise.

P01 = 02 Same as P01 = 01, except includes the contribution (same information as above) of each engine at each observer location.

P02 = 01 Print out the fan noise component contributions of each engine at each observer location.

P03 = 01 Print out the compressor noise component contributions of each engine at each observer location.

ENGINE AND AIRCRAFT CONFIGURATION AND DESIGN POINT INPUTS PLUS REFERENCE PARAMETERS

NC
I3

NC - Engine exhaust nozzle configuration code.

=001 Single-flow exhaust
=002 Dual-flow exhaust

DX1
F10.

DX1 - Overall or maximum engine nacelle length, i.e. distance from primary nozzle exit to the inlet. See Figure 1.

Input the following line, If NC = 002,

DX2
F10.

DX2 - Distance between primary and secondary nozzle exit planes. See Figure 1.

FAN INPUTS [SRC(1) OR SRC(2) = 01]

NS	IGV
I2	I2

NS - Number of fan stages (maximum of 2)

IGV - Code for fan first-stage inlet guide vanes
= 00 No inlet guide vanes
= 01 Inlet guide vanes present

Input following two lines for each fan stage, I = 1, NS:

MTRD(I)
F10.

NRB(I)	NSV(I)	RSSF(I)
I3	I3	F10.

Repeat this input for the second fan stage if NS = 2.

MTRD(I) - Rotor tip relative Mach number at engine design point (ratio of the flow velocity relative to the fan tip to the local speed of sound at the inlet to the fan stage).

NRB(I) - Number of rotor blades.

NSV(I) - Number of stator vanes.

RSSF(I) - Rotor-stator spacing (percent) see Figure 2.

Input the following line, if SRC(2) = 01 and TC2 = 01,

XLFA	HDFA	FDFA
F10.	F10.	F10.

XLFA - Effective length of fan exhaust duct acoustic treatment
HDFA - Effective duct height between opposite acoustic liner faces
FDFA - Acoustic liner design frequency (peak attenuation frequency) (Hz)

Input the following line for fan and/or compressor noise if TC1 = 01 or 03; and if SRC(1) = 01, or if SRC(3) > 0 and TC3 > 1,

XLFF	HDFF	FDFF	NSFF
F10.	F10.	F10.	F10.

XLFF - Effective length of engine inlet acoustic treatment
HDFF - Effective duct height between opposite acoustic liner faces
FDFF - Acoustic liner design frequency (peak attenuation frequency) (Hz)
NSFF - Number of acoustic splitter rings in the inlet

COMPRESSOR NOISE INPUTS [SRC(3) = 01 OR 02]

The following input applies to the first compressor stage only.

MTRDC
F10.

MTRDC - Rotor tip relative Mach number at engine design point. (See definition of MTRD(I) above.)

NRBC	NSVC	RSSC
I3	I3	F10.

NRBC - Number of rotor blades
NSVC - Number of stator vanes
RSSC - Rotor-stator spacing (percent), see Figure 2.

Input the following line if TC3 = 01 or 03,

XLC	HDC	FDC
F10.	F10.	F10.

XLC - Effective length of compressor inlet acoustic treatment
HDC - Effective duct height between opposite acoustic liner faces
FDC - Acoustic liner design frequency (Hz)

Input the following reference values if either fan or compressor noise is to be computed, i.e. SRC(1) = 01, or SRC(2) = 01, or SRC(3) = 01 or 02.

DTREFF	MFREF	RREFF
F10.	F10.	F10.

DTREFF - Reference fan stage temperature rise, 44.4 C° (80 F°)
MFREF - Reference mass flow rate, 142.9 kg/s (315 lbm/s, 9.79 slug/s)
RREFF - Reference source-to-observer distance, 1 m (3.281 ft, 39.37 in)

TURBINE NOISE INPUTS [SRC(4) = 01]

NTB	DTT	AP
I3	F10.	F10.

NTB - Number of rotor blades in last turbine stage.
DTT - Blade tip diameter of last turbine stage
AP - Primary or core nozzle exit area

UREFT	AREFT
F10.	F10.

UREFT - Reference tip speed, 340.3 m/s (1116.4 f/s)
AREFT - Reference nozzle area, 0.0929 m^2 (1.0 f^2, 144 in^2)

Input the following line if TC4 = 01,

FDT
F10.

FDT - Turbine acoustic treatment design frequency (peak attenuation frequency) (Hz)

CORE (COMBUSTION) NOISE INPUTS [SRC(5) = 01]

DTTD	WREF	DTREFC
F10.	F10.	F10.

DTTD - Total temperature drop across the turbine (all stages) at the engine design point.

WREF - Reference combustor airflow, 15.9 kg/s (35 lbm/s, 1.09 slug/s)

DTREFC - Reference combustor temperature rise, 777.8 C° (1400 F°)

Input the following line if TC5 = 01,

FDCR
F10.

FDCR - Core (combustion) noise acoustic treatment design frequency (Hz)

Input the following two lines (as indicated) if either turbine [SRC(4) = 01] or core noise [SRC(5) = 01] is to be computed:

RREFTC
F10.

RREFTC - Reference source-to-observer distance, 70.4 m (230.9 ft)

If TC4 = 01, or TC5 = 01,

XLTP	HDTP
F10.	F10.

XLTP - Effective length of acoustic treatment in core exhaust nozzle for turbine and/or core noise suppression

HDTP - Effective duct height between opposite acoustic liner faces

JET MIXING NOISE INPUTS [SRC(6) = 01]

D1	TREF
F10.	F10.

D1 - Primary exhaust nozzle exit diameter
TREF - Reference exhaust total temperature, 555.6°K (1000°R)

NPLUG
12

NPLUG - Primary nozzle code
= 00 No plug in primary nozzle
= 01 If primary exhaust is a plug nozzle

Input the following line, if NPLUG = 01

HAP
F10.

HAP - Annulus height of primary plug nozzle

Input the following line, if NC = 002

D2	AR	RW
F10.	F10.	F10.

D2 - Diameter of secondary jet nozzle exit
AR - Ratio of secondary jet exit area to primary jet exit area
RW - Ratio of secondary jet mass-flow rate to primary jet mass-flow rate

SHOCK NOISE INPUT

Input the following line, if SRC(7) = 01 or SRC(9) = 01,

DE1
F10.

DE1 - Primary nozzle exit equivalent diameter

Input the following line, if SRC(8) = 01 or SRC(10) = 01,

DE2	HA
F10.	F10.

DE2 - Secondary nozzle exit equivalent diameter
HA - Secondary nozzle exit annulus height

Input the following line, if SRC(9) = 01,

A1
F10.

A1 - Primary nozzle exit area

Input the following line, if SRC(10) = 01,

A2
F10.

A2 - Secondary nozzle exit area

Input the following line, if SRC(9) = 01 or SRC(10) = 01,

AREFSS
F10.

AREFSS - Reference nozzle exit area, 2.60 $(10)^{-3}$ m^2 (0.028 f^2, 4.03 in^2)

Input the following line, if SRC(6) = 01 or SRC(7) = 01 or SRC(8) = 01,

RG	GC
F10.	F10.

RG - Gas constant, 286.95 N.m/kg. °K (53.34 lb_f.f/lbm °R, 1716.16 lb_f.f/slug. °R)

GC - Dimensional constant, 1.00 kg.m/N.s^2 (32.174 lb_m.f/lb_f.s^2, 1.00 slug.f/lb_f.s^2)

TRAILING-EDGE NOISE INPUTS [SRC(11) = 01]

DELC	VREF
I3	F10.

DELC - Code for turbulent boundary layer thickness at trailing edge (δ_{te})

= 00 Estimate δ_{te} from equation for the turbulent boundary layer thickness on a flat plate

= 01 δ_{te} to be input for each observer location

TURBULENT BOUNDARY LAYER NOISE [SRC(12) = 01]

NJ	DELSC
12	12

NJ - Number of elemental areas into which surface being considered is subdivided for computational purposes, maximum value = 20.

DELSC - Code for turbulent boundary layer displacement thickness (δ^*)

= 00 Estimate δ^* from equation for turbulent boundary layer thickness on a flat plate

= 01 δ^* to be input for each elemental area and for each observer location

Note: The aircraft surface area being considered for turbulent boundary layer noise generation will normally be subdivided into elements. Each element is considered as a flat surface and a point source. This should be considered in selecting the number and orientation of the surface elements.

AT(J), J = 1, NJ

F10.	F10.			F10.
⋮	⋮	⋮	⋮	⋮

5 values per line

AT(J) - Surface area of the J^{th} surface element, see Figure 3.

UREFBL	AREFBL	RREFBL
F10.	F10.	F10.

UREFBL - Reference freestream velocity, 236 m/s (774.3 f/s, 458.7 knots, 527.9 MPH)

AREFBL - Reference element area, 0.0929 m^2 (1.0 f^2, 144 in^2)

RREFBL - Reference source-to-observer distance, 1.0 m (3.281 ft, 39.37 in)

Input the following line, if DELSC = 00,

LT(J), J = 1, NJ

F10.	F10.			F10.
⋮	⋮	⋮	⋮	⋮

5 values per line

LT(J) - Distance from point at which boundary layer growth begins to center of Jth surface element. See Figure 3.

INPUT FOR DESIRED FLIGHT CONDITIONS

NFLTC

13

NFLTC - Number of flight conditions

* *NOTE: Repeat all remaining input for each flight condition.* *

ALT	MA	PSC
F10.	F10.	F10.

ALT - Flight altitude*
MA - Flight Mach number
PSC - Power setting code*

**For output identification purposes only.*

RHOA	CA	TA
F10.	F10.	F10.

RHOA - Ambient air density
CA - Ambient speed of sound
TA - Ambient temperature (absolute)

FAN NOISE INPUTS [SRC(1) = 01 or SRC(2) = 01]

MFF	FRPM
F10.	F10.

MFF - Mass flow rate through the fan
FRPM - Fan rotational speed (RPM)

Input the following line for each fan stage (where I = 1, NS)

DTSG(I)	MTR(I)	MT(I)
F10.	F10.	F10.

Repeat this line for the second stage if NS = 2.

DTSG(I) - Total temperature rise across the I^{th} fan stage
MTR(I) - Rotor tip relative Mach number for the I^{th} fan state [see definition of MTRD(I) above] MTR(I) $\leq$ MTRD(I)
MT(I) - Rotor tip Mach number for the I^{th} fan stage (i.e. ratio of tip speed to local speed of sound)

Input the following line, if SRC(2) = 01 and if TC2 = 01,

MDFA	CDFA
F10.	F10.

MDFA - Mean flow Mach number through the treated portion of the fan exhaust duct

CDFA - Local speed of sound in the treated portion of the fan exhaust duct

Input the following line, if TC1 = 01 or 03; and SRC(1) = 01, or SRC(3) > 0 and TC3 > 1,

MDFF	CDFF
F10.	F10.

MDFF - Mean flow Mach number through the treated portion of the engine inlet
CDFF - Local speed of sound in the treated portion of the engine inlet

Input the following line, if TC1 > 1; and SRC(1) = 01, or SRC(3) > 0 and TC3 > 1,

MI
F10.

MI - Engine inlet throat Mach number

COMPRESSOR INPUTS [SRC(3) = 01 OR 02]

The following input applies to the first compressor stage:

MFC	CRPM
F10.	F10.

MFC - Mass-flow rate through the compressor
CRPM - Compressor rotation speed (RPM)

DTC	MTRC	MTC
F10.	F10.	F10.

DTC - Total temperature rise across the first compressor stage
MTRC - Rotor tip relative Mach number [see definition of MTRD(I) above] MTRC ≤ MTRDC
MTC - Rotor tip Mach number [see definition of MT(I) above]

Input the following line, if TC3 = 01 or 03,

MDC	CDC
F10.	F10.

MDC - Mean flow Mach number through the treated section of the compressor inlet

CDC - local speed of sound in the treated section of the compressor inlet

TURBINE INPUTS [SRC(4) = 01]

PR	TRPM
F10.	F10.

PR - Low-pressure turbine (LPT) total-to-static pressure ratio (i.e. ratio of total pressure at LPT inlet to the turbine exit static pressure.

TRPM - Low-pressure turbine rotational speed (RPM)

CORE INPUTS [SRC(5) = 01]

W3	RHO3	T3	T4
F10.	F10.	F10.	F10.

W3 - Combustor air mass-flow rate
RHO3 - Combustor inlet air density
T3 - Combustor inlet total temperature
T4 - Combustor exit total temperature

Input the following line, if TC4 = 01 or TC5 = 01,

MDTP	CDTP
F10.	F10.

MDTP - Mean flow Mach number through the acoustically treated portion of the engine core exhaust duct

CDTP - local speed of sound associated with MDTP above

JET MIXING AND SHOCK NOISE INPUTS

Input the following line, if SRC(6) = 01, or SRC(7) = 01, or SRC(9) = 01,

V1
F10.

V1 - Primary jet exhaust velocity (fully expanded flow)

Input the following line, if SRC(6) = 01 and NC = 002, or SRC(8) = 01, or SRC(10) = 01,

V2
F10.

V2 - Secondary jet exhaust velocity (fully expanded flow)

Input the following line, if SRC(6) = 01, or SRC(7) = 01,

T1
F10.

T1 - Primary exhaust total temperature (absolute)

Input the following line, if SRC(6) = 01 and NC = 002, or SRC(8) = 01,

T2
F10.

T2 - Secondary exhaust total temperature (absolute)

Input the following line, if SRC(9) = 01,

NPR1
F10.

NPR1 - Primary exhaust nozzle pressure ratio.

Input the following line, if SRC(10) = 01,

NPR2
F10.

NPR2 - Secondary exhaust nozzle pressure ratio.

TURBULENT BOUNDARY LAYER NOISE INPUTS [SRC(12) = 01]

Input the following line, if DELSC = 01,

DELS(J), J = 1, NJ

F10.	F10.	⟶	F10.

5 values per line

DELS(J) - Turbulent boundary layer displacement thickness at the J^{th} element of the surface to be considered.

TEN OR TBLN INPUTS

Input the following line, if SRC(11) = 01 and DELC = 00, or SRC(12) = 01 and DELSC = 00,

MUA
F10.

MUA - Ambient viscosity

INPUTS FOR OBSERVER LOCATIONS

NLOC
I3

NLOC - Number of observer locations to be considered for this flight case

*   *

NOTE: Repeat all remaining input for each observer location for the specified flight case.

*   *

LOCID
I3

LOCID - Observer location identification number

TRAILING-EDGE NOISE INPUTS [SRC(11) = 01]

XLTE	XTE	YTE
F10.	F10.	F10.

XLTE - Length of trailing edge considered at this observer location

XTE - Distance from center of trailing edge to observer location measured in the surface flow direction (usually along the wing chord) (positive forward). See Figure 4.

YTE - Observer location measured perpendicular to the extended wing chord line.

Input the following line, if DELC = 00,

CBAR
F10.

CBAR - Wing chord or flow-surface length used to compute turbulent boundary layer thickness at the surface trailing edge.

Input the following line, if DELC = 01,

DELTA
F10.

DELTA - Turbulent boundary layer thickness at trailing edge.

TURBULENT BOUNDARY LAYER NOISE INPUTS [SRC(12) = 01]

XT(J)	YT(J)	ZT(J)
F10.	F10.	F10.

J = 1, NJ

⋮

Repeat NJ times for each element J = 1, NJ

XT(J), YT(J), ZT(J) - Coordinates of the observer location relative to the center of the J^{th} element of the surface considered for turbulent boundary layer noise generation. See Figure 3.

NENG
I3

NENG - Number of engines considered for this observer location

Repeat the following two lines for each engine for the last specified observer location:

NOENG(J)
I3

NOENG(J) - Number identification of the J^{th} engine considered, where J = 1, NENG.

X	Y
F10.	F10.

X,Y - Coordinates of observer location relative to engine NOENG(J). The origin is at the center of the primary nozzle exit plane. X is measured positive forward along the engine centerline. Y is measured perpendicular to the engine centerline.

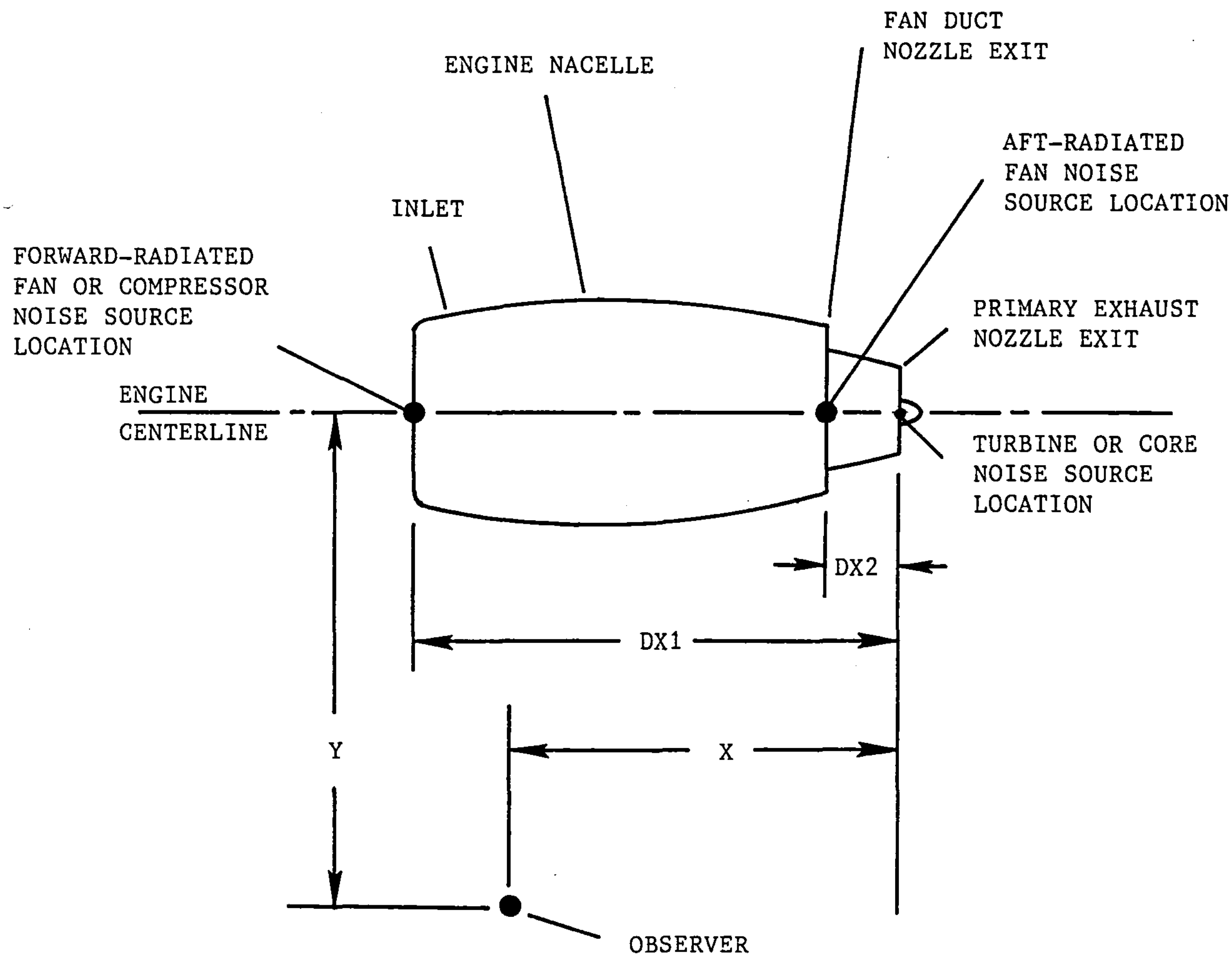
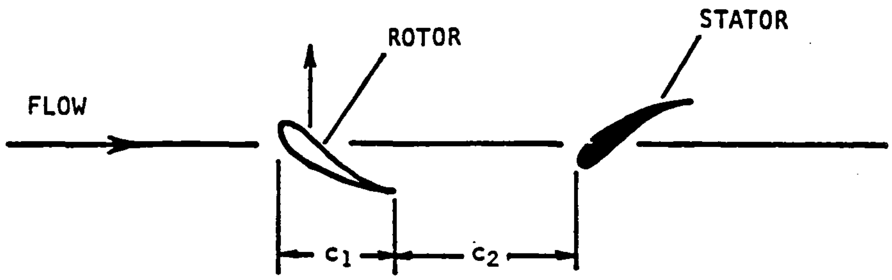
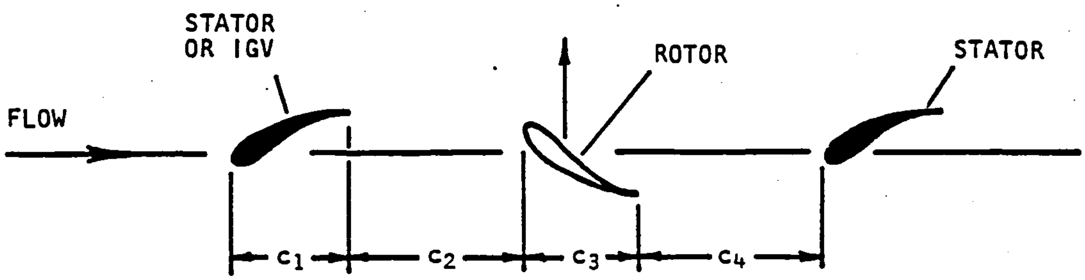


Figure 1. Description of geometry input for fan or compressor noise, observer location for propulsion noise sources, and turbomachinery source locations.



$$RSSF = (c_2/c_1) \times 100$$

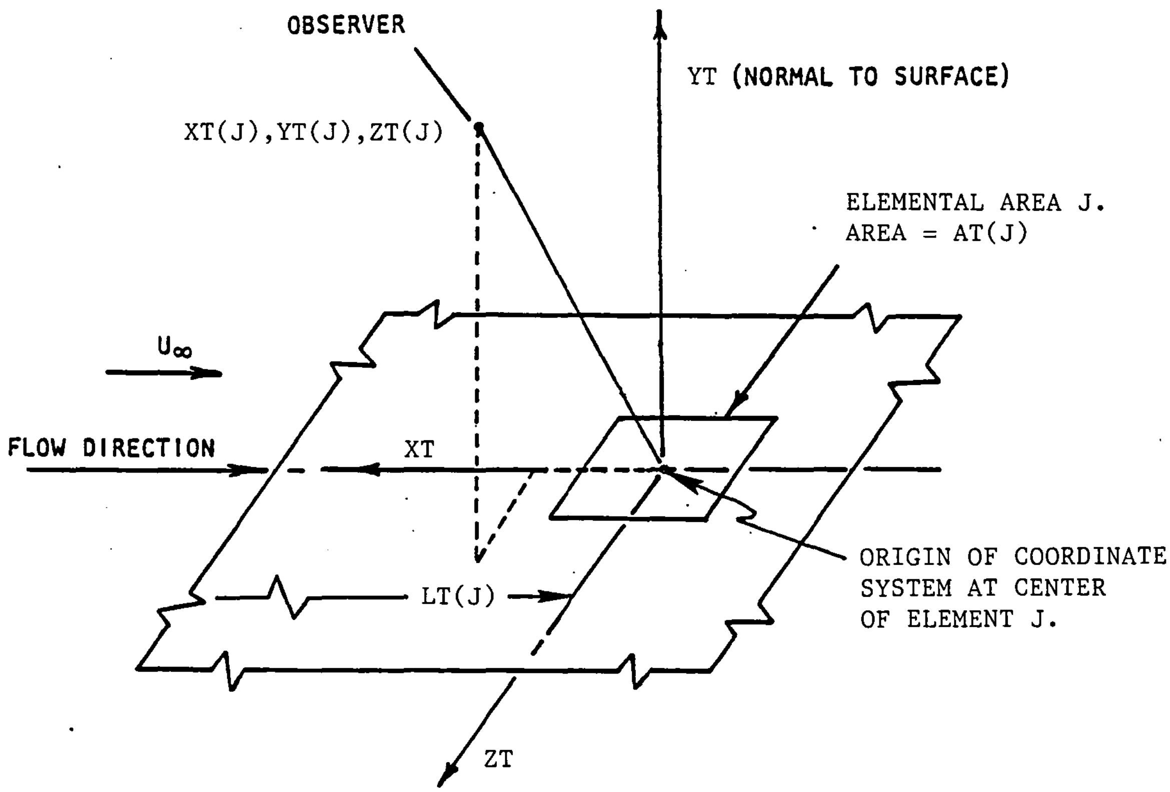
(a) GEOMETRY FOR 1ST-STAGE FANS WITHOUT INLET GUIDE VANES.



RSSF or RSSC = MINIMUM OF: $(c_2/c_1) \times 100$ OR $(c_4/c_3) \times 100$

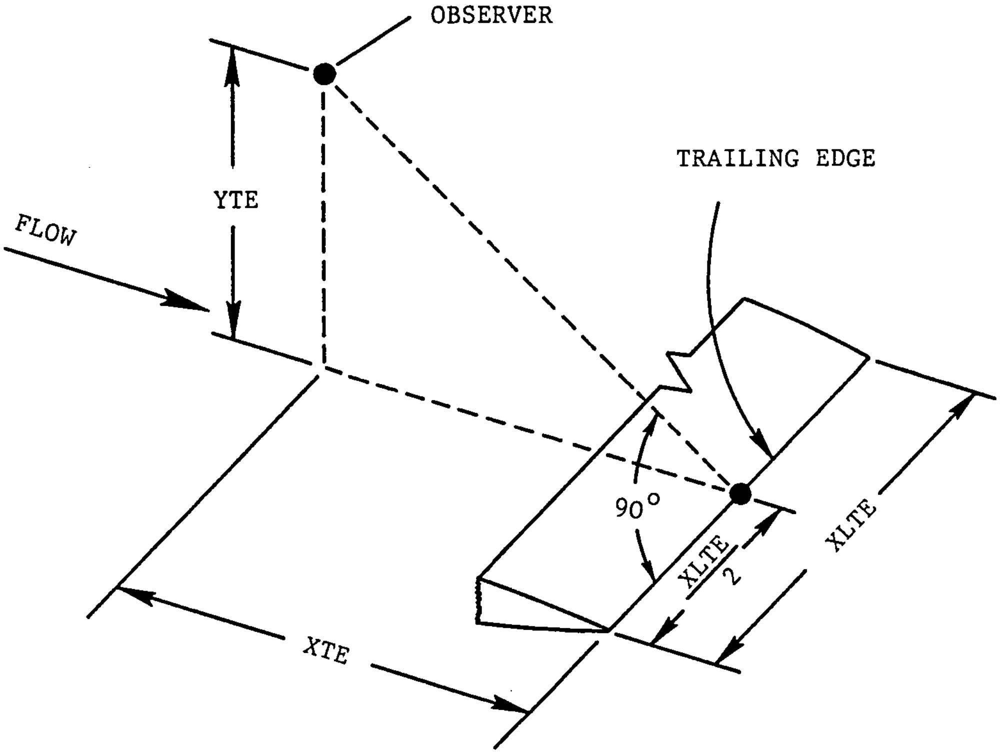
(b) GEOMETRY FOR 1ST-STAGE FANS WITH INLET GUIDE VANES (IGV), 2ND-STAGE FANS, OR 1ST-STAGE OF COMPRESSORS

Figure 2. Fan or compressor rotor-stator geometry.



NOTE: TOTAL AREA FOR PREDICTION = $\sum_{J=1}^{NJ} AT(J)$

Figure 3. Geometry for turbulent boundary layer noise.



Note: The observer location must lie in a plane perpendicular to the trailing edge at its midpoint.

Figure 4. Source/observer geometry for trailing-edge noise.

PROGRAM OUTPUT

The Cruise Noise Prediction Program (LFCNO) predicts one-third octave band sound pressure levels (from 50 to 10,000 Hz) and overall sound pressure levels (OASPL's) for up to nine aircraft noise sources and the total noise at selected locations on an aircraft surface for each selected flight condition. The predicted levels are for free-field, lossless conditions. Optional output includes the fan or compressor component noise contributions at each observer location for each engine. Another option allows the user to suppress the output for individual engines and receive only the total and total component noise at each observer location for each flight condition.

In most cases, where input data or computed noise prediction parameters fall outside allowable or desirable ranges, the program will printout a message indicating the exceedance. The computer run may or may not terminate depending on the problem. Adherence to the limitations and input requirements specified in the input description and to the input flowchart will avert most problems. Table I indicates those occurrences which will result in a diagnostic or warning message.

TABLE I

PROGRAM DIAGNOSTICS AND WARNING MESSAGES

PROGRAM ROUTINE	PROBLEM	RUN TERMINATED
MAIN	Airplane Mach number, $M_A \geqslant 1.0$	Yes
FAN	Blade passage frequency outside range of 44.7 to 22390 Hz	Yes
	Rotor tip relative Mach number exceeds design value	Yes
TURB (Turbine)	Computed peak 1/3 O.B. sound pressure level exceeds computed overall sound pressure level. (This check is a holdover from initial program checkout; it would indicate a basic problem with the prediction equations)	Yes
JETMX (Jet Mixing Noise)	Observer location is outside allowable range of 30 equivalent nozzle diameters from either the nozzle exit plane or centerline.	Yes
	Observer located within the jet exhaust region defined by a 7.5° angle from the exhaust centerline at the nozzle lip.	Yes
	The observer must be located forward of the engine inlet if the observer distance from the engine centerline is less than the computed source distance from the engine centerline	Yes

TABLE I - continued

PROGRAM ROUTINE	PROBLEM	RUN TERMINATED
EXTFRQ (called by Jet Mixing Noise Routine)	The center frequency of one or more of the three octave bands of the basic procedure fall outside the Stroubal number range of the prediction method.	Yes
	Extrapolation of the frequency range to cover 50 to 10,000 Hz exceeds the frequency range of the normalized or "reduced" (THOMSON) spectrum shapes used in the extrapolation.	No
SHOCK (Shock broadband)	One or more frequencies (50 to 10,000 Hz) fall outside the Stroubal number range of the prediction procedure.	No
XFORM (forward-speed transformation routine)	Observer location same as source location	Yes

PROGRAM LISTINGS

MAIN

```
      PROGRAM MAIN(INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT)
C
C          DRIVER PROGRAM FOR NEAR-FIELD CRUISE NOISE PREDICTION
C
C          LATEST REVISION ON 12-12-79
C
      REAL MFF,MFC,MFREF,DTSG(2),MTR(2),MTRD(2),MT(2),MTRC,MTRDC,MTC,
     2 RSSF(2),MDFF,MDFA,NSFF,MDC,MI,MDTP,TITLE(24),
     3 SFFBB(24,4),SFFDT(24,4),SFFCTN(24,4),SFF(24,4),SFABB(24,4),
     4 SFADT(24,4),SFA(24,4),SFAN(24,4),OSFFBB(4),OSFFDT(4),OSCTN(4),
     5 OASFF(4),OSFABB(4),OSFADT(4),OASFA(4),OASFAN(4),
     6 SCBB(24,4),SCDT(24,4),SCCTN(24,4),SCMX(24,4),OSCBB(4),OSCDT(4),
     7 OSCCTN(4),OASCMX(4),ST(24,4),OASTUR(4),SCR(24,4),OASCOR(4)
     8 ,SJP(24,4),SJS(24,4),SJMX(24,4),OSJP(4),OSJS(4),OASJMX(4)
      REAL MA,F(24),NPR1,NPR2,MUA,LT(20),AT(20),XT(20),
     2 YT(20),ZT(20),DELS(20),STEN(24)
      REAL SPSBB(24,4),SSSBB(24,4),SBB1(24),SBB2(24),OSPSBB(4),
     2 OSSSBB(4),SSP(24,4),SSS(24,4),OSSSP(4),OSSSS(4)
     3 ,STOT(24,4),OASTOT(4)
      REAL SFFT(24),SFAT(24),SFANT(24),SCMXT(24),STT(24),SCRT(24),
     2 SJPT(24),SJST(24),SJMXT(24),SPSBBT(24),SSSBBT(24),
     3 SSPT(24),SSST(24),STOTAL(24)
      INTEGER SRC(12),ERR,SC1,SC2,NRB(2),NSV(2),PO1,
     2 PO2,PO3,DELC,DELSC,TC1,TC2,TC3,TC4,TC5,NOENG(4)
      COMMON MA,RHOA,CA,RHO0,C0,CIMPD,DX1,DX2,ERR
      COMMON/FAN/ IGV,S1(24),S2(24),S3(24),S4(24),S5(24),DTREFF,MFREF,
     2 RREFF,XLFF,HDFF,MDFF,CDFF,FDFF,NSFF,MI,XLFA,HDFA,MDFA,CDFA,FDFA,
     3 XLC,HDC,MDC,CDC,FDC
      COMMON /TC/STC(24),AREFT,UREFT,WREF,DTREFC,XLTP,HDTP,MDTP,CDTP
      COMMON /JMX/SJ1(24),SJ2(24),TREF,RG,GC,HAP,RW,D2,V2,T2,AR
      COMMON /TBL/UREFBL,AREFBL,RREFBL,STBL(24)
C
C          PERMANENT DATA
C
      DATA F/50.,63.,80.,100.,125.,160.,200.,250.,315.,400.,500.,
     2 630.,800.,1000.,1250.,1600.,2000.,2500.,3150.,4000.,
     3 5000.,6300.,8000.,10000./
C
C
C          READ GENERAL INPUT
C
C
      READ(5,104) TITLE
      READ(5,100) (SRC(I),I=1,12)
      READ(5,100) TC1,TC2,TC3,TC4,TC5
      READ(5,103) RHO0,C0
      READ(5,100) PO1,PO2,PO3
      READ(5,105) NC
      READ(5,103) DX1
      DX2=0.0
```

```
      IF(NC.EQ.2) READ(5,103) DX2
C
      ERR=0
C
C           INPUT FORMAT STATEMENTS
C
  100 FORMAT(12I2)
  101 FORMAT(5F10.0)
  102 FORMAT(3F10.0)
  103 FORMAT(8F10.0)
  104 FORMAT(12A6)
  105 FORMAT(2I3,F10.0)
  106 FORMAT(I3,5F10.2)
C
C           READ FAN INPUTS
C
      IF(SRC(1).EQ.0.AND.SRC(2).EQ.0) GO TO 6
      READ(5,100) NS,IGV
      DO 4 I=1,NS
      READ(5,103) MTRD(I)
      READ(5,105) NRB(I),NSV(I),RSSF(I)
    4 CONTINUE
      IF(SRC(2).EQ.1.AND.TC2.EQ.1) READ(5,103) XLFA,HDFA,FDFA
    6 CONTINUE
      IF(SRC(1).EQ.0.OR.TC1.EQ.0) GO TO 7
      GO TO 8
    7 IF(SRC(3).EQ.0.OR.TC3.LE.1) GO TO 9
    8 IF(TC1.EQ.1.OR.TC1.EQ.3) READ(5,103) XLFF,HDFF,FDFF,NSFF
    9 CONTINUE
C
C
C           READ COMPRESSOR INPUTS
C
C
      IF(SRC(3).EQ.0) GO TO 10
      READ(5,103) MTRDC
      READ(5,105) NRBC,NSVC,RSSC
      IF(TC3.EQ.1.OR.TC3.EQ.3) READ(5,103) XLC,HDC,FDC
   10 CONTINUE
C
C           REF VALUES FOR FAN OR COMPRESSOR
C
      IF(SRC(1).EQ.1.OR.SRC(2).EQ.1.OR.SRC(3).GE.1) READ(5,103) DTREFF,
     2 MFREF,RREFF
C
C           READ TURBINE INPUTS
C
      IF(SRC(4).EQ.0) GO TO 12
      READ(5,106) NTB,DTT,AP
      READ(5,103) UREFT,AREFT
```

```
      IF(TC4.EQ.1) READ(5,103) FDT
   12 CONTINUE
C
C          READ CORE INPUTS
C
      IF(SRC(5).EQ.0) GO TO 14
      READ(5,103) DTTD,WREF,DTREFC
      IF(TC5.EQ.1) READ(5,103) FDCR
   14 CONTINUE
C
C      READ REFERENCE DISTANCE FOR TURBINE AND CORE
C
      IF(SRC(4).EQ.1.OR.SRC(5).EQ.1) READ(5,103) RREFTC
      IF(TC4.EQ.1.OR.TC5.EQ.1) READ(5,103) XLTP,HDTP
C
C
C          READ JET MIXING NOISE INPUTS
C
      IF(SRC(6).EQ.0) GO TO 18
      READ(5,103) D1,TREF
      READ(5,100) NPLUG
      IF(NPLUG.EQ.1) READ(5,103) HAP
      IF(NC.EQ.2) READ(5,103) D2,AR,RW
   18 CONTINUE
C
C       READ SHOCK NOISE INPUTS
C
      IF(SRC(7).EQ.1.OR.SRC(9).EQ.1) READ(5,103) DE1
      IF(SRC(8).EQ.1.OR.SRC(10).EQ.1) READ(5,103) DE2,HA
      IF(SRC(9).EQ.1) READ(5,103) A1
      IF(SRC(10).EQ.1) READ(5,103) A2
C
      IF(SRC(9).EQ.1.OR.SRC(10).EQ.1) READ(5,103) AREFSS
C
C    COMMON INPUTS FOR JET MIXING AND SHOCK NOISE
C
      IF(SRC(6).EQ.1.OR.SRC(7).EQ.1.OR.SRC(8).EQ.1) READ(5,103) RG,GC
C
C      READ TRAILING-EDGE NOISE INPUTS
C
      IF(SRC(11).EQ.1) READ(5,106) DELC,VREF
C
C      READ TURB. BOUNDARY LAYER NOISE INPUTS
C
      IF(SRC(12).EQ.0) GO TO 22
      READ(5,100) NJ,DELSC
      READ(5,101) (AT(J),J=1,NJ)
      READ(5,103) UREFBL,AREFBL,RREFBL
      IF(DELSC.EQ.0) READ(5,101) (LT(J),J=1,NJ)
   22 CONTINUE
```

```
C
C        FLIGHT CONDITION INPUTS = FUNC(ALT,MA,POWER SETTING)
C
      READ(5,105) NFLTC
      NFC=1
   23 READ(5,103) ALT,MA,PSC
      READ(5,103) RHOA,CA,TA
      IF(MA.GE.1.0) GO TO 400
C
C      FAN INPUTS
C
      IF(SRC(1).EQ.0.AND.SRC(2).EQ.0) GO TO 26
      READ(5,103) MFF,FRPM
      DO 24 I=1,NS
      READ(5,103) DTSG(I),MTR(I),MT(I)
   24 CONTINUE
      IF(SRC(2).EQ.1.AND.TC2.EQ.1) READ(5,103) MDFA,CDFA
   26 CONTINUE
      IF(SRC(1).EQ.0.OR.TC1.EQ.0) GO TO 28
      GO TO 30
   28 IF(SRC(3).EQ.0.OR.TC3.LE.1) GO TO 32
   30 IF(TC1.EQ.1.OR.TC1.EQ.3) READ(5,103) MDFF,CDFF
      IF(TC1.EQ.2.OR.TC1.EQ.3) READ(5,103) MI
   32 CONTINUE
C
C           COMPRESSOR INPUTS
C
      IF(SRC(3).EQ.0) GO TO 34
      READ(5,103) MFC,CRPM
      READ(5,103) DTC,MTRC,MTC
      IF(TC3.EQ.1.OR.TC3.EQ.3) READ(5,103) MDC,CDC
   34 CONTINUE
C
C           TURBINE INPUTS
C
      IF(SRC(4).EQ.1) READ(5,103) PR,TRPM
C
C           CORE INPUTS
C
      IF(SRC(5).EQ.1) READ(5,103) W3,RHO3,T3,T4
C
C           TURBINE OR CORE INPUT
C
      IF(TC4.EQ.1.OR.TC5.EQ.1) READ(5,103) MDTP,CDTP
C
C           JETMX AND SHOCK INPUTS
C
      IF(SRC(6).EQ.1.OR.SRC(7).EQ.1.OR.SRC(9).EQ.1) READ(5,103) V1
      IF(SRC(6).EQ.1.AND.NC.EQ.2.OR.SRC(8).EQ.1.OR.SRC(10).EQ.1)
     2 READ(5,103) V2
```

```
      IF(SRC(6).EQ.1.OR.SRC(7).EQ.1) READ(5,103) T1
      IF(SRC(6).EQ.1.AND.NC.EQ.2.OR.SRC(8).EQ.1) READ(5,103) T2
C
C          SHOCK INPUTS
C
      IF(SRC(9).EQ.1) READ(5,103) NPR1
      IF(SRC(10).EQ.1) READ(5,103) NPR2
C
C          TBLN INPUT
C
      IF(DELSC.EQ.1) READ(5,101) (DELS(J),J=1,NJ)
C
C          READ COMMON INPUTS FOR TEN AND TBLN
C
      IF(SRC(11).EQ.1.AND.DELC.EQ.0.OR.SRC(12).EQ.1.AND.DELSC.EQ.0)
     2 READ(5,103) MUA
      CIMPD=10.*ALOG10(RHOA*CA/(RHOO*CO))
C
C            OBSERVER INPUTS
C
      READ(5,105) NLOC
      NO=1
   40 READ(5,105) LOCID
      IF(SRC(11).EQ.0) GO TO 41
      READ(5,103) XLTE,XTE,YTE
      DELTA=0.0
      IF(DELC.EQ.0) READ(5,103) CBAR
      IF(DELC.EQ.1) READ(5,103) DELTA
   41 CONTINUE
      IF(SRC(12).EQ.0) GO TO 42
      READ(5,102) (XT(J),YT(J),ZT(J),J=1,NJ)
   42 CONTINUE
      READ(5,105) NENG
      J=1
   45 READ(5,105) NOENG(J)
      READ(5,103) X,Y
      XX=X
      YY=Y
C
C
C
C          COMPUTE ENGINE COMPONENT NOISE LEVELS
C
C
C
C      INITIALIZE COMPUTED DATA STORAGE ARRAYS
C
      DO 50 I=1,24
      SFFBB(I,J)=0.0
      SFFDT(I,J)=0.0
```

```
      SFFCTN(I,J)=0.0
      SFF(I,J)=0.0
      SFABB(I,J)=0.0
      SFADT(I,J)=0.0
      SFA(I,J)=0.0
      SFAN(I,J)=0.0
   50 CONTINUE
      OSFFBB(J)=0.0
      OSFFDT(J)=0.0
      OSCTN(J)=0.0
      OASFF(J)=0.0
      OSFABB(J)=0.0
      OSFADT(J)=0.0
      OASFA(J)=0.0
      OASFAN(J)=0.0
C
      IF(SRC(1).EQ.0.AND.SRC(2).EQ.0) GO TO 60
C
C          COMPUTE DESIRED FAN NOISE COMPONENTS
C
      SC1=SRC(1)
      SC2=SRC(2)
      SUM1=0.0
      SUM2=0.0
      SUM3=0.0
      SUM4=0.0
      SUM5=0.0
C
C
      DO 56 K=1,NS
      DELT=DTSG(K)
      XMTR=MTR(K)
      XMTRD=MTRD(K)
      XMT=MT(K)
      XNR=NRB(K)
      XNS=NSV(K)
      RSS=RSSF(K)
      NCODE=K
      CALL FAN(XX,YY,MFF,FRPM,SC1,SC2,NCODE,TC1,TC2,TC3,DELT,XMTR,
     2 XMTRD,XMT,XNR,XNS,RSS,BPFF,FREFF)
      IF(ERR.EQ.1) GO TO 1000
      IF(K.EQ.2) GO TO 51
      BPFF1=BPFF
      FREFF1=FREFF
      GO TO 52
   51 BPFF2=BPFF
      FREFF2=FREFF
   52 CONTINUE
C
      DO 55 I=1,24
```

```
      IF(SC1.EQ.0) GO TO 53
      IF(S1(I).GT.0.0) SUM1=SUM1+10.**(S1(I)/10.)
      IF(S2(I).GT.0.0) SUM2=SUM2+10.**(S2(I)/10.)
      IF(S3(I).GT.0.0) SUM3=SUM3+10.**(S3(I)/10.)
C
      IF(SFFBB(I,J).GT.0.0.OR.S1(I).GT.0.0)
     2 SFFBB(I,J)=10.*ALOG10(10.**(SFFBB(I,J)/10.)+10.**(S1(I)/10.))
      IF(SFFDT(I,J).GT.0.0.OR.S2(I).GT.0.0)
     2 SFFDT(I,J)=10.*ALOG10(10.**(SFFDT(I,J)/10.)+10.**(S2(I)/10.))
      IF(SFFCTN(I,J).GT.0.0.OR.S3(I).GT.0.0)
     2 SFFCTN(I,J)=10.*ALOG10(10.**(SFFCTN(I,J)/10.)+10.**(S3(I)/10.))
      IF(K.NE.NS) GO TO 53
      IF(SFFBB(I,J).GT.0.0.OR.SFFDT(I,J).GT.0.0.OR.SFFCTN(I,J).GT.0.0)

     2 SFF(I,J)=10.*ALOG10(10.**(SFFBB(I,J)/10.)+
     3 10.**(SFFDT(I,J)/10.)+10.**(SFFCTN(I,J)/10.))
C
   53 IF(SC2.EQ.0) GO TO 54
      IF(S4(I).GT.0.0) SUM4=SUM4+10.**(S4(I)/10.)
      IF(S5(I).GT.0.0) SUM5=SUM5+10.**(S5(I)/10.)
C
      IF(SFABB(I,J).GT.0.0.OR.S4(I).GT.0.0)
     2 SFABB(I,J)=10.*ALOG10(10.**(SFABB(I,J)/10.)+10.**(S4(I)/10.))
      IF(SFADT(I,J).GT.0.0.OR.S5(I).GT.0.0)
     2 SFADT(I,J)=10.*ALOG10(10.**(SFADT(I,J)/10.)+10.**(S5(I)/10.))
      IF(K.NE.NS) GO TO 54
      IF(SFABB(I,J).GT.0.0.OR.SFADT(I,J).GT.0.0) SFA(I,J)=
     2 10.*ALOG10(10.**(SFABB(I,J)/10.)+10.**(SFADT(I,J)/10.))
   54 IF(K.NE.NS) GO TO 55
      IF(SFF(I,J).GT.0.0.OR.SFA(I,J).GT.0.0) SFAN(I,J)=
     2 10.*ALOG10(10.**(SFF(I,J)/10.)+10.**(SFA(I,J)/10.))
C
   55 CONTINUE
   56 CONTINUE
C
      IF(SC1.EQ.0) GO TO 57

      IF(SUM1.GT.0.0) OSFFBB(J)=10.*ALOG10(SUM1)
      IF(SUM2.GT.0.0) OSFFDT(J)=10.*ALOG10(SUM2)
      IF(SUM3.GT.0.0) OSCTN(J)=10.*ALOG10(SUM3)
      SUMX=SUM1+SUM2+SUM3
      IF(SUMX.GT.0.0) OASFF(J)=10.*ALOG10(SUMX)
      IF(SC2.EQ.0) OASFAN(J)=OASFF(J)
   57 IF(SC2.EQ.0) GO TO 58
      IF(SUM4.GT.0.0) OSFABB(J)=10.*ALOG10(SUM4)
      IF(SUM5.GT.0.0) OSFADT(J)=10.*ALOG10(SUM5)
      SUMY=SUM4+SUM5
      IF(SUMY.GT.0.0) OASFA(J)=10.*ALOG10(SUMY)
      IF(SC1.EQ.0) OASFAN(J)=OASFA(J)
      SUMXY=SUMX+SUMY
      IF(SC1.EQ.1.AND.SUMXY.GT.0.0) OASFAN(J)=10.*ALOG10(SUMXY)
   58 CONTINUE
```

```
   60 CONTINUE
C
C      COMPUTE COMPRESSOR NOISE
C
      DO 61 I=1,24
      SCBB(I,J)=0.0
      SCDT(I,J)=0.0
      SCCTN(I,J)=0.0
      SCMX(I,J)=0.0
   61 CONTINUE
      OSCBB(J)=0.0
      OSCDT(J)=0.0
      OSCCTN(J)=0.0
      OASCMX(J)=0.0
C
C
      IF(SRC(3).EQ.0) GO TO 70
      XNRC=NRBC
      XNSC=NSVC
      NCODE=2+SRC(3)
      CALL FAN(XX,YY,MFC,CRPM,0,0,NCODE,TC1,TC2,TC3,DTC,MTRC,MTRDC,
     2 MTC,XNRC,XNSC,RSSC,BPFC,FREFC)
      IF(ERR.EQ.1) GO TO 1000
      SUM1=0.0
      SUM2=0.0
      SUM3=0.0
      DO 62 I=1,24
      IF(S1(I).GT.0.0) SUM1=SUM1+10.**(S1(I)/10.)
      IF(S2(I).GT.0.0) SUM2=SUM2+10.**(S2(I)/10.)
      IF(S3(I).GT.0.0) SUM3=SUM3+10.**(S3(I)/10.)
      SCBB(I,J)=S1(I)
      SCDT(I,J)=S2(I)
      SCCTN(I,J)=S3(I)
      IF(S1(I).GT.0.0.OR.S2(I).GT.0.0.OR.S3(I).GT.0.0) SCMX(I,J)=
     2 10.*ALOG10(10.**(S1(I)/10.)+10.**(S2(I)/10.)+10.**(S3(I)/10.))
   62 CONTINUE
      IF(SUM1.GT.0.0) OSCBB(J)=10.*ALOG10(SUM1)
      IF(SUM2.GT.0.0) OSCDT(J)=10.*ALOG10(SUM2)
      IF(SUM3.GT.0.0) OSCCTN(J)=10.*ALOG10(SUM3)
      SUMC=SUM1+SUM2+SUM3
      IF(SUMC.GT.0.0) OASCMX(J)=10.*ALOG10(SUMC)
   70 CONTINUE
C
C      COMPUTE TURBINE NOISE
C
      DO 71 I=1,24
      ST(I,J)=0.0
   71 CONTINUE
      OASTUR(J)=0.0
C
```

```
      IF(SRC(4).EQ.0) GO TO 80
      XNB=NTB
      CALL TURB(F,PR,TRPM,DTT,AP,XNB,XX,YY,RREFTC,TC4,FDT)
      IF(ERR.EQ.1) GO TO 1000
      SUM=0.0
      DO 72 I=1,24
      ST(I,J)=STC(I)
      IF(STC(I).GT.0.0) SUM=SUM+10.**(STC(I)/10.)
   72 CONTINUE
      IF(SUM.GT.0.0) OASTUR(J)=10.*ALOG10(SUM)
   80 CONTINUE
C
C      COMPUTE CORE NOISE
C
      DO 81 I=1,24
      SCR(I,J)=0.0
   81 CONTINUE
      OASCOR(J)=0.0
C
      IF(SRC(5).EQ.0) GO TO 90
      CALL CORE(F,W3,RHO3,T3,T4,DTTD,XX,YY,NC,RREFTC,TC5,FDCR)
      IF(ERR.EQ.1) GO TO 1000
      SUM=0.0
      DO 82 I=1,24
      SCR(I,J)=STC(I)
      IF(STC(I).GT.0.0) SUM=SUM+10.**(STC(I)/10.)
   82 CONTINUE
      IF(SUM.GT.0.0) OASCOR(J)=10.*ALOG10(SUM)
   90 CONTINUE
C
C      COMPUTE JET MIXING NOISE
C
      DO 91 I=1,24
      SJP(I,J)=0.0
      SJS(I,J)=0.0
      SJMX(I,J)=0.0
   91 CONTINUE
      OSJP(J)=0.0
      OSJS(J)=0.0
      OASJMX(J)=0.0
C
      IF(SRC(6).EQ.0) GO TO 200
      XJ=-XX
      YJ=YY
      NCOAX=NC-1
      CALL JETMX(F,TA,D1,V1,T1,NPLUG,NCOAX,XJ,YJ)
      IF(ERR.EQ.1) GO TO 1000
      SUM1=0.0
      SUM2=0.0
      DO 93 I=1,24
```

```
      IF(SJ1(I).GT.0.0) SUM1=SUM1+10.**(SJ1(I)/10.)
      IF(SJ2(I).GT.0.0) SUM2=SUM2+10.**(SJ2(I)/10.)
      SJP(I,J)=SJ1(I)
      SJS(I,J)=SJ2(I)
      IF(SJ1(I).GT.0.0.OR.SJ2(I).GT.0.0) SJMX(I,J)=
     2 10.*ALOG10(10.**(SJ1(I)/10.)+10.**(SJ2(I)/10.))
   93 CONTINUE
      IF(SUM1.GT.0.0) OSJP(J)=10.*ALOG10(SUM1)
      IF(SUM2.GT.0.0) OSJS(J)=10.*ALOG10(SUM2)
      SUMT=SUM1+SUM2
      IF(SUMT.GT.0.0) OASJMX(J)=10.*ALOG10(SUMT)
  200 CONTINUE
C
C               COMPUTE SHOCK BROADBAND NOISE
C
      DO 250 I=1,24
      SPSBB(I,J)=0.0
      SSSBB(I,J)=0.0
  250 CONTINUE
      OSPSBB(J)=0.0
      OSSSBB(J)=0.0
      IF(SRC(7).EQ.0) GO TO 255
      CALL SHOCK(F,V1,T1,DE1,DE1,7,RG,GC,XX,YY,SBB1)
      IF(ERR.EQ.1) GO TO 1000
      SUM=0.0
      DO 253 I=1,24
      IF(SBB1(I).GT.0.0) SUM=SUM+10.**(SBB1(I)/10.)
      SPSBB(I,J)=SBB1(I)
  253 CONTINUE
      IF(SUM.GT.0.0) OSPSBB(J)=10.*ALOG10(SUM)
  255 CONTINUE
C
      IF(SRC(8).EQ.0) GO TO 260
      CALL SHOCK(F,V2,T2,DE2,HA,8,RG,GC,XX,YY,SBB2)
      IF(ERR.EQ.1) GO TO 1000
      SUM=0.0
      DO 258 I=1,24
      IF(SBB2(I).GT.0.0) SUM=SUM+10.**(SBB2(I)/10.)
      SSSBB(I,J)=SBB2(I)
  258 CONTINUE
      IF(SUM.GT.0.0) OSSSBB(J)=10.*ALOG10(SUM)
  260 CONTINUE
C
C         COMPUTE SHOCK SCREECH NOISE
C
      DO 262 I=1,24
      SSP(I,J)=0.0
  262 CONTINUE
      OSSSP(J)=0.0
      IF(SRC(9).EQ.0) GO TO 265
```

```
      IF(NPR1.LT.2.0) GO TO 265
      CALL SCRCH(V1,DE1,DE1,NPR1,A1,AREFSS,XX,YY,9,SS1,SS2,NB1,NB2)
      IF(ERR.EQ.1) GO TO 1000
      DO 264 I=1,24
      IF(I.EQ.NB1) SSP(I,J)=SS1
      IF(I.EQ.NB2) SSP(I,J)=SS2
  264 CONTINUE
      IF(SS1.GT.0.0.OR.SS2.GT.0.0) OSSSP(J)=
     2 10.*ALOG10(10.**(SS1/10.)+10.**(SS2/10.))
C
  265 DO 267 I=1,24
      SSS(I,J)=0.0
  267 CONTINUE
      OSSSS(J)=0.0
      IF(SRC(10).EQ.0) GO TO 270
      IF(NPR2.LT.2.0) GO TO 270
      CALL SCRCH(V2,HA,DE2,NPR2,A2,AREFSS,XX,YY,10,SS1,SS2,NB1,NB2)
      IF(ERR.EQ.1) GO TO 1000
      DO 268 I=1,24
      IF(I.EQ.NB1) SSS(I,J)=SS1
      IF(I.EQ.NB2) SSS(I,J)=SS2
  268 CONTINUE
      IF(SS1.GT.0.0.OR.SS2.GT.0.0) OSSSS(J)=
     2 10.*ALOG10(10.**(SS1/10.)+10.**(SS2/10.))
  270 CONTINUE
C
      DO 598 I=1,24
      STOT(I,J)=0.0
  598 CONTINUE
      OASTOT(J)=0.0
      SUMT=0.0
      DO 600 I=1,24
      S=10.**(SFAN(I,J)/10.)+10.**(SCMX(I,J)/10.)+10.**(ST(I,J)/10.)+
     2 10.**(SCR(I,J)/10.)+10.**(SJMX(I,J)/10.)+10.**(SPSBB(I,J)/10.)+
     3 10.**(SSSBB(I,J)/10.)+10.**(SSP(I,J)/10.)+10.**(SSS(I,J)/10.)
      IF(S.GT.0.0) STOT(I,J)=10.*ALOG10(S)
      SUMT=SUMT+S
  600 CONTINUE
      IF(SUMT.GT.0.0) OASTOT(J)=10.*ALOG10(SUMT)
C
      J=J+1
      IF(J.LE.NENG) GO TO 45
C
C      COMPUTE AIRFRAME NOISE
C
      DO 272 I=1,24
      STEN(I)=0.0
      STBL(I)=0.0
  272 CONTINUE
      OASTEN=0.0
```

```
      OASTBL=0.0
C
      IF(SRC(11).EQ.0) GO TO 280
      CALL TEN(F,XLTE,DELTA,CBAR,MUA,VREF,XTE,YTE,STEN)
      IF(ERR.EQ.1) GO TO 1000
      SUM=0.0
      DO 274 I=1,24
      IF(STEN(I).GT.0.0) SUM=SUM+10.**(STEN(I)/10.)
  274 CONTINUE
      IF(SUM.GT.0.0) OASTEN=10.*ALOG10(SUM)
  280 CONTINUE
C
      IF(SRC(12).EQ.0) GO TO 290
      CALL TBLN(XT,YT,ZT,AT,LT,DELS,NJ,MUA,DELSC)
      IF(ERR.EQ.1) GO TO 1000
      SUM=0.0
      DO 282 I=1,24
      IF(STBL(I).GT.0.0) SUM=SUM+10.**(STBL(I)/10.)
  282 CONTINUE
      IF(SUM.GT.0.0) OASTBL=10.*ALOG10(SUM)
  290 CONTINUE
C
      IF(P01.EQ.0) GO TO 210
      IF(P01.EQ.1) GO TO 203
      DO 202 J=1,NENG
      WRITE(6,305) TITLE
      WRITE(6,300) ALT,MA,PSC,LOCID,NOENG(J)
      WRITE(6,301)
      WRITE(6,302) (F(I),SFF(I,J),SFA(I,J),SFAN(I,J),SCMX(I,J),
     2 ST(I,J),SCR(I,J),SJP(I,J),SJS(I,J),SJMX(I,J),SPSBB(I,J),
     3 SSSBB(I,J),SSP(I,J),SSS(I,J),STOT(I,J),I=1,24)
      WRITE(6,304) OASFF(J),OASFA(J),OASFAN(J),OASCMX(J),OASTUR(J),
     2 OASCOR(J),OSJP(J),OSJS(J),OASJMX(J),OSPSBB(J),
     3 OSSSBB(J),OSSSP(J),OSSSS(J),OASTOT(J)
C
  300 FORMAT(T30,25HFLIGHT CONDITION:   ALT =,F7.0,
     2 7H   MA =,F6.3,20H   POWER SET. CODE =,F5.2,//,T40,
     3 23HOBSERVER LOCATION NO. =,I4,//,T45,10HENGINE NO.,I4,//)
  301 FORMAT(T10,51H1/3 OCT. BAND SPL'S AND OASPL'S  DB RE 0.00002 N/M2,
     2 //,T3,4HFREQ,T11,17HFAN     FAN     FAN,T54,16HJET MIXING NOISE,
     3 5X,25HSHOCK BB    SHOCK SCREECH,/,T3,4H(HZ),T11,10HFWD     AFT,
     4 50H    TOTAL    CMX     TURB    CORE    PRI     SEC    TOTAL,3X,
     5 39HPRI     SEC     PRI     SEC           TOTAL,/)
  302 FORMAT(1X,F6.0,13F7.1,7X,F7.1)
  304 FORMAT(/,2X,'OASPL',13F7.1,7X,F7.1)
  305 FORMAT(1H1,//,8X,12A6,/,8X,12A6,///)
  202 CONTINUE
C
  203 CONTINUE
      DO 518 I=1,24
```

```
      STOTAL(I)=0.0
      SFFT(I)=0.0
      SFAT(I)=0.0
      SFANT(I)=0.0
      SCMXT(I)=0.0

      STT(I)=0.0

      SCRT(I)=0.0
      SJPT(I)=0.0
      SJST(I)=0.0
      SJMXT(I)=0.0
      SPSBBT(I)=0.0
      SSSBBT(I)=0.0
      SSPT(I)=0.0
      SSST(I)=0.0
  518 CONTINUE
      OSUM1=0.0
      OSUM2=0.0
      OSUMF=0.0
      OSUM3=0.0
      OSUM4=0.0
      OSUM5=0.0
      OSUM6P=0.0
      OSUM6S=0.0
      OSUM6=0.0
      OSUM7=0.0
      OSUM8=0.0
      OSUM9=0.0
      OSUM10=0.0
      OSUMI=0.0
      OAS1=0.0
      OAS2=0.0
      OASF=0.0
      OAS3=0.0
      OAS4=0.0
      OAS5=0.0
      OAS6P=0.0
      OAS6S=0.0
      OAS6=0.0
      OAS7=0.0
      OAS8=0.0
      OAS9=0.0
      OAS10=0.0
      OAST=0.0
      DO 520 I=1,24
      SUM1=0.0
      SUM2=0.0
      SUM3=0.0
      SUM4=0.0
      SUM5=0.0
      SUM6P=0.0
```

```
      SUM6S=0.0
      SUM7=0.0
      SUM8=0.0
      SUM9=0.0
      SUM10=0.0
      DO 510 J=1,NENG
      IF(SFF(I,J).GT.0.0) SUM1=SUM1+10.**(SFF(I,J)/10.)
      IF(SFA(I,J).GT.0.0) SUM2=SUM2+10.**(SFA(I,J)/10.)
      IF(SCMX(I,J).GT.0.0) SUM3=SUM3+10.**(SCMX(I,J)/10.)
      IF(ST(I,J).GT.0.0) SUM4=SUM4+10.**(ST(I,J)/10.)
      IF(SCR(I,J).GT.0.0) SUM5=SUM5+10.**(SCR(I,J)/10.)
      IF(SJP(I,J).GT.0.0) SUM6P=SUM6P+10.**(SJP(I,J)/10.)
      IF(SJS(I,J).GT.0.0) SUM6S=SUM6S+10.**(SJS(I,J)/10.)
      IF(SPSBB(I,J).GT.0.0) SUM7=SUM7+10.**(SPSBB(I,J)/10.)
      IF(SSSBB(I,J).GT.0.0) SUM8=SUM8+10.**(SSSBB(I,J)/10.)
      IF(SSP(I,J).GT.0.0) SUM9=SUM9+10.**(SSP(I,J)/10.)
      IF(SSS(I,J).GT.0.0) SUM10=SUM10+10.**(SSS(I,J)/10.)
  510 CONTINUE
      SUMI=SUM1+SUM2+SUM3+SUM4+SUM5+SUM6P+SUM6S+SUM7+SUM8+SUM9+SUM10+
     2 10.**(STEN(I)/10.)+10.**(STBL(I)/10.)
      IF(SUMI.GT.0.0) STOTAL(I)=10.*ALOG10(SUMI)
C
      IF(SUM1.GT.0.0) SFFT(I)=10.*ALOG10(SUM1)
      IF(SUM2.GT.0.0) SFAT(I)=10.*ALOG10(SUM2)
      SUMF=SUM1+SUM2
      IF(SUMF.GT.0.0) SFANT(I)=10.*ALOG10(SUMF)
      IF(SUM3.GT.0.0) SCMXT(I)=10.*ALOG10(SUM3)
      IF(SUM4.GT.0.0) STT(I)=10.*ALOG10(SUM4)
      IF(SUM5.GT.0.0) SCRT(I)=10.*ALOG10(SUM5)
      IF(SUM6P.GT.0.0) SJPT(I)=10.*ALOG10(SUM6P)
      IF(SUM6S.GT.0.0) SJST(I)=10.*ALOG10(SUM6S)
      SUM6=SUM6P+SUM6S
      IF(SUM6.GT.0.0) SJMXT(I)=10.*ALOG10(SUM6)
      IF(SUM7.GT.0.0) SPSBBT(I)=10.*ALOG10(SUM7)
      IF(SUM8.GT.0.0) SSSBBT(I)=10.*ALOG10(SUM8)
      IF(SUM9.GT.0.0) SSPT(I)=10.*ALOG10(SUM9)
      IF(SUM10.GT.0.0) SSST(I)=10.*ALOG10(SUM10)
C
      OSUMI=OSUMI+SUMI
      OSUM1=OSUM1+SUM1
      OSUM2=OSUM2+SUM2
      OSUMF=OSUMF+SUMF
      OSUM3=OSUM3+SUM3
      OSUM4=OSUM4+SUM4
      OSUM5=OSUM5+SUM5
      OSUM6P=OSUM6P+SUM6P
      OSUM6S=OSUM6S+SUM6S
      OSUM6=OSUM6+SUM6
      OSUM7=OSUM7+SUM7
      OSUM8=OSUM8+SUM8
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      OSUM9=OSUM9+SUM9
      OSUM10=OSUM10+SUM10
  520 CONTINUE
C
      IF(OSUM1.GT.0.0) OAS1=10.*ALOG10(OSUM1)
      IF(OSUM2.GT.0.0) OAS2=10.*ALOG10(OSUM2)
      IF(OSUMF.GT.0.0) OASF=10.*ALOG10(OSUMF)
      IF(OSUM3.GT.0.0) OAS3=10.*ALOG10(OSUM3)
      IF(OSUM4.GT.0.0) OAS4=10.*ALOG10(OSUM4)
      IF(OSUM5.GT.0.0) OAS5=10.*ALOG10(OSUM5)
      IF(OSUM6P.GT.0.0) OAS6P=10.*ALOG10(OSUM6P)
      IF(OSUM6S.GT.0.0) OAS6S=10.*ALOG10(OSUM6S)
      IF(OSUM6.GT.0.0) OAS6=10.*ALOG10(OSUM6)
      IF(OSUM7.GT.0.0) OAS7=10.*ALOG10(OSUM7)
      IF(OSUM8.GT.0.0) OAS8=10.*ALOG10(OSUM8)
      IF(OSUM9.GT.0.0) OAS9=10.*ALOG10(OSUM9)
      IF(OSUM10.GT.0.0) OAS10=10.*ALOG10(OSUM10)
      IF(OSUMI.GT.0.0) OAST=10.*ALOG10(OSUMI)
C
      WRITE(6,305) TITLE
      WRITE(6,605) ALT,MA,PSC,LOCID
      WRITE(6,601)
      WRITE(6,602) (F(I),SFFT(I),SFAT(I),SFANT(I),SCMXT(I),STT(I),
     2 SCRT(I),SJPT(I),SJST(I),SJMXT(I),SPSBBT(I),SSSBBT(I),
     3 SSPT(I),SSST(I),STEN(I),STBL(I),STOTAL(I),I=1,24)
      WRITE(6,604) OAS1,OAS2,OASF,OAS3,OAS4,OAS5,OAS6P,OAS6S,
     2 OAS6,OAS7,OAS8,OAS9,OAS10,OASTEN,OASTBL,OAST
C
  605 FORMAT(T30,25HFLIGHT CONDITION:   ALT =,F7.0,7H   MA =,
     2 F6.3,20H   POWER SET. CODE =,F5.2,//,T40,
     3 23HOBSERVER LOCATION NO. =,I4,//,T25,
     4 31HTOTAL ENGINE AND AIRFRAME NOISE,//)
  601 FORMAT(T10,51H1/3 OCT. BAND SPL'S AND OASPL'S DB RE 0.00002 N/M2,
     2 //,T3,4HFREQ,T11,17HFAN    FAN    FAN,T54,16HJET MIXING NOISE,
     3 5X,25HSHOCK BB    SHOCK SCREECH,3X,8HAIRFRAME,/,T3,
     4 4H(HZ),T11,10HFWD    AFT,
     5 50H   TOTAL   CMX    TURB    CORE    PRI    SEC    TOTAL,
     6 3X,24HPRI    SEC    PRI    SEC,4X,
     7 19HTEN    TBLN   TOTAL,/)
  602 FORMAT(1X,F6.0,15F7.1,F8.1)
  604 FORMAT(/,2X,5HOASPL,15F7.1,F8.1)
  210 CONTINUE
      IF(SRC(1).EQ.0.AND.SRC(2).EQ.0.OR.PO2.NE.1) GO TO 220
      DO 206 J=1,NENG
      WRITE(6,305) TITLE
      WRITE(6,300) ALT,MA,PSC,LOCID,NOENG(J)
      WRITE(6,306)
      WRITE(6,308) (F(I),SFFBB(I,J),SFFDT(I,J),SFFCTN(I,J),SFF(I,J),
     2 SFABB(I,J),SFADT(I,J),SFA(I,J),SFAN(I,J),I=1,24)
      WRITE(6,309) OSFFBB(J),OSFFDT(J),OSCTN(J),OASFF(J),
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     2 OSFABB(J),OSFADT(J),OASFA(J),OASFAN(J)
C
  306 FORMAT(T24,20HFAN NOISE COMPONENTS,
     2 //,T12,20H1/3 OCT. BAND SPL'S ,
     2 32HAND OASPL'S - DB RE 0.00002 N/M2,//,T40,
     3 19H**  EXHAUST DUCT **,/,T8,
     4 51H*** INLET RADIATED NOISE ***    *  RADIATED NOISE *,/,
     5 T63,5HTOTAL,/,T4,25HFREQ  BROAD  DSCRT CMBNTN,T40,
     6 12HBROAD  DSCRT,T64,3HFAN,/,T4,
     7 55H(HZ)  -BAND  TONES  TONES  TOTAL    -BAND  TONES  TOTAL,
     8 9H    NOISE,/)
  308 FORMAT(1X,F6.0,4F7.1,2X,3F7.1,2X,F7.1)
  309 FORMAT(/,2X,5HOASPL,4F7.1,2X,3F7.1,2X,F7.1)
C
  206 CONTINUE
  220 CONTINUE
C
      IF(SRC(3).EQ.0.OR.P03.NE.1) GO TO 230
      DO 228 J=1,NENG
      WRITE(6,305) TITLE
      WRITE(6,300) ALT,MA,PSC,LOCID,NOENG(J)
      WRITE(6,222)
      WRITE(6,224) (F(I),SCBB(I,J),SCDT(I,J),SCCTN(I,J),SCMX(I,J),
     2 I=1,24)
      WRITE(6,226) OSCBB(J),OSCDT(J),OSCCTN(J),OASCMX(J)
C
  222 FORMAT(T13,27HCOMPRESSOR NOISE COMPONENTS,//,T11,
     2 31H1/3 OCT. BAND SPL'S AND OASPL'S,/,T17,
     3 18HDB RE 0.00002 N/M2,//,T11,22HFREQ    BROAD    DSCRT,
     4 9H   CMBNTN,
     5 /,T11,22H(HZ)    -BAND    TONES,18H    TONES    TOTAL,/)
  224 FORMAT(8X,F6.0,4F9.1)
  226 FORMAT(/,9X,5HOASPL,4F9.1)
  228 CONTINUE
  230 CONTINUE
C
C
      NO=NO+1
      IF(NO.LE.NLOC) GO TO 40
      NFC=NFC+1
      IF(NFC.LE.NFLTC) GO TO 23
      GO TO 1000
C
  400 WRITE(6,402)
  402 FORMAT(//,5X,
     2 59HAIRPLANE MACH NUMBER MUST BE LESS THAN 1.0 - RUN TERMINATED,
     3 /)
 1000 STOP
      END
```

FAN

```
      SUBROUTINE FAN(X,Y,W,N,SC1,SC2,NCODE,TC1,TC2,TC3,DELT,MTR,MTRD,
     2 MT,XNR,XNS,RSS,BPF,FREF)
      DIMENSION ANG(19),BBDIRI(19),BBDIRD(19),DTDIRI(19),DTDIRD(19),
     2 CTNDIR(19),F(27),SCTN12(24),SCTN14(24),SCTN18(24),DSPL(24)
      REAL N,MTR,MTRD,MT,MA,LBBAR,LBBPK,LBB,LTBAR,LTPK,LT,
     2 LCB12,LCB14,LCB18,LC12,LC14,LC18,LC12PK,LC14PK,LC18PK
     3 ,MDFF,NSFF,MI,MDFA,MDC
      INTEGER SC,SC1,SC2,ERR,BN,TC1,TC2,TC3
      COMMON /FAN/IGV,SPLIBB(24),SPLIDT(24),SICTN(24),SPLDBB(24),
     2 SPLDDT(24),DTREF,WREF,RREF,XLFF,HDFF,MDFF,CDFF,FDFF,NSFF,MI,
     3 XLFA,HDFA,MDFA,CDFA,FDFA,XLC,HDC,MDC,CDC,FDC
      COMMON MA,RHOA,CA,RHOO,CO,CIMPD,DX1,DX2,ERR
C
C   *****  DIRECTIVITY DATA  *****
C
      DATA ANG/0.0,10.,20.,30.,40.,50.,60.,70.,80.,90.,100.,110.,
     2 120.,130.,140.,150.,160.,170.,180./
      DATA BBDIRI/-2.2,-1.0,0.,0.,0.,-2.0,-4.5,-7.5,-11.0,-15.0,
     2 -19.5,-25.0,-30.6,-36.3,-42.1,-47.6,-53.3,-58.8,-64.6/
      DATA BBDIRD/-41.7,-37.4,-33.1,-28.8,-24.3,-20.1,-15.8,-11.5,
     2 -8.0,-5.0,-2.7,-1.2,-0.3,0.,-2.0,-6.0,-10.0,-15.0,-20.0/
      DATA DTDIRI/-2.9,-1.5,0.,0.,0.,-1.2,-3.5,-6.8,-10.5,-14.5,
     2 -19.0,-23.3,-27.8,-32.4,-36.9,-41.5,-46.0,-50.4,-55.0/
      DATA DTDIRD/-38.8,-34.8,-30.8,-26.8,-22.8,-18.9,-15.0,-11.0,
     2 -8.0,-5.0,-3.0,-1.0,0.,0.,-2.0,-5.5,-9.0,-13.0,-18.0/
      DATA CTNDIR/-9.5,-8.5,-7.0,-5.0,-2.0,0.,0.,-3.5,-7.5,-9.0,
     2 -9.5,-10.0,-10.5,-11.0,-11.5,-12.0,-12.5,-13.0,-13.5/
C
C   *****  27 1/3 OB CENTER FREQUENCIES
C
      DATA F/50.,63.,80.,100.,125.,160.,200.,250.,315.,400.,500.,630.,
     2 800.,1000.,1250.,1600.,2000.,2500.,3150.,4000.,5000.,6300.,
     3 8000.,10000.,12500.,16000.,20000./
C
C   *****  NOTES***************
C
C     NCODE  =  01    FOR FIRST-STAGE FAN
C            =  02    FOR SECOND-STAGE FAN
C            =  03    FOR COMPRESSOR WITHOUT CTN COMPONENT
C            =  04    FOR COMPRESSOR WITH CTN COMPONENT
C
C      IGV   =  00    NO INLET GUIDE VANES FOR 1ST STAGE FAN
C            =  01    INLET GUIDE VANES PRESENT FOR 1ST STAGE FAN
C
C     IGV'S ASSUMED PRESENT FOR 2ND STAGE FANS AND COMPRESSORS
C
C     RUN WILL TERMINATE IF THE BLADE PASSAGE FREQUENCY (BPF)
C     WORKS OUT TO BE LESS THAN 44.7 OR GREATER THAN 22390 HZ.
C
C     BPF MUST BE EQUAL TO OR GREATER THAN 355 HZ OR
```

```
C      GARBAGE MAY RESULT (FOR COMBINATION TONE NOISE)
C
C      THE REF FREQUENCY FOR BROADBAND SPECTRA  (2.5*BPF)
C      IS ALLOWED TO BE LARGER THAN 22390 HZ.
C
       IF(MTR.GT.MTRD) GO TO 820
C
C   *****  COMPUTE PARAMETERS COMMON TO INLET AND DISCHARGE DUCT  *****
C
       DENOM=20.*ALOG10(DELT/DTREF)+10.*ALOG10(W/WREF)+63.0
       RSSCBB=-5.0*ALOG10(RSS/300.)
       RSSCDT=-10.0*ALOG10(RSS/300.)
       DELTA=ABS(MT/(1.0-(XNS/XNR)))
       BPF=N*XNR/60.
       IF(BPF.LT.44.7.OR.BPF.GT.22390.) GO TO 810
       CALL BNDN(BPF,27,BN)
       FB=F(BN)
       IREF=BN
       FREF=2.5*FB
       NFREF=BN+4
       IF(NFREF.LE.27) FREF=F(NFREF)
C
       IF(NCODE.GE.3) GO TO 8
       IF(SC1.EQ.1) GO TO 8
       GO TO 95
     8 CONTINUE
C
C   *************************************************************
C   *      COMPUTE NOISE RADIATED FROM THE INLET                *
C   *************************************************************
C
C
C   *****  COMPUTE BROADBAND COMPONENT OF INLET RADIATED NOISE  *****
C
C
C   *****  CALCULATE THE PEAK 1/3 OB SPL (LBBPK)
C
       IF(MTR.GT.0.9) GO TO 14
       IF(MTRD.GT.1.0) GO TO 16
       LBBAR=58.5
       GO TO 20
    16 LBBAR=58.5+20.*ALOG10(MTRD)
       GO TO 20
    14 IF(MTRD.GE.1.0) GO TO 18
       LBBAR=57.6-20.*ALOG10(MTR)
       GO TO 20
    18 LBBAR=57.6+20.*ALOG10(MTRD)-20.*ALOG10(MTR)
    20 CONTINUE
       LBBPK=LBBAR+DENOM
C
```

```
C     *****  COMPUTE SOURCE EMISSION ANGLE (PHP) AND ACTUAL SOUND
C     *****  PROPAGATION PATH LENGTH (RP) FROM INPUT VALUES OF
C     *****  DESIRED ANGLE AND DISTANCE RELATIVE TO THE INLET.
C     *****  (FORWARD SPEED EFFECT)
C
         SC=1
         IF(NCODE.GE.3) SC=3
         CALL XFORM(X,Y,0.0,MA,SC,DX1,DX2,PH,PHP,R,RP,ERR)
         IF(ERR.EQ.1) GO TO 900
         PHI=PH
         RI=R
         PHPI=PHP
         RPI=RP
C
C     *****  COMPUTE CORRECTION FOR CONVECTIVE AMPLIFICATION
C
         CAI=-40.*ALOG10(1.0-MA*COS(PHP/57.29577951))
C
C     *****  CORRECT THE PEAK LEVEL FOR DIRECTIVITY, DISTANCE,
C     *****  LOCAL IMPEDANCE, AND CONVECTIVE AMPLIFICATION
C
         DEL=GIRC(PHP,ANG,BBDIRI,19,1)
         LBB=LBBPK+DEL-20.*ALOG10(RP/RREF)+CIMPD+CAI
C
C     *****  CORRECT FOR ROTOR-STATOR SPACING
C
         LBB=LBB+RSSCBB
C
C     *****  COMPUTE BROADBAND SPECTRUM
C
         DO 40 J=1,24
         DEL=10.*ALOG10(EXP(-4.264*(ALOG10(F(J)/FREF))**2))
         SPLIBB(J)=LBB+DEL
         IF(SPLIBB(J).LT.0.0) SPLIBB(J)=0.0
      40 CONTINUE
C
C     *****  COMPUTE DISCRETE TONE SPL'S OF INLET RADIATED NOISE  *****
C
C
C     *****  COMPUTE PEAK LEVEL OF THE FUNDAMENTAL TONE (LTPK)
C
         IF(MTR.GT.0.72) GO TO 48
         IF(MTRD.GT.1.0) GO TO 42
         LTBAR=60.5
         GO TO 50
      42 LTBAR=60.5+20.*ALOG10(MTRD)
         GO TO 50
      48 IF(MTRD.GE.1.0) GO TO 46
         XLTBAR=60.5+50.*ALOG10(MTR/0.72)
         YLTBAR=59.5-80.*ALOG10(MTR)
```

```
      LTBAR=AMIN1(XLTBAR,YLTBAR)
      GO TO 50
   46 XLTBAR=60.5+20.*ALOG10(MTRD)+50.*ALOG10(MTR/0.72)
      YLTBAR=59.5+80.*ALOG10(MTRD/MTR)
      LTBAR=AMIN1(XLTBAR,YLTBAR)
   50 CONTINUE
      LTPK=LTBAR+DENOM
C
C  *****  CORRECT THE PEAK LEVEL FOR DIRECTIVITY, DISTANCE,
C  *****  LOCAL IMPEDANCE, AND CONVECTIVE AMPLIFICATION
C
      DEL=GIRC(PHP,ANG,DTDIRI,19,1)
      LT=LTPK+DEL-20.*ALOG10(RP/RREF)+CIMPD+CAI
C
C  *****  CORRECT FOR ROTOR-STATOR SPACING
C
      LT=LT+RSSCDT
C
C  *****  CORRECT FOR ROTOR-STATOR INTERACTION AND COMPUTE
C  *****  THE DISCRETE TONE HARMONIC LEVELS
C
      DO 51 J=1,24
      SPLIDT(J)=0.0
   51 CONTINUE
      DO 59 K=1,6
      FBK=FB*K
      IF(FBK.GT.11220.) GO TO 60
      CALL BNDN(FBK,24,BN)
      IF(K.EQ.1) GO TO 53
      IF(BN.EQ.JK) GO TO 60
   53 JK=BN
C
      IF(NCODE.EQ.1.AND.IGV.EQ.0) GO TO 56
      IF(K.GT.1) GO TO 55
      SPLIDT(JK)=LT
      IF(DELTA.LT.1.05) SPLIDT(JK)=LT-8.0
      GO TO 58
   55 SPLIDT(JK)=LT-3.0-3.0*K
      GO TO 58
   56 SPLIDT(JK)=LT+3.0-3.0*K
      IF(DELTA.LT.1.05.AND.K.EQ.1) SPLIDT(JK)=LT-8.0
   58 CONTINUE
   59 CONTINUE
   60 CONTINUE
C
C  *****  COMPUTE COMBINATION TONE NOISE (INLET ONLY)  *****
C    (FIRST-STAGE FANS OR COMPRESSORS IF DESIRED WHERE MTR > 1.0)
C
      DO 71 I=1,24
      SICTN(I)=0.0
```

```
   71 CONTINUE
      IF(NCODE.EQ.2.OR.NCODE.EQ.3.OR.MTR.LE.1.0) GO TO 75
C
C     *****  COMPUTE PEAK LEVEL FOR EACH OF 3 COMPONENTS
C
   70 IF(MTR.GT.1.146) GO TO 61
      LCB12=785.68*ALOG10(MTR)+30.0
      GO TO 62
   61 LCB12=-49.62*ALOG10(MTR)+79.44
   62 CONTINUE
      IF(MTR.GT.1.322) GO TO 63
      LCB14=391.81*ALOG10(MTR)+30.0
      GO TO 64
   63 LCB14=-50.06*ALOG10(MTR)+83.57
   64 CONTINUE
      IF(MTR.GT.1.610) GO TO 65
      LCB18=199.20*ALOG10(MTR)+30.0
      GO TO 66
   65 LCB18=-49.89*ALOG10(MTR)+81.52
   66 CONTINUE
      LC12PK=LCB12+DENOM
      LC14PK=LCB14+DENOM
      LC18PK=LCB18+DENOM
C
C     *****  CORRECT THE PEAK LEVELS FOR DIRECTIVITY, DISTANCE,
C     *****  LOCAL IMPEDANCE, AND CONVECTIVE AMPLIFICATION
C
      DEL=GIRC(PHP,ANG,CTNDIR,19,1)
      LC12=LC12PK+DEL-20.*ALOG10(RP/RREF)+CIMPD+CAI
      LC14=LC14PK+DEL-20.*ALOG10(RP/RREF)+CIMPD+CAI
      LC18=LC18PK+DEL-20.*ALOG10(RP/RREF)+CIMPD+CAI
C
C     *****  CORRECT FOR  IGV'S, IF PRESENT
C
      IF(NCODE.EQ.1.AND.IGV.EQ.0) GO TO 72
      LC12=LC12-5.0
      LC14=LC14-5.0
      LC18=LC18-5.0
   72 CONTINUE
C
C     *****  COMPUTE SPECTRUM SHAPE FOR EACH OF 3 CTN COMPONENTS
C
      IR12=IREF-3
      IR14=IREF-6
      IR18=IREF-9
      DO 80 J=1,24
      IF(J.LT.IR12) SPLDEL=30.0*ALOG10(F(J)/FB)+9.03
      IF(J.EQ.IR12) SPLDEL=0.0
      IF(J.GT.IR12) SPLDEL=-30.0*ALOG10(F(J)/FB)-9.03
      SCTN12(J)=LC12+SPLDEL
```

```
      IF(SCTN12(J).LT.0.0) SCTN12(J)=0.0
C
      IF(J.LT.IR14) SPLDEL=50.0*ALOG10(F(J)/FB)+30.1
      IF(J.EQ.IR14) SPLDEL=0.0
      IF(J.GT.IR14) SPLDEL=-50.0*ALOG10(F(J)/FB)-30.1
      SCTN14(J)=LC14+SPLDEL
      IF(SCTN14(J).LT.0.0) SCTN14(J)=0.0
C
      IF(J.LT.IR18) SPLDEL=50.0*ALOG10(F(J)/FB)+45.15
      IF(J.EQ.IR18) SPLDEL=0.0
      IF(J.GT.IR18) SPLDEL=-30.0*ALOG10(F(J)/FB)-27.09
      SCTN18(J)=LC18+SPLDEL
      IF(SCTN18(J).LT.0.0) SCTN18(J)=0.0
      IF(SCTN12(J).GT.0.0.OR.SCTN14(J).GT.0.0.OR.SCTN18(J).GT.0.0)
     2 SICTN(J)=10.*ALOG10(10.**(SCTN12(J)/10.)+10.**(SCTN14(J)/10.)+
     2 10.**(SCTN18(J)/10.))
   80 CONTINUE
   75 CONTINUE
C
      IF(NCODE.LE.2) GO TO 87
      IF(TC3.EQ.1.OR.TC3.EQ.3) GO TO 81
      IF(TC3.EQ.2) GO TO 86
      GO TO 89
   87 IF(TC1.GE.1) GO TO 86
      GO TO 89
   81 CALL DCTRT(DSPL,XLC,HDC,MDC,CDC,FDC,0.0,0.0,PHP,1)
      DO 84 I=1,24
      SPLIBB(I)=SPLIBB(I)-DSPL(I)
      SPLIDT(I)=SPLIDT(I)-DSPL(I)
      SICTN(I)=SICTN(I)-DSPL(I)
   84 CONTINUE
      IF(TC3.EQ.1) GO TO 82
   86 CALL DCTRT(DSPL,XLFF,HDFF,MDFF,CDFF,FDFF,NSFF,MI,PHP,TC1)
      DO 83 I=1,24
      SPLIBB(I)=SPLIBB(I)-DSPL(I)
      SPLIDT(I)=SPLIDT(I)-DSPL(I)
      SICTN(I)=SICTN(I)-DSPL(I)
   83 CONTINUE
   82 DO 85 I=1,24
      IF(SPLIBB(I).LT.0.0) SPLIBB(I)=0.0
      IF(SPLIDT(I).LT.0.0) SPLIDT(I)=0.0
      IF(SICTN(I).LT.0.0) SICTN(I)=0.0
   85 CONTINUE
   89 CONTINUE
C
      IF(NCODE.GE.3.OR.SC2.EQ.0) GO TO 195
C
   95 CONTINUE
C
C    ************************************************************
```

```
C  *   COMPUTE NOISE RADIATED FROM THE FAN DISCHARGE DUCT     *
C  ************************************************************
C
C  *****  CALCULATE THE BROADBAND NOISE COMPONENT   *****
C
C
C  *****  COMPUTE THE PEAK 1/3 OB SPL (XLBBPK)
C
       IF(MTR.GT.1.0) GO TO 110
       IF(MTRD.GT.1.0) GO TO 112
       XLBBAR=60.0
       GO TO 116
   112 XLBBAR=60.0+20.*ALOG10(MTRD)
       GO TO 116
   110 XLBBAR=60.0+20.*ALOG10(MTRD)-20.*ALOG10(MTR)
   116 CONTINUE
       XLBBPK=XLBBAR+DENOM
C
C  *****  COMPUTE SOURCE EMISSION ANGLE (PHP) AND ACTUAL SOUND
C  *****  PROPAGATION PATH LENGTH (RP) FROM INPUT VALUES OF
C  *****  DESIRED ANGLE AND DISTANCE RELATIVE TO THE DISCHARGE
C  *****  DUCT. (FORWARD SPEED EFFECT)
C
       CALL XFORM(X,Y,0.0,MA,2,DX1,DX2,PH,PHP,R,RP,ERR)
       IF(ERR.EQ.1) GO TO 900
       PHPD=PHP
       RPD=RP
       PHD=PH
       RD=R
C
C  *****  COMPUTE CORRECTION FOR CONVECTIVE AMPLIFICATION
C
       CAD=-40.*ALOG10(1.0-MA*COS(PHP/57.29577951))
C
C  *****  CORRECT THE PEAK LEVEL FOR DIRECTIVITY, DISTANCE,
C  *****  LOCAL IMPEDANCE, AND CONVECTIVE AMPLIFICATION
C
       DEL=GIRC(PHP,ANG,BBDIRD,19,1)
       XLBB=XLBBPK+DEL-20.*ALOG10(RP/RREF)+CIMPD+CAD
C
C  *****  CORRECT FOR ROTOR-STATOR SPACING
C
       XLBB=XLBB+RSSCBB
C
C  *****  CORRECT FOR IGV'S, IF PRESENT
C
       IF(NCODE.EQ.1.AND.IGV.EQ.0) GO TO 134
       XLBB=XLBB+3.0
   134 CONTINUE
C
```

```
C   *****  COMPUTE THE BROADBAND SPECTRUM
C
       DO 140 J=1,24
       DEL=10.*ALOG10(EXP(-4.264*(ALOG10(F(J)/FREF))**2))
       SPLDBB(J)=XLBB+DEL
       IF(SPLDBB(J).LT.0.0) SPLDBB(J)=0.0
   140 CONTINUE
C
C   *****  COMPUTE THE DISCRETE TONE LEVELS OF THE DISCHARGE DUCT  *****
C
C
C   *****  COMPUTE THE PEAK LEVEL OF THE FUNDAMENTAL TONE (XLTPK)
C
       IF(MTR.GT.1.0) GO TO 148
       IF(MTRD.GT.1.0) GO TO 142
       XLTBAR=63.0
       GO TO 150
   142 XLTBAR=63.0+20.*ALOG10(MTRD)
       GO TO 150
   148 XLTBAR=63.0+20.*ALOG10(MTRD)-20.*ALOG10(MTR)
   150 CONTINUE
       XLTPK=XLTBAR+DENOM
C
C   *****  CORRECT THE PEAK LEVEL FOR DIRECTIVITY, DISTANCE,
C   *****  LOCAL IMPEDANCE, AND CONVECTIVE AMPLIFICATION
C
       DEL=GIRC(PHP,ANG,DTDIRD,19,1)
       XLT=XLTPK+DEL-20.*ALOG10(RP/RREF)+CIMPD+CAD
C
C   *****  CORRECT FOR ROTOR-STATOR SPACING
C
       XLT=XLT+RSSCDT
C
C   *****  CORRECT FOR IGV'S, IF PRESENT
C
       IF(NCODE.EQ.1.AND.IGV.EQ.0) GO TO 154
       XLT=XLT+6.0
   154 CONTINUE
C
C   *****  COMPUTE LEVELS OF THE HARMONICS OF THE FUNDAMENTAL TONE
C
       DO 157 J=1,24
       SPLDDT(J)=0.0
   157 CONTINUE
       DO 165 K=1,6
       FBK=FB*K
       IF(FBK.GT.11220.) GO TO 170
       CALL BNDN(FBK,24,BN)
       IF(K.EQ.1) GO TO 159
       IF(BN.EQ.JK) GO TO 170
```

```
  159 JK=BN
      IF(NCODE.EQ.1.AND.IGV.EQ.0) GO TO 156
      IF(K.GT.1) GO TO 155
      SPLDDT(JK)=XLT
      IF(DELTA.LT.1.05) SPLDDT(JK)=XLT-8.0
      GO TO 158
  155 SPLDDT(JK)= XLT-3.0-3.0*K
      GO TO 158
  156 SPLDDT(JK)=XLT+3.0-3.0*K
      IF(DELTA.LT.1.05.AND.K.EQ.1) SPLDDT(JK)=XLT-8.0
  158 CONTINUE
  165 CONTINUE
  170 CONTINUE
C
      IF(TC2.EQ.0) GO TO 195
      CALL DCTRT(DSPL,XLFA,HDFA,MDFA,CDFA,FDFA,0.0,0.0,PHP,4)
      DO 173 I=1,24
      SPLDBB(I)=SPLDBB(I)-DSPL(I)
      SPLDDT(I)=SPLDDT(I)-DSPL(I)
      IF(SPLDBB(I).LT.0.0) SPLDBB(I)=0.0
      IF(SPLDDT(I).LT.0.0) SPLDDT(I)=0.0
  173 CONTINUE
C
  195 CONTINUE
C
      GO TO 900
C
C  *****  ERROR MESSAGES  *****
C
  810 IF(NCODE.LE.2) WRITE(6,320)
      IF(NCODE.GE.3) WRITE(6,321)
  320 FORMAT(///,2X,'FAN BPF IS OUTSIDE ALLOWABLE RANGE - RUN',
     2 ' TERMINATED',/)
  321 FORMAT(//,2X,41HCOMPRESSOR BPF IS OUTSIDE ALLOWABLE RANGE,
     2 17H - RUN TERMINATED,/)
      GO TO 890
  820 WRITE(6,322)
  322 FORMAT(//,2X,'MTR MUST BE LES THAN OR EQUAL TO MTRD',
     2 ' FOR FAN OR COMPRESSOR NOISE - RUN TERMINATED',/)
  890 ERR=1
  900 RETURN
      END
```

TURB

```
      SUBROUTINE TURB(F,PR,N2,D,AE,XNB,X,Y,RREF,TC4,FDT)
      DIMENSION F(24),BBSPEC(30),FBPF(30),OASDIR(10),SPLDIR(10),
     2 DIRANG(10)
      REAL N2,MA,MDTP,DSPL(24)
      INTEGER ERR,BN,TC4
      COMMON /TC/SPL(24),AREF,UREF,WREF,DTREF,XLTP,HDTP,MDTP,CDTP
      COMMON MA,RHOA,CA,RHOO,CO,CIMPD,DX1,DX2,ERR
C
      DATA BBSPEC/-60.0,-41.0,-36.0,-29.5,-26.0,-21.5,-14.5,-10.9,
     2 -8.3,-6.6,-5.4,-4.4,-3.7,-3.0,-2.5,-1.7,-1.0,-0.5,-0.25,0.00,
     3 -0.2,-0.4,-0.6,-1.0,-1.3,-1.7,-2.2,-2.8,-3.5,-4.5/
      DATA FBPF/.001,.005,.01,.02,.03,.05,.10,.15,.20,.25,.30,.35,
     2 .40,.45,.50,.60,.70,.80,.90,1.00,1.10,1.20,1.30,1.40,1.50,
     3 1.60,1.70,1.80,1.90,2.00/
C
      DATA OASDIR/-13.8,-4.6,-4.5,-1.5,0.0,-1.3,-2.8,-4.2,-5.4,-6.6/
      DATA SPLDIR/-25.6,-9.5,-8.8,-2.5,0.0,-4.3,-6.5,-11.8,-14.4,-19.5/
      DATA DIRANG/0.0,90.,92.,111.,120.,130.,140.,150.,160.,180./
C
C
C   ***  COMPUTE DOMINANT (LAST) STAGE TIP SPEED  ***
C
      UT=(D/2.)*(2.0*3.14*N2/60.)
C
C   ***  COMPUTE TOTAL OASPL (LOSSLESS) AT 120 DEG, 200 FT  ***
C   ***  SIDELINE CORRECTED FOR LOCAL IMPEDANCE             ***
C
      OASPK=40.*ALOG10(1.0-(1.0/PR)**0.286)-20.*ALOG10(UT/UREF)+
     2 10.*ALOG10(AE/AREF)+CIMPD+109.0
C
C      INITIALIZE SPECTRUM
C
      DO 10 I=1,24
      SPL(I)=0.0
   10 CONTINUE
C
C   ***  COMPUTE DISCRETE 1/3 O.B. SPL (LOSSLESS) AT 120 DEG,  ***
C   ***  200 FT SIDELINE                                       ***
C
      SPLPK=OASPK-5.0
C
C   ***  COMPUTE SOURCE EMISSION ANGLE AND ACTUAL DISTANCE  ***
C   ***  I.E., MEASURED ANGLE AND DISTANCE CORRECTED FOR    ***
C   ***  FORWARD SPEED                                      ***
C
      CALL XFORM(X,Y,0.0,MA,4,DX1,DX2,PH,PHP,R,RP,ERR)
      IF(ERR.EQ.1) GO TO 50
C
C   ***  APPLY DIRECTIVITY AND DISTANCE CORRECTIONS TO PEAK  ***
C   ***  TOTAL OASPL AND PEAK TONE SPL                       ***
```

```
C
      OASDEL=GIRC(PHP,DIRANG,OASDIR,10,1)
      OASPL=OASPK+OASDEL-20.*ALOG10(RP/RREF)
C
      SPLDEL=GIRC(PHP,DIRANG,SPLDIR,10,1)
      SPLT=SPLPK+SPLDEL-20.*ALOG10(RP/RREF)
C
C   ***  APPLY CORRECTION FOR CONVECTIVE AMPLIFICATION  ***
C
      CAMP=-40.*ALOG10(1.0-MA*COS(PHP/57.3))
      OASPL=OASPL+CAMP
      SPLT=SPLT+CAMP
      IF(OASPL.LE.0.0.OR.SPLT.LE.0.0) GO TO 50
      IF(SPLT.GE.OASPL) GO TO 48
C
C   ***  COMPUTE BROADBAND OASPL (LOSSLESS)  ***
C
      OASBB=10.*ALOG10(10.**(OASPL/10.)-10.**(SPLT/10.))
C
C   ***  COMPUTE BLADE PASSAGE FREQUENCY  ***
C
      BPF=XNB*N2/60.
C
C   ***  FIND 1/3 O.B. CONTAINING THE BPF  ***
C
      IF(BPF.GE.44.7.AND.BPF.LE.11220.) GO TO 19
      FPK=BPF
      BN=0
      GO TO 21
   19 CALL BNDN(BPF,24,BN)
      FPK=F(BN)
   21 CONTINUE
C
C   ***  COMPUTE TOTAL SPECTRUM (LOSSLESS)  ***
C
      DO 30 J=1,24
      FRAT=F(J)/FPK
      DEL=GIRC(FRAT,FBPF,BBSPEC,30,1)
      SPL(J)=DEL-7.3+OASBB
      IF(SPL(J).LT.0.0.AND.J.NE.BN) SPL(J)=0.0
      IF(J.NE.BN) GO TO 30
      SPLPBB=SPL(J)
      SPL(J)=10.*ALOG10(10.**(SPLPBB/10.)+10.**(SPLT/10.))
   30 CONTINUE
C
      IF(TC4.EQ.0) GO TO 50
      CALL DCTRT(DSPL,XLTP,HDTP,MDTP,CDTP,FDT,0.0,0.0,PHP,4)
      DO 32 I=1,24
      SPL(I)=SPL(I)-DSPL(I)
      IF(SPL(I).LT.0.0) SPL(I)=0.0
```

```
   32 CONTINUE
      GO TO 50
C
C
   48 WRITE(6,100)
  100 FORMAT(//,5X,45HTONE SPL NOT LESS THAN TOTAL OASPL IN TURBINE,
     2 23H NOISE - RUN TERMINATED,/)
      ERR=1
   50 RETURN
      END
```

CORE

```
      SUBROUTINE CORE(FREQ,W3,RHO3,T3,T4,DT,X,Y,NFLAG,RREF,TC5,FDCR)
      DIMENSION FREQ(24),DELPWL(24),DIRDF(24,19),
     2 ANGDF(19),DIRSF(19),ANGSF(19),SPWL(24),SPLA(24)
      REAL MA,MDTP,DSPL(24)
      INTEGER ERR,TC5
      COMMON /TC/SPL(24),AREF,UREF,WREF,DTREF,XLTP,HDTP,MDTP,CDTP
      COMMON MA,RHOA,CA,RHO0,C0,CIMPD,DX1,DX2,ERR
C
C     POWER SPECTRUM SHAPE , REF P156, FAA-RD-77-4
C
      DATA DELPWL/-24.0,-20.0,-16.0,-13.0,-10.0,-7.0,-4.5,-2.5,
     2 -1.0,0.0,-1.0,-2.5,-4.5,-7.0,-10.0,-13.0,-16.0,-20.0,-24.0,
     3 -27.5,-31.5,-36.0,-40.0,-45.0/
C
C     DIRECTIVITY INDICES FOR DUAL-FLOW ENGINE EXHAUST
C     GEOMETRY, REF P155, FAA-RD-77-4.  EXTRAPOLATED BELOW 40 DEG AND
C     ABOVE 140 DEG TO COVER RANGE FROM 0 TO 180 DEG.  OCT 77.
C
C
      DATA ((DIRDF(I,J),I=1,24),J=1,19)/4*-5.1,3*-9.4,17*-15.9,
     2 4*-4.8,3*-8.6,17*-14.4,4*-4.5,3*-8.0,17*-12.9,
     3 4*-4.3,3*-7.2,17*-11.5,4*-4.0,3*-6.5,17*-10.0,
     2 4*-3.8,3*-5.8,17*-8.5,4*-3.2,-5.0,-4.5,-5.0,17*-6.5,4*-3.0,
     3 -4.0,-3.5,18*-4.5,4*-2.7,-3.0,-2.5,-4.0,17*-2.5,4*-2.0,
     4 -1.5,-1.5,-3.0,17*-0.5,4*-0.8,0.0,0.0,-1.8,17*1.0,4*0.8,
     5 1.8,1.5,1.0,17*2.5,4*3.0,4.0,3.5,3.5,17*5.0,5*5.0,4.8,
     6 5.5,17*4.5,4*7.0,5.0,6.0,6.5,17*3.5,4*7.2,4.7,5.9,6.6,17*2.2,
     7 4*7.0,4.0,5.3,6.3,17*0.7,4*6.4,3.1,4.4,5.6,17*-1.1,
     8 4*5.6,1.8,3.2,4.5,17*-3.2/
      DATA ANGDF/0.0,10.,20.,30.,40.,50.,60.,70.,80.,90.,100.,110.,
     2 120.,130.,140.,150.,160.,170.,180./
C
C     DIRECTIVITY INDICES FOR SINGLE-FLOW ENGINE EXHAUST GEOMETRY
C     REF GE'S PROPOSED APPENDIX TO ARP 876 FOR COMBUSTOR NOISE
C     PREDICTION, JULY 1977.  EXTRAPOLATED BELOW 10 DEG AND ABOVE
C     160 DEG TO COVER RANGE FROM 0 TO 180 DEG.  OCT 77.
C
      DATA DIRSF/-8.5,-8.0,-7.5,-7.0,-6.5,-6.0,-5.3,-4.6,-4.0,-1.7,
     2 0.7,3.0,5.0,3.5,1.2,-1.9,-5.1,-8.8,-12.6/
      DATA ANGSF/0.0,10.,20.,30.,40.,50.,60.,70.,80.,90.,100.,110.,
     2 120.,130.,140.,150.,160.,170.,180./
C
C
C    THIS PROGRAM COMPUTES A CORE NOISE PREDICTION AT A POINT USING
C    THE GENERAL ELECTRIC ENGINE PREDICTION METHOD DESCRIBED IN
C    FAA-RD-77-4, DATED FEB 1977, AND THEIR PROPOSED APPENDIX TO
C     ARP 876 (COMBUSTOR NOISE PREDICTION) FOR THE SAE A-21 JET
C     NOISE SUBCOMMITTEE, JULY 1977.
C     SPL'S ARE DB RE 0.00002 N/M2     FREE-FIELD (LOSSLESS)
C
```

```
C
C     COMPUTE OVERALL SOUND POWER
C
      OAPWL=10.*ALOG10((W3/WREF)*((T4-T3)/DTREF)**2*(RHO3/RHO0)**2)
     2 -40.*ALOG10(DT/DTREF)+123.5
C
C     COMPUTE POWER SPECTRUM REF. P156 OF FAA-RD-77-4
C     PEAK FREQUENCY IS 400 HZ.
C
      SPWLPK=OAPWL-6.8
      DO 10 I=1,24
   10 SPWL(I)=SPWLPK+DELPWL(I)
C
C     CONVERT POWER SPECTRUM TO SOUND PRESSURE LEVEL SPECTRUM
C          IMPEDANCE COMPUTED FROM AMBIENT STATIC CONDITIONS
C          ATMOSPHERIC ATTENUATION IS NEGLECTED
C
      DO 20 I=1,24
      SPLA(I)=SPWL(I)+CIMPD-20.8
   20 CONTINUE
C
C
C     APPLY DIRECTIVITY FOR SINGLE-FLOW OR DUAL-FLOW ENGINE
C     EXHAUST TO OBTAIN SPL'S AT DESIRED ANGLE.
C     COMPUTE EQUIVALENT STATIC DIRECTIVITY ANGLE AND DISTANCE
C     IF MA > 0.0
C     ALSO CORRECT FOR SPHERICAL DISPERSION
C
      CALL XFORM(X,Y,0.0,MA,5,DX1,DX2,PH,PHP,R,RP,ERR)
      IF(ERR.EQ.1) GO TO 70
      IF(NFLAG.EQ.2) GO TO 40
      DIRCOR=GIRC(PHP,ANGSF,DIRSF,19,1)
      DO 30 I=1,24
      SPL(I)=SPLA(I)+DIRCOR-20.*ALOG10(RP/RREF)-37.0
   30 CONTINUE
      GO TO 50
   40 DO 45 I=1,24
      F=FREQ(I)
      DC=DTAB2(PHP,F,ANGDF,FREQ,19,24,1,1,DIRDF,24,IERR)
      SPL(I)=SPLA(I)+DC-20.*ALOG10(RP/RREF)-37.0
   45 CONTINUE
   50 CONTINUE
C
C      NO RELATIVE VELOCITY EFFECT IS APPLIED TO POWER LEVEL
C      NO DYNAMIC AMPLIFICATION EFFECT IS APPLIED
C
C      CORRECT 1/3 O.B. SPL'S FOR CONVECTIVE AMPLIFICATION AT
C      FORWARD SPEED AS FOLLOWS:
C
      C=-40.*ALOG10(1.0-MA*COS(PHP/57.3))
```

```
      DO 47 I=1,24
      SPL(I)=SPL(I)+C
      IF(SPL(I).LT.0.0) SPL(I)=0.0
   47 CONTINUE
C
      IF(TC5.EQ.0) GO TO 70
      CALL DCTRT(DSPL,XLTP,HDTP,MDTP,CDTP,FDCR,0.0,0.0,PHP,4)
      DO 49 I=1,24
      SPL(I)=SPL(I)-DSPL(I)
      IF(SPL(I).LT.0.0) SPL(I)=0.0
   49 CONTINUE
C
   70 RETURN
      END
```

JETMX

```
      SUBROUTINE JETMX(FREQ,T0,D,VJ1,TJ1,NPLUG,NCOAX,X,Y)
      DIMENSION A(4,17),
     2 ARAT(5),HN(4),FREQ(24),XOR(4),YOR(4),RS(4),THS(4),RSTAR(4),
     3 THSTAR(4),P2PRF2(4),F1(4),F2(4)
      REAL MC(5,17),LGSTN(17),LP1(4),LP2(4),MA,M,NAR,MSTAR,ME,
     2 MCX
      INTEGER ERR
      COMMON /JMX/SPL1(24),SPL2(24),TREF,RG,GC,H,RW,
     2 D2,VJ2,TJ2,NAR
      COMMON MA,RHOA,CA,RHO0,C0,CIMPD,DX1,DX2,ERR
      DATA ((A(I,J),J=1,17),I=1,4)/0.8239,-1.24,-2.3019,1.4745,
     2 45.759,-2.1086,3.3692,-2.3864,12.808,-1.8167,-1.7894,1.1641,
     3 4.512,-0.028729,0.789,-0.51772,2.293E14,
     4 0.4176,-1.7269,-1.3226,1.3507,18.932,-3.2199,1.3276,-0.1765,
     5 8.4045,-1.5494,-0.16571,0.22007,5.2846,1.3015,0.85116,
     6 -0.60053,1.993E13,
     7 0.32555,0.2482,-4.0206,2.6807,202.88,3.8424,10.520,-8.0248,
     8 10.491,-0.019983,0.73551,-0.76495,4.5428,0.20763,0.27691,
     9 0.036298,6.086E13,
     1 0.74038,-3.4538,-4.7181,3.2662,331.55,0.53294,9.5983,-6.829,
     2 10.429,0.36732,0.89132,-0.87600,2.6963,1.8687,3.0174,
     3 -2.1329,4.794E13/
      DATA ((MC(I,J),J=1,17),I=1,5)/2.00,1.22,0.46,0.74,1.06,1.41,
     2 1.78,2.16,2.55,2.95,3.36,3.80,4.24,4.70,5.00,5.10,5.10,
     3 0.85,0.80,1.02,1.34,1.68,2.07,2.49,2.93,3.38,3.85,4.31,4.72,
     4 5.04,5.10,5.10,5.10,5.10,
     5 0.00,0.66,1.45,2.16,2.82,3.47,4.07,4.62,4.97,5.04,5.06,5.08,
     6 5.10,5.10,5.10,5.10,5.10,
     7 0.00,0.74,1.66,2.46,3.15,3.74,4.23,4.62,4.91,5.04,5.06,5.08,
     8 5.10,5.10,5.10,5.10,5.10,
     9 0.95,1.60,2.63,3.60,4.32,4.77,4.99,5.02,5.03,5.04,5.06,5.08,
     1 5.10,5.10,5.10,5.10,5.10/
      DATA ARAT/1.0,3.0,6.0,10.0,15.0/
      DATA LGSTN/-1.15,-1.0,-0.8,-0.6,-0.4,-0.2,0.0,0.2,0.4,0.6,
     2 0.8,1.0,1.2,1.4,1.6,1.8,2.0/
      DATA HN/1.25,0.221,0.442,0.884/
C
      VA=MA*CA
C
C
C   *****  STEP 1  *****
C
C
C     SET PRIMARY OR SINGLE NOZZLE EXIT MACH NO., OR,
C     IF MA > 0.0, COMPUTE RELATIVE MACH NO. FOR A SINGLE NOZZLE
C
      NSEC=0
      TJ=TJ1
      M=1.0/SQRT((1.33*RG*TJ*GC)/(VJ1*VJ1)-(1.33-1.0)/2.0)
      IF(MA.LE.0.0) GO TO 15
```

```
      IF(NCOAX.EQ.1) GO TO 15
      MSTAR=M*(1.0-VA/VJ1)**0.75
      M=MSTAR
   15 CONTINUE
C
C   *****  STEP 2  *****
C
C
C     COMPUTE EFFECTIVE NOZZLE DIAMETER, RD PARAMETER FOR PLUG
C     NOZZLES AND REDUCED COORDINATES OF RECEIVER LOCATION
C
      RD=1.0
      DE=D
      IF(NPLUG.NE.1) GO TO 18
      DE=2.0*SQRT(H*(D-H))
      RD=2.0*H/DE
   18 CONTINUE
C
C   *****  STEP 3  *****
C
      XR=X/DE
      YR=Y/DE
   19 CONTINUE
      IF(XR.GT.30.0.OR.XR.LT.-30.0) GO TO 81
      IF(YR.LT.0.0.OR.YR.GT.30.0) GO TO 81
C
C   *****  STEP 4  *****
C
C
C     COMPUTE POLAR COORDINATES OF RECEIVER RELATIVE TO THE
C     SOURCE LOCATION AS A FUNCTION OF FREQUENCY, CORRECTED
C     FOR FORWARD SPEED IF NECESSARY.
C
      DO 20 I=1,4
      XOR(I)=A(I,13)*M**A(I,14)*(TJ/TREF)**(A(I,15)+A(I,16)*M)
      YOR(I)=0.5+0.132*XOR(I)
      IF(YR.GT.YOR(I)) GO TO 7
      CK=-DX1
      IF(XR.GE.CK) GO TO 81
      THS(I)=3.14159265
      RS(I)=XOR(I)-XR
      THSTAR(I)=THS(I)
      RSTAR(I)=RS(I)/(1.0-MA)
      GO TO 12
    7 THS(I)=ATAN((YR-YOR(I))/(XR-XOR(I)))
      IF(THS(I).LT.0.0) THS(I)=THS(I)+3.14159265
      IF(THS(I).LT.0.1309) GO TO 81
      RS(I)=SQRT((XR-XOR(I))**2+(YR-YOR(I))**2)
C
C   *****  STEP 5   INTEGRATED INTO DO LOOP OF STEP 4  *****
```

```
C
    1 THSTAR(I)=THS(I)
      RSTAR(I)=RS(I)
      IF(MA.LE.0.0) GO TO 12
      CTHSTR=(1.0/(1.0-MA*MA))*((1.0/TAN(THS(I)))-MA*SQRT(1.0-MA*MA+
     2 (1.0/TAN(THS(I)))**2))
      IF(CTHSTR.NE.0.0) THSTAR(I)=ATAN(1.0/CTHSTR)
      IF(THSTAR(I).LT.0.0) THSTAR(I)=THSTAR(I)+3.14159265
      IF(CTHSTR.EQ.0.0) THSTAR(I)=1.570796
      RSTAR(I)=(YR-YOR(I))/SIN(THSTAR(I))
   12 CONTINUE
   20 CONTINUE
C
C  *****  STEP 6  *****
C
C
C     COMPUTE PREDICTION EQN COEFFICIENTS WHICH ARE NOT A
C     FUNCTION OF FREQUENCY
C
   21 C1=M**2.34
      C2=10.65*(TJ/T0)**0.93
      C3=-15.18*(TJ/T0)**1.11*M**0.89
      C6=17.5*(TJ/(3.0*TREF))**(0.89*(M*M-1.0))
      C7=0.41*(TJ/(3.6*TREF))**(0.566*(M*M-1.0))
C
C  *****  STEP 7  *****
C
C
C     COMPUTE PREDICTION EQN COEFFICIENTS WHICH ARE A FUNCTION
C     OF FREQUENCY AND THE MEAN SQUARE ACOUSTIC PRESSURE
C     FOR EACH OF THE THREE OCTAVE BANDS AND THE OVERALL
C     INCLUDING A CORRECTION FOR DYNAMIC AMPLIFICATION
C     (EFFECTS OF FORWARD SPEED ON DIRECTIVITY ANGLE AND
C     PROPAGATION PATH LENGTH ARE ALSO INCLUDED)
C
      DO 30 I=1,4
      R=RSTAR(I)
      THET=THSTAR(I)
      C4=A(I,5)*M**A(I,6)*(TJ/TREF)**(A(I,7)+A(I,8)*M)
      C5=A(I,9)*M**A(I,10)*(TJ/TREF)**(A(I,11)+A(I,12)*M)
      ALP2=A(I,1)*M**A(I,2)*(TJ/TREF)**(A(I,3)+A(I,4)*M)
      C9=((1.0+ALP2*M*M)/(ALP2*M*M+(1.0-(M*COS(THET))/
     2 (1.0+C6*EXP(-C7*R)))**2))**(5./2.)
      C10=1.0+(C4*EXP(-C5*THET))/(1.0+C6*EXP(-C7*R/4.))
      P2PRF2(I)=((A(I,17)*C9/C10)*(TJ/TREF)**1.54*M**4.0*(1.0+COS(THET)
     2 **4.0)*(C1/(R*R)+C2/R**4.0+C3/R**6.0))/(1.0-MA*COS(3.14159265
     3 -THET))
   30 CONTINUE
      IF(NSEC.EQ.1) GO TO 70
C
```

```
C     *****  STEP 8 AND 17  *****
C
C
C        COMPUTE SPL IN EACH FREQUENCY BAND FOR THE PRIMARY
C        OR SINGLE NOZZLE JET AND CORRECT FOR LOCAL ACOUSTIC
C        IMPEDANCE
C
         RCC=CIMPD
         DO 42 I=1,4
         LP1(I)=10.*ALOG10(P2PRF2(I))+RCC
         IF(NPLUG.EQ.1) LP1(I)=10.*ALOG10(P2PRF2(I))+3.0*ALOG10(0.10+
        2 2.0*H/DE)+RCC
      42 CONTINUE
C
C
C        COMPUTE CENTER FREQUENCIES FOR EACH FREQUENCY BAND OF
C        PRIMARY OR SINGLE NOZZLE JET
C
         DO 48 I=1,4
         F1(I)=HN(I)*CA/(DE*RD**0.4)
      48 CONTINUE
         IF(NCOAX.NE.1) GO TO 55
C
C     *****  STEP 9  *****
C
C
C        FOR COAXIAL JETS, COMPUTE CORRECTION TO PRIMARY JET
C        SPL'S TO ACCOUNT FOR THE PRESENCE OF THE SECONDARY JET
C
         DO 54 I=1,4
         ABCIS=ALOG10(F1(I)*DE*RD**0.4/VJ1)
         MCX=DTAB2(ABCIS,NAR,LGSTN,ARAT,17,5,1,1,MC,5,IERR)
         DLP=10.*MCX*ALOG10(1.0-VJ2/VJ1)
         LP1(I)=LP1(I)+DLP
      54 CONTINUE
         GO TO 55
C
C     *****  STEP 11  *****
C
C
C        FOR COAXIAL JETS, COMPUTE EFFECTIVE SECONDARY JET
C        FLOW PARAMETERS
C
      57 NSEC=1
         DE=D2
         RD=1.0
         TTE=(TJ1+RW*TJ2)/(1.0+RW)
         VJE=(VJ1+RW*VJ2)/(1.0+RW)
         ME=SQRT(1./((1.4*RG*TTE*GC)/(VJE*VJE)-(1.4-1.0)/2.0))
C
```

```
C
      IF(MA.GT.0.0) ME=ME*(1.0-VA/VJE)**0.75
      M=ME
      TJ=TTE
C
C  *****  STEP 12  *****
C
      X2=X+DX2
      XR=X2/DE
      YR=Y/DE
      GO TO 19
C
C  *****  STEP 8 FOR THE SECONDARY JET  *****
C
C
C     FOR COAXIAL JETS, COMPUTE SECONDARY JET SPL'S IN EACH
C     FREQUENCY BAND AND EACH BANDS CENTER FREQUENCY
C     INCLUDING CORRECTION FOR LOCAL ACOUSTIC IMPEDANCE
C
   70 CONTINUE
      DO 75 I=1,4
      LP2(I)=10.*ALOG10(P2PRF2(I))+RCC
      F2(I)=HN(I)*CA/DE
   75 CONTINUE
C
C     CALL SUBROUTINE TO EXPAND FREQUENCY RANGE AND COMPUTE
C     1/3 O.B. AND SPECTRAL LEVELS FOR 50 TO 10,000 HZ
C
C
C  *****  STEPS 10,14,15,AND 20  *****
C
C     SECONDARY JET:
C
      CALL EXTFRQ(SPL2,FREQ,LP2(2),LP2(3),LP2(4),F2(2),F2(3),
     2 F2(4),CA,VJE,DE,XR,YR,ERR,F2MIN,F2MAX,RD)
      IF(ERR.EQ.1) GO TO 250
C
C
      GO TO 65
C
C
C     PRIMARY OR SINGLE NOZZLE JET:
C
   55 CALL EXTFRQ(SPL1,FREQ,LP1(2),LP1(3),LP1(4),F1(2),F1(3),
     2 F1(4),CA,VJ1,DE,XR,YR,ERR,F1MIN,F1MAX,RD)
      IF(ERR.EQ.1) GO TO 250
C
C
C
C
```

```
C
C
      IF(NCOAX.EQ.1) GO TO 57
      GO TO 250
C
C
   65 CONTINUE
C
      GO TO 250
   81 WRITE(6,300)
  300 FORMAT(//,2X,44HOBSERVER LOCATION OUTSIDE ALLOWABLE ENVELOPE,
     2 38H FOR JET MIXING NOISE - RUN TERMINATED,/)
      ERR=1
  250 RETURN
      END
```

```
      SUBROUTINE EXTFRQ(SPL,FQ,LPA,LPB,LPC,FA,FB,FC,CO,VJ,D,XR,
     2 YR,ERR,FMIN,FMAX,R)
      DIMENSION F(20),FQ(24),XD(5),SPL(24)
      REAL LSA,LSX,LSC,LSY,LP(20),LF(20),LSTN(31),LR(5,31),
     2 LPA,LPB,LPC,LPX,LPY
      INTEGER ERR
      DATA LSTN/-1.40,-1.30,-1.22,-1.15,-1.10,-1.04,-1.00,-0.92,-0.80,
     2 -0.70,-0.60,-0.52,-0.40,-0.30,-0.22,-0.15,-0.10,-0.04,0.00,
     3 0.08,0.20,0.30,0.40,0.48,0.60,0.70,0.78,0.84,0.90,0.95,1.00/
      DATA XD/-30.,5.,10.,20.,30./
      DATA ((LR(I,J),J=1,31),I=1,5)/23.8,21.9,20.5,19.2,18.2,17.3,16.6,
     2 15.3,13.4,11.9,10.4,9.2,7.5,6.2,5.2,4.5,3.8,3.4,3.0,2.6,2.2,
     3 2.2,2.6,2.9,3.6,4.2,4.9,5.5,6.0,6.6,7.1,
     4 23.8,21.9,20.5,19.2,18.2,17.3,16.6,15.3,13.4,11.9,10.4,9.2,
     5 7.5,6.2,5.2,4.5,3.8,3.4,3.0,2.6,2.2,2.2,2.6,2.9,3.6,4.2,4.9,
     6 5.5,6.0,6.6,7.1,
     7 19.9,18.1,16.8,15.6,14.6,13.8,13.0,11.9,10.0,8.6,7.4,6.5,5.3,
     8 4.3,3.8,3.2,3.0,2.8,2.6,2.7,3.2,3.8,4.7,5.4,6.8,7.9,9.0,
     9 10.0,10.9,11.7,12.4,
     1 16.5,14.9,13.3,12.3,11.4,10.6,9.9,8.9,7.3,6.2,5.3,4.8,4.1,3.8,
     2 3.8,4.0,4.2,4.6,5.0,5.6,6.9,8.0,9.3,10.4,12.4,14.0,15.5,16.6,
     3 17.7,18.7,19.5,
     4 13.6,11.4,9.9,8.6,7.6,6.8,6.2,5.2,4.1,3.6,3.6,3.8,4.7,5.8,6.8,
     5 7.6,8.5,9.2,10.0,11.3,13.6,15.5,17.4,19.2,21.9,24.1,26.0,27.5,
     6 28.9,30.1,31.4/
C
C
      N=3
C
C     SET CENTER FREQS FOR THE THREE PREDICTED OCTAVE-BANDS
C
      F(1)=FA
      F(2)=FB
      F(3)=FC
      LP(1)=LPA
      LP(2)=LPB
      LP(3)=LPC
C
C     EXTEND THE LOW-FREQ RANGE TO AT LEAST 50 HZ, IF NECESSARY
C
C
C
      IF(FA.LE.50.0) GO TO 40
      SA=0.221*CO/VJ
      LSA=ALOG10(SA)
      IF(LSA.LT.-1.40.OR.LSA.GT.1.0) GO TO 89
      DLPA=DTAB2(LSA,XR,LSTN,XD,31,5,1,1,LR,5,IERR)
    7 FX=F(1)/2.0
      SX=(FX/FA)*SA
      LSX=ALOG10(SX)
```

```
      IF(LSX.LT.-1.40) WRITE(6,87)
      DLPX=DTAB2(LSX,XR,LSTN,XD,31,5,1,1,LR,5,IERR)
      LPX=LPA-DLPX+DLPA
      IF(LPX.LT.0.0) LPX=0.0
      N=N+1
      DO 10 NK=2,N
      I=N+2-NK
      F(I)=F(I-1)
   10 LP(I)=LP(I-1)
      F(1)=FX
      LP(1)=LPX
      IF(F(1).GT.50.0) GO TO 7
C
C     EXTEND HI-FREQ RANGE TO AT LEAST 10000 HZ, IF NECESSARY
C
   40 IF(F(N).GE.10000.0) GO TO 50
      SC=0.884*C0/VJ
      LSC=ALOG10(SC)
      IF(LSC.GT.1.0) GO TO 89
      DLPC=DTAB2(LSC,XR,LSTN,XD,31,5,1,1,LR,5,IERR)
   42 FY=2.0*F(N)
      SY=(FY/FC)*SC
      LSY=ALOG10(SY)
      DLPY=DTAB2(LSY,XR,LSTN,XD,31,5,1,1,LR,5,IERR)
      LPY=LPC-DLPY+DLPC
      IF(LPY.LT.0.0) LPY=0.0
      N=N+1
      F(N)=FY
      LP(N)=LPY
      IF(F(N).LT.10000.0) GO TO 42
C
C     FROM THE NOW GENERATED OCT-BAND SPL SPECTRUM COVERING THE
C     FREQ RANGE FROM 50 TO 10000 HZ, INTERPOLATE THE OCTAVE-
C     BAND LEVELS AT EACH 1/3 OCT-BAND CENTER FREQ FROM 50 TO
C     10000 HZ AND CORRECT TO 1/3 OCT-BAND LEVELS BY SUBTRACTING
C     4.85 DB
C
C
   50 DO 58 I=1,N
   58 LF(I)=ALOG10(F(I))
      DO 60 I=1,24
      FK=ALOG10(FQ(I))
      OBSPL=GIRC(FK,LF,LP,N,1)
      SPL(I)=OBSPL-4.85
   60 IF(SPL(I).LT.0.0) SPL(I)=0.0
C
   87 FORMAT(//,2X,48HWARNING - IN JET MIXING NOISE, ATTEMPT TO EXPAND,
     2 24H LOW FREQ RANGE TO 50 HZ,/,12X,18HEXCEEDED LIMITS OF,
     3 24H THOMSON SPECTRUM SHAPES,/)
      GO TO 100
```

```
   89 WRITE(6,80)
      ERR=1
   80 FORMAT(//,2X,46HFOR JET MIXING NOISE, ONE OR MORE OF THE THREE,
     2 50H PREDICTED OCTAVE BANDS FALLS OUTSIDE THE STROUHAL,
     3 /,2X,40H NO. RANGE OF THE REDUCED SPECTRA SHAPES,
     4 17H - RUN TERMINATED,/)
  100 RETURN
      END
```

SHOCK

```
      SUBROUTINE SHOCK(FREQ,VJ,TJ,DE,HJ,SC,RG,GC,X,Y,SPL)
C *****   SHOCK BROADBAND NOISE FOR THE LFC PROGRAM   ***********
C
C
      DIMENSION FREQ(24),SX(20),HX(20),CX(20),SPL(24)
      REAL K0,K1,MJ,L0,L1,MC,MA,LOGSI
      INTEGER S,SC,ERR
C
      COMMON MA,RHOA,CA,RHO0,C0,CIMPD,DX1,DX2,ERR
      DATA SX/-0.6990,-0.5229,-0.3979,-0.1549,0.0,0.1761,0.3010,
     2 0.4771,0.5441,0.6020,0.6532,0.6990,0.7782,0.8451,0.9031,
     3 1.000,1.301,1.602,1.832,1.845/
      DATA HX/116.0,121.6,125.5,132.5,137.7,142.7,145.7,148.5,
     2 149.1,149.2,149.1,148.8,147.9,146.7,145.7,143.7,137.4,
     3 130.5,125.4,125.2/
      DATA CX/0.70,0.71,0.71,0.72,0.73,0.74,0.74,0.71,0.69,0.67,
     2 0.64,0.62,0.58,0.54,0.50,0.45,0.28,0.12,0.02,0.02/
C
      DO 10 I=1,24
      SPL(I)=0.0
   10 CONTINUE
      C=0.70
      K0=1.10
      K1=1.31
      NS=8
      BC=0.2316
      GAMA=1.33
      IF(SC.EQ.8) GAMA=1.4
      MJ=1.0/SQRT((GAMA*RG*TJ*GC)/(VJ*VJ)-(GAMA-1.0)/2.0)
      IF(MJ.LE.1.0) GO TO 70
C
C *****  STEP 1  *****
C
      BETA=SQRT(MJ*MJ-1.0)
      L0=K0*HJ*BETA
      L1=K1*HJ*BETA
      MC=C*VJ/CA
      VC=C*VJ
C
C *****  STEP 2  *****
C
C *****  COMPUTE EMISSION ANGLE AND ACTUAL SOUND PATH LENGTH  *****
C
      CALL XFORM(X,Y,0.0,MA,SC,DX1,DX2,PH,PHP,R,RP,ERR)
      IF(ERR.EQ.1) GO TO 70
C
C *****  STEP 3  *****
C
      W1=6.2832*BC*HJ*BETA/CA
C
```

```
      IF(BETA.GT.1.0) GO TO 101
      ANS1=(40.0*ALOG10(BETA))-(20.0*ALOG10(RP/DE))
      GO TO 105
  101 ANS1=(20.0*ALOG10(BETA))-(20.0*ALOG10(RP/DE))
C
  105 CONTINUE
C
C  *****  STEP 4  *****
C
      DF=1.0-MC*COS((180.-PHP)/57.29577951)
      W2=L1*DF/VC
C
C
C  *****  STEP 5  *****
C
      DO 666 I=1,24
      SI=2.0*3.14159*FREQ(I)*L0/CA
      IF(SI.LT.0.2.OR.SI.GT.70.0) WRITE(6,1500) SC,I
 1500 FORMAT(//,2X,35HWARNING - FOR SHOCK BROADBAND NOISE,
     2 10H, SOURCE =,I2,24H ,THE STROUHAL PARAMETER,/,12X,
     3 16H OF 1/3 O.B. NO.,I3,20H IS OUTSIDE RANGE OF,
     4 15H MASTER SPECTRA,/)
      LOGSI=ALOG10(SI)
      HI=GIRC(LOGSI,SX,HX,20,1)
      CI=GIRC(LOGSI,SX,CX,20,1)
C
C
C
C
      WC=2.0*3.14159*FREQ(I)
      IIEND=NS-1
      SUMI=0.0
      DO 210 N=1,IIEND
      CI2=CI**(N*N)
      ISEND=NS-N
      SUMS=0.0
      DO 220 S=1,ISEND
      IS=S-1
      QNS=W2*N*(1.0-(0.06*(IS+((N+1.0)/2.0))))
      QCOS=COS(QNS*WC)
      QSIN=SIN((QNS*WC*BC)/2.0)
      WORK3=(QCOS*QSIN)/QNS
      SUMS=SUMS+WORK3
  220 CONTINUE
      WORK4=CI2*SUMS
      SUMI=SUMI+WORK4
  210 CONTINUE
C
      WORK5=(4.0*SUMI)/(NS*BC*WC)
      ANS2=1.0+WORK5
```

```
      ANS2=10.0*ALOG10(ABS(ANS2))
C
      ANS3=10.*ALOG10(W1*FREQ(I))
C
      SPL(I)=HI+ANS1+ANS3+ANS2
C
  666 CONTINUE
C
C
C  *** STEP 5(G)  *****
C
      CAMP=-40.*ALOG10(1.0-MA*COS(PHP/57.29577951))
      DAMP=-10.*ALOG10(1.0-MA*COS(PHP/57.29577951))
      DO 30 I=1,24
      SPL(I)=SPL(I)+CIMPD+CAMP+DAMP
      IF(SPL(I).LT.0.0) SPL(I)=0.0
   30 CONTINUE
C
   70 RETURN
      END
```

SCRCH

```
      SUBROUTINE SCRCH(VJ,HJ,DJ,NPR,A,AREF,X,Y,SC,SPL1,SPL2,NB1,NB2)
      REAL NPR,MA,PR(9),SPLRF1(9),SPLRF2(9)
      INTEGER SC,ERR
      COMMON MA,RHOA,CA,RHOO,CO,CIMPD,DX1,DX2,ERR
C
      DATA PR/2.0,2.5,3.0,3.5,4.0,4.5,5.0,6.0,7.0/
      DATA SPLRF1/110.,127.,136.,141.,143.5,144.5,144.5,143.,140.5/
      DATA SPLRF2/110.,124.,130.,133.,134.5,135.,134.5,132.,128./
C
      IF(NPR.LT.2.0) GO TO 30
      XS=3.5*HJ*SQRT(NPR-1.893)
C
      CALL XFORM(X,Y,XS,MA,SC,DX1,DX2,PH,PHP,R,RP,ERR)
      IF(ERR.EQ.1) GO TO 30
C
C      STEP 3
C
      SPL1RF=GIRC(NPR,PR,SPLRF1,9,1)
      SPL2RF=GIRC(NPR,PR,SPLRF2,9,1)
C
      SPL1R=SPL1RF+10.*ALOG10(A/AREF)
      SPL2R=SPL2RF+10.*ALOG10(A/AREF)
C
C      STEP 4
C
      RREF=4.0*DJ
      DSPL1=20.*ALOG10((COS(PHP/(2.*57.29577951)))**2+
     2 0.5*(SIN(PHP/(2.*57.29577951)))**2)-20.*ALOG10(RP/RREF)+2.5
C
      DSPL2=20.*ALOG10(SIN(PHP/57.29577951))-20.*ALOG10(RP/RREF)
C
C      STEP 5
C
      SPL1=SPL1R+DSPL1
      SPL2=SPL2R+DSPL2
C
C      STEP 6
C
      DSPL=CIMPD-40.*ALOG10(1.0-MA*COS(PHP/57.29577951))
      SPL1=SPL1+DSPL
      SPL2=SPL2+DSPL
      IF(SPL1.LT.0.0) SPL1=0.0
      IF(SPL2.LT.0.0) SPL2=0.0
C
C      STEP 7
C
      MJA=VJ/CA
C
      F1=(CA*(MA+0.625*(MJA-MA))*(1.0-MA)*(1.0+0.625*MJA))/
     2 (1.25*SQRT(NPR-1.893)*(1.0+0.625*(MJA-MA))*MJA*HJ)
```

```
C
      F2=2.0*F1
      IF(F1.GE.44.7.AND.F1.LE.11220.) GO TO 12
      WRITE(6,100)
      SPL1=0.0
      NB1=0
      GO TO 14
   12 CALL BNDN(F1,24,NB)
      NB1=NB
   14 IF(F2.GE.44.7.AND.F2.LE.11220.) GO TO 16
      WRITE(6,102)
      SPL2=0.0
      NB2=0
      GO TO 18
   16 CALL BNDN(F2,24,NB)
      NB2=NB
   18 CONTINUE
  100 FORMAT(/,2X,40HFOR SHOCK SCREECH TONES, THE FUNDAMENTAL,
     2 45H FREQUENCY IS OUTSIDE RANGE OF 50 TO 10000 HZ,/)
  102 FORMAT(//,2X,44HFOR SHOCK SCREECH TONES, THE SECOND HARMONIC,
     2 45H FREQUENCY IS OUTSIDE RANGE OF 50 TO 10000 HZ,/)
C
   30 RETURN
      END
```

DCTRT

```
      SUBROUTINE DCTRT(DSI,L,HD,MD,CD,FD,NS,MI,PHP,IC)
      REAL FQ(24),DSI(24),L,MD,MI,NS,M
      DATA FQ/50.,63.,80.,100.,125.,160.,200.,250.,315.,400.,500.,
     2 630.,800.,1000.,1250.,1600.,2000.,2500.,3150.,4000.,5000.,
     3 6300.,8000.,10000./
      DO 5 I=1,24
      DSI(I)=0.0
    5 CONTINUE
      IF(IC.EQ.0) GO TO 35
      IF(IC.EQ.2) GO TO 25
      M=MD
      IF(IC.NE.4) M=-MD
      DDBPK=10.*(L/HD)**0.7
      XLAMD=CD/FD
      F1=1.0/(HD/XLAMD)**0.6
      F2=1.0-(M/2.0)*(2.0-(HD/XLAMD))
C
      IF(IC.EQ.4) GO TO 10
      F3=(140.-PHP)/80.
      IF(PHP.LE.60.0) F3=((4.0-NS)/4.)*(PHP/100.)+0.15*NS+0.4
      GO TO 15
C
   10 F3=PHP/130.
      IF(PHP.GT.130.) F3=(205.-PHP)/75.
   15 CONTINUE
C
      DDBFD=DDBPK*F1*F2*F3
C
      DO 20 I=1,24
      DSI(I)=DDBFD
      IF(FQ(I).GT.FD.OR.FQ(I).LT.FD) DSI(I)=
     2 DDBFD*EXP(-((ABS(ALOG10(FQ(I)/FD)))**1.3/0.35))
   20 CONTINUE
      IF(IC.NE.3) GO TO 35
   25 DSHMI=0.0
      IF(MI.LE.0.5) GO TO 35
      DSHMI=216.*(MI-0.5)**2.5
      DO 30 I=1,24
      DSI(I)=DSI(I)+DSHMI
   30 CONTINUE
   35 CONTINUE
      RETURN
      END
```

TEN

```
      SUBROUTINE TEN(FREQ,L,DELTA,C,MUA,VREF,X,Y,SPL)
      DIMENSION FREQ(24),SPL(24)
      REAL L,MA,MUA
      INTEGER ERR
      COMMON MA,RHOA,CA,RHO0,C0,CIMPD,DX1,DX2,ERR
C
      VA=MA*CA
C
C   *****  STEP 1  *****
C
C   *****  COMPUTE ESTIMATED TURB. BL THICHNESS AT T.E.  *****
C
      IF(DELTA.LE.0.0) DELTA=0.376*C/(VA*C*RHOA/MUA)**0.2
C
C   *****  STEP 2  *****
C
C   *****  CALCULATE FORWARD SPEED TRANSFORMATIONS  *****
C
      CALL XFORM(X,Y,0.0,MA,11,DX1,DX2,PH,PHP,R,RP,ERR)
      IF(ERR.EQ.1) GO TO 910
C
C   *****  STEP 3  *****
C
      BETAP=2.0*57.29577951*ATAN(L/(2.0*RP))
C
C   *****  STEP 4  *****
C
C
C   *****  COMPUTE THE OVERALL SOUND PRESSURE LEVEL  *****
C
      OASPL1=50.*ALOG10(VA/VREF)+10.*ALOG10(DELTA*BETAP/RP)
     2 +10.*ALOG10((COS((PHP/2.0)/57.29577951))**2)+80.7
C
C   *****  STEP 5  *****
C
C   *****  CORRECT OASPL FOR LOCAL ACOUSTIC IMPEDANCE  *****
C   *****  AND CONVECTIVE AMPLIFICATION                *****
C
      CAMP=-40.*ALOG10(1.0-MA*COS(PHP/57.29577951))
      OASPL1=OASPL1+CIMPD+CAMP
C
C   *****  STEP 6  *****
C
C   *****  COMPUTE THE PEAK FREQUENCY  *****
C
      FPK=0.1*VA/DELTA
C
C   *****  STEP 7  *****
C
C   *****  FIND 1/3 O.B. CONTAINING THE PEAK FREQ, FPK  *****
```

```
C
      DO 6 I=1,24
      SPL(I)=0.0
    6 CONTINUE
      IF(FPK.LT.44.7.OR.FPK.GT.11220.) GO TO 905
      CALL BNDN(FPK,24,NB)
      IREF=NB
C
C  *****  COMPUTE THE 1/3 O.B. SPECTRUM  *****
C
      DO 30 I=1,24
      SPL(I)=OASPL1+10.*ALOG10(0.613*((FREQ(I)/FREQ(IREF))**4)/
     2 (ABS((FREQ(I)/FREQ(IREF))**1.5+0.5))**4)
      IF(SPL(I).LT.0.0) SPL(I)=0.0
   30 CONTINUE
C
C  *****  STEP 8   SHIELDING  - -  NOT APPLIED  *****
      GO TO 910
  905 WRITE(6,200)
  200 FORMAT(//,2X,43HPEAK FREQ OF TRAILING-EDGE NOISE IS OUTSIDE,
     2 45H RANGE OF 50 TO 10000 HZ - NO T.E.N. COMPUTED,/)
  910 RETURN
      END
```

```
      SUBROUTINE TBLN(X,Y,Z,A,L,DELS,NAJ,MUA,IC)
C  *****  TURBULENT BOUNDARY LAYER NOISE PREDICTION   *****
C
C
      DIMENSION A(20),X(20),Y(20),Z(20),DELS(20),SPL(24,20)
      REAL MA,MUA,L(20)
      INTEGER ERR
      COMMON /TBL/UREF,AREF,RREF,SPLT(24)
      COMMON MA,RHOA,CA,RHOO,CO,CIMPD,DX1,DX2,ERR
C
C  *****  BEGIN ELEMENTAL AREA LOOP  *****
C
      U=MA*CA
      DO 6 J=1,NAJ
      DO 4 I=1,24
      SPL(I,J)=0.0
    4 CONTINUE
    6 CONTINUE
      DO 200 J=1,NAJ
C
C  *****  STEP 1  *****
C
C  *****  FORWARD SPEED TRANSFORMATION  *****
C
      IF(Y(J).LE.0.0) GO TO 200
      XX=X(J)
      YY=SQRT(Y(J)*Y(J)+Z(J)*Z(J))
      CALL XFORM(XX,YY,0.0,MA,12,DX1,DX2,PH,PHP,R,RP,ERR)
      IF(ERR.EQ.1) GO TO 910
C
C  *****  STEP 1(D)  *****
C
      GMP=57.29577951*ACOS(Y(J)/RP)
C
C  *****  STEP 2  *****
C
      OASPL=0.0
      IF(GMP.LT.90.0) OASPL=60.*ALOG10(U/UREF)+10.*ALOG10(A(J)/AREF)
     2 -20.*ALOG10(RP/RREF)+20.*ALOG10(COS(GMP/57.29577951))
     3 +91.1
C
C  *****  STEP 3  *****
C
C  *****  CORRECT FOR CONVECTIVE AND DYNAMIC AMPLIFICATION  *****
C
      CAMP=-30.*ALOG10(1.0-0.18*MA*COS(PHP/57.29577951))
      DAMP=-10.*ALOG10(1.0-MA*COS(PHP/57.29577951))
      IF(GMP.LT.90.0) OASPL=OASPL+CAMP+DAMP
C
C  *****  STEP 4  *****
```

```
C
C    *****  CORRECT FOR LOCAL ACOUSTIC IMPEDANCE  *****
C
       IF(GMP.LT.90.0) OASPL=OASPL+CIMPD
C
       IF(OASPL.LE.0.0) GO TO 200
C
C    *****  STEP 5  *****
C
       IF(IC.EQ.1) GO TO 10
       DELTA=0.376*L(J)/(RHOA*U*L(J)/MUA)**0.2
       DELTAS=DELTA/8.0
       GO TO 15
    10 DELTAS=DELS(J)
    15 FPK=0.01102*U/DELTAS
C
C    *****  STEP 6  *****
C
C
C    *****  FIND THE 1/3 OB CONTAINING THE PEAK FREQ, FPK  *****
C
       IF(FPK.LT.44.7.OR.FPK.GT.11220.) GO TO 40
       CALL BNDN(FPK,24,NB)
       NJ=NB
C
       SPLPK=OASPL-7.0
       DO 38 I=1,24
       IF(I.EQ.NJ) SPL(I,J)=SPLPK
       IF(I.EQ.(NJ-1)) SPL(I,J)=SPLPK-1.0
       IF(I.EQ.(NJ-2)) SPL(I,J)=SPLPK-2.0
       IF(I.LT.(NJ-2)) SPL(I,J)=SPLPK-2.0-(NJ-2-I)*2.7
       IF(I.GT.NJ) SPL(I,J)=SPLPK+(NJ-I)*2.2
       IF(SPL(I,J).LT.0.0) SPL(I,J)=0.0
    38 CONTINUE
C
       GO TO 200
    40 WRITE(6,300) J
   300 FORMAT(/,2X,46HFOR TURB. B.L. NOISE, PEAK FREQ OF ELEMENT NO.,
      2 I3,17H IS OUTSIDE RANGE,/,2X,29H OF 50 TO 10000 HZ - NO NOISE,
      3 39H CONTRIBUTION COMPUTED FOR THIS ELEMENT,/)
C
   200 CONTINUE
C
C    *****  STEPS 8 AND 9  *****
C
C    *****  COMPUTE TOTAL 1/3 OB SPECTRUM AND OASPL  *****
C
       DO 48 I=1,24
       SPLT(I)=0.0
    48 CONTINUE
```

```
      DO 50 I=1,24
      SUM=0.0
      DO 58 J=1,NAJ
      IF(SPL(I,J).GT.0.0) SUM=SUM+10.**(SPL(I,J)/10.)
   58 CONTINUE
      IF(SUM.GT.0.0) SPLT(I)=10.*ALOG10(SUM)
   50 CONTINUE
C
C
  910 CONTINUE
      RETURN
      END
```

XFORM

```
      SUBROUTINE XFORM(XP,YA,XS,M,SC,DX1,DX2,PH,PHP,R,RP,ERR)
C
C              AIRPLANE MACH NO. (M)  MUST BE LESS THAN 1.0
C
      INTEGER SC,ERR
      REAL M
      Y=YA
      IF(SC.EQ.1.OR.SC.EQ.3) GO TO 10
      IF(SC.EQ.4.OR.SC.EQ.5) GO TO 20
      IF(SC.EQ.7.OR.SC.EQ.9) GO TO 30
      IF(SC.EQ.8.OR.SC.EQ.10) GO TO 40
      IF(SC.EQ.11.OR.SC.EQ.12) GO TO 20
C   SC=2
      X=XP-DX2
      GO TO 50
   10 X=XP-DX1
      GO TO 50
   20 X=XP
      GO TO 50
   30 X=XP+XS
      GO TO 50
   40 X=XP-DX2+XS
   50 CONTINUE
C
C      GIVEN X AND Y, COMPUTE R AND PH
C     GIVEN R, PH, AND M, COMPUTE RP AND PHP
C
      IF(X.EQ.0.0.AND.Y.EQ.0.0) GO TO 120
      IF(Y.GT.0.0) GO TO 90
      IF(X.GT.0.0) GO TO 82
      PH=180.0
      PHP=180.0
      R=-X
      RP=R/(1.0+M)
      GO TO 150
   82 PH=0.0
      PHP=0.0
      R=X
      RP=R/(1.0-M)
      GO TO 150
   90 IF(X.GT.0.0.OR.X.LT.0.0) GO TO 92
      PH=90.0
      R=Y
      GO TO 94
   92 R=SQRT(X*X+Y*Y)
      PH=57.29577951*ATAN(Y/X)
      IF(PH.LT.0.0) PH=PH+180.0
   94 CONTINUE
      IF(M.GT.0.0) GO TO 98
      PHP=PH
```

```
      RP=R
      GO TO 150
   98 COTPH=1.0/TAN(PH/57.29577951)
      COTPHP=(1.0/(1.0-M*M))*(COTPH+M*SQRT(1.0-M*M+COTPH*COTPH))
      PHP=90.0
      IF(COTPHP.GT.0.0.OR.COTPHP.LT.0.0) PHP=57.29577951*
     2 ATAN(1.0/COTPHP)
      IF(PHP.LT.0.0) PHP=PHP+180.0
      RP=R*SIN(PH/57.29577951)/SIN(PHP/57.29577951)
      GO TO 150
  120 WRITE(6,122) SC
  122 FORMAT(//,5X,'FOR SOURCE CODE =',I3,' THE OBSERVER LOCATION',
     2 ' IS SAME AS SOURCE LOCATION - RUN TERMINATED',/)
      ERR=1
  150 RETURN
      END
```

BNDN

```
      SUBROUTINE BNDN(FX,NTOB,BN)
      INTEGER BN
      REAL F(27)
      DATA F/50.,63.,80.,100.,125.,160.,200.,250.,315.,400.,500.,
     2 630.,800.,1000.,1250.,1600.,2000.,2500.,3150.,4000.,5000.,
     3 6300.,8000.,10000.,12500.,16000.,20000./
C
      KK=NTOB-1
      BN=NTOB
      DO 10 J=1,KK
      FC=SQRT(F(J)*F(J+1))
      IF(FX.GT.FC) GO TO 10
      BN=J
      GO TO 12
   10 CONTINUE
   12 CONTINUE
      RETURN
      END
```

GIRC

```
      FUNCTION GIRC(ARG,X,Y,NX,IO)
C     AITKIN INTERPOLATION
C     ARG=INDEPENDENT ARGUMENT
C     X=INDEPENDENT TABLE
C     Y=DEPENDENT TABLE
C     NX=NUMBER VALVES X TABLE
C     IO=1 FIRST ORDER INTERPOLATION
C     IO=2 SECOND ORDER INTERPOLATION
      DIMENSION X(1),Y(1),XX(4),YY(4),EE(3),FF(2)
      IEND=NX-IO+1
      IF(X(1)-X(2))10,20,20
C     ASCENDING ORDER
   10 DO 15 I=1,IEND
      IF(X(I)-ARG)15,30,30
   15 CONTINUE
   16 IB=NX-IO
      IEX=0
      GO TO 45
   20 DO 25 I=1,IEND
      IF(X(I)-ARG)30,30,25
   25 CONTINUE
      GO TO 16
   30 IF(IO-1)35,35,40
   35 IF(I-1)36,36,37
   36 IB=1
      GO TO 45
   37 IB=I-IO
      GO TO 45
   40 IF(I-2)41,41,42
   41 IEX=0
      GO TO 36
   42 IEX=1
      GO TO 37
   45 DO 50 I=1,4
      XX(I)=X(IB)-ARG
      YY(I)=Y(IB)
   50 IB=IB+1
      DO 60 I=1,3
   60 EE(I)=XX(I+1)-XX(I)
      DO 70 I=1,2
   70 FF(I)=EE(I)+EE(I+1)
      DO 80 I=1,3
      EE(I)=(YY(I)*XX(I+1)-YY(I+1)*XX(I))/EE(I)
      IF(IO-1)100,100,80
   80 CONTINUE
      DO 90 I=1,2
   90 EE(I)=(XX(I+2)*EE(I)-XX(I)*EE(I+1))/FF(I)
      IF(IEX)100,100,95
   95 EE(1)=(EE(1)+EE(2))/2.
  100 GIRC=EE(1)
      RETURN
      END
```

DTAB2

```
      FUNCTION DTAB2 (XX,ZI,X,Z,NX,NZ,KX,KZ,Y,M,IERR)
C     DTAB   DOUBLE INTERPOLATION
C  XX=VALUE TO BE INTERPOLATED X DIRECTION
C  ZI=VALUE TO BE INTERPOLATED Z DIRECTION
C  X= X TABLE
C  Z= Z TABLE
C  NX=NUMBER X VALUES IN TABLE
C  NZ=NUMBER Z VALUES IN TABLE
C  KX=1 IF LINEAR INTERPOLATION X DIRECTION
C    =2 IF CURVILINEAR
C  KZ=1 IF LINEAR INTERPOLATION Z DIRECTION
C    =2 IF CURVILINEAR
C  Y= Y ARRAY
C  M= ROW DIMENSION Y ARRAY
C  IERR=1 SUCCESSFUL RETURN
C     =2 UNSUCCESSFUL RETURN
      DIMENSION X(1),Z(1),Y(1),X2(4),Z2(4),Y2(16),INX(2),IKX(2),
     1ISV(2),IXINT(2)
      ZZ=ZI
      INX(1)=NX
      INX(2)=NZ
      IKX(1)=KX
      IKX(2)=KZ
      DO 200 I=1,2
      IF(INX(I)-2)1000,140,10
 10   IF(I-1)11,11,12
 11   IF(X(1)-X(2))20,1000,30
C     ASCENDING ORDER
 20   DO 21 J=1,NX
      IF(X(J)-XX)21,40,50
 21   CONTINUE
C     VALUE BEYOND END OF TABLE
 22   ISV(I)=INX(I)-IKX(I)
 23   IXINT(I)=IKX(I)
      GO TO 150
 12   IF(Z(1)-Z(2))25,1000,35
 25   DO 26 J=1,NZ
      IF(Z(J)-ZZ)26,40,50
 26   CONTINUE
      GO TO 22
C     DESCENDING ORDER
 30   DO 31 J=1,NX
      IF(X(J)-XX)50,40,31
 31   CONTINUE
      GO TO 22
 35   DO 36 J=1,NZ
       IF(Z(J)-ZZ) 50,40,36
 36   CONTINUE
      GO TO 22
C     VALUE EQUAL VALUE IN TABLE
```

```
40    IXINT(I)=0
      ISV(I)=J
      GO TO 150
50    IF(J-1)60,60,70
60    ISV(I)=1
      GO TO 23
70    IF(J-2)60,60,80
80    ISV(I)=J-IKX(I)
      IF(IKX(I)-2)23,90,90
90    IF(ISV(I)+2+IKX(I)-INX(I))100,100,23
100   IXINT(I)=3
      GO TO 150
140   IXINT(I)=1

      ISV(I)=1
150   J1=ISV(I)
      IF(I-1)155,155,160
155   DO 156 J=1,4
      X2(J)=X(J1)
156   J1=J1+1
      GO TO 200
160   DO 165 J=1,4
      Z2(J)=Z(J1)
165   J1=J1+1
200   CONTINUE
      IC=1
      K=(ISV(1)-1)*M+ISV(2)-M
      DO 220 I=1,4
      K=K+M
      DO 210 J=1,4
      K1=K+J-1
      Y2(IC)=Y(K1)
210   IC=IC+1
220   CONTINUE
225   IF(IXINT(2))301,301,230
230   IZO=IXINT(2)

      IZO2=IZO

      DO 280 K=1,IZO
      DO 270 I=1,IZO2
      DZ1=Z2(I)-ZZ
      KI=K+I
      DZ2=Z2(KI)-ZZ
      DZ=DZ2-DZ1
      IXO=IXINT(1)*4+I
      DO 260 J=I,IXO,4
260   Y2(J)=(Y2(J)*DZ2-Y2(J+1)*DZ1)/DZ
270   CONTINUE
      IZO2=IZO2-1
280   CONTINUE
301   IF(IXINT(1))400,400,300
300   IXINT(2)=IXINT(1)
```

```
      IXINT(1)=0
 302  IC=1
      DO 310 I=1,4
      Z2(I)=X2(I)
      Y2(I)=Y2(IC)
 310  IC=IC+4
      ZZ=XX
      GO TO 225
 400  DTAB2 =Y2(1)
      IERR=1
      RETURN
 1000 IERR=2
      DTAB2 =0.
      RETURN
      END
```

SAMPLE CASE

This sample case is one of the program runs made to generate comparisons between the predictions of this program and the noise levels measured in-flight on the NASA/Dryden JetStar. The input data used are shown on the next two pages, followed by the program output.

```
            JETSTAR CRUISE NOISE CHECK CASE
            TP'S 3A,3B,3C   MIC LOCATIONS 1 AND 3
0100000101010100000000000
0000000000
0.076475  1116.4
010100
001
10.20
0101
1.25
024054 20.
80.        315.       3.281
080      1.455      0.915
1116.4     1.0
450.       35.        1400.
230.9
1.079      1000.
00
1.079
53.34      32.174
003
36000.     0.70       1.9
0.022798   968.5      390.3
16.1       13911.
28.        1.118      1.044
3.52       13911.
16.1       0.0932     756.       1662.
1896.
1292.
002
001
002
001
10.20      15.38
002
10.20      17.88
003
002
001
13.80      10.06
002
13.80      12.56
36000.     0.75       2.0
0.022798   968.5      390.3
17.2       14461.
31.        1.149      1.078
3.68       14461.
17.2       0.1029     790.       1789.
2041.
1382.
```

002			
001			
002			
001			
10.20	15.38		
002			
10.20	17.88		
003			
002			
001			
13.80	10.06		
002			
13.80	12.56		
36000.	0.80	2.1	
0.022798	968.5	390.3	
18.3	14990.		
33.	1.180	1.110	
3.81	14990.		
18.3	0.1132	821.	1913.
2186.			
1470.			
002			
001			
002			
001			
10.20	15.38		
002			
10.20	17.88		
003			
002			
001			
13.80	10.06		
002			
13.80	12.56		

Sample Case Output

```
WARNING - IN JET MIXING NOISE, ATTEMPT TO EXPAND LOW FREQ RANGE TO 50 HZ
          EXCEEDED LIMITS OF THOMSON SPECTRUM SHAPES

WARNING - IN JET MIXING NOISE, ATTEMPT TO EXPAND LOW FREQ RANGE TO 50 HZ
          EXCEEDED LIMITS OF THOMSON SPECTRUM SHAPES
```

JETSTAR CRUISE NOISE CHECK CASE
TP'S 3A,3B,3C   MIC LOCATIONS 1 AND 3

FLIGHT CONDITION: ALT = 36000.   MA = .700   POWER SET. CODE = 1.90

OBSERVER LOCATION NO. = 1

TOTAL ENGINE AND AIRFRAME NOISE

1/3 OCT. BAND SPL'S AND OASPL'S DB RE 0.00002 N/M2,

FREQ	FAN	FAN	FAN				JET MIXING NOISE			SHOCK BB		SHOCK SCREECH		AIRFRAME		
(HZ)	FWD	AFT	TOTAL	CMX	TURB	CORE	PRI	SEC	TOTAL	PRI	SEC	PRI	SEC	TEN	TBLN	TOTAL
50.	44.1	.0	44.1	.0	47.0	71.4	74.8	.0	74.8	94.1	.0	.0	.0	.0	.0	94.2
63.	47.1	.0	47.1	.0	50.3	75.4	76.7	.0	76.7	98.0	.0	.0	.0	.0	.0	98.1
80.	50.2	.0	50.2	.0	54.7	79.4	78.6	.0	78.6	101.7	.0	.0	.0	.0	.0	101.8
100.	53.1	.0	53.1	.0	58.3	82.4	80.5	.0	80.5	104.8	.0	.0	.0	.0	.0	104.8
125.	56.0	.0	56.0	.0	59.7	85.4	82.2	.0	82.2	107.5	.0	.0	.0	.0	.0	107.6
160.	59.2	.0	59.2	.0	61.6	88.4	84.0	.0	84.0	110.4	.0	.0	.0	.0	.0	110.4
200.	62.2	.0	62.2	.0	63.4	90.9	85.7	.0	85.7	112.0	.0	.0	.0	.0	.0	112.0
250.	65.1	.0	65.1	.0	65.2	92.9	86.9	.0	86.9	112.8	.0	.0	.0	.0	.0	112.8
315.	68.2	.0	68.2	.0	67.5	94.4	88.1	.0	88.1	113.7	.0	.0	.0	.0	.0	113.8
400.	71.4	.0	71.4	.0	70.0	95.4	89.3	.0	89.3	116.9	.0	.0	.0	.0	.0	117.0
500.	74.5	.0	74.5	.0	71.9	94.4	89.9	.0	89.9	124.3	.0	.0	.0	.0	.0	124.3
630.	77.8	.0	77.8	.0	73.8	92.9	90.5	.0	90.5	131.2	.0	.0	.0	.0	.0	131.2
800.	80.8	.0	80.8	.0	75.9	90.9	91.1	.0	91.1	132.6	.0	.0	.0	.0	.0	132.6
1000.	83.8	.0	83.8	.0	78.0	88.4	92.2	.0	92.2	130.5	.0	.0	.0	.0	.0	130.5
1250.	87.0	.0	87.0	.0	79.9	85.4	93.3	.0	93.3	130.1	.0	.0	.0	.0	.0	130.1
1600.	89.9	.0	89.9	.0	82.5	82.4	94.5	.0	94.5	129.3	.0	.0	.0	.0	.0	129.3
2000.	92.8	.0	92.8	.0	85.0	79.4	94.9	.0	94.9	128.6	.0	.0	.0	.0	.0	128.6
2500.	95.7	.0	95.7	.0	86.9	75.4	95.3	.0	95.3	127.3	.0	.0	.0	.0	.0	127.3
3150.	94.0	.0	94.0	.0	89.1	71.4	95.7	.0	95.7	126.2	.0	.0	.0	.0	.0	126.3
4000.	93.5	.0	93.5	.0	91.2	67.9	95.3	.0	95.3	125.1	.0	.0	.0	.0	.0	125.1
5000.	100.4	.0	100.4	.0	92.8	63.9	94.9	.0	94.9	123.8	.0	.0	.0	.0	.0	123.8
6300.	94.8	.0	94.8	.0	94.3	59.4	94.5	.0	94.5	122.5	.0	.0	.0	.0	.0	122.5
8000.	95.6	.0	95.6	.0	95.7	55.4	93.8	.0	93.8	121.2	.0	.0	.0	.0	.0	121.2
10000.	100.3	.0	100.3	.0	96.7	50.4	93.0	.0	93.0	120.0	.0	.0	.0	.0	.0	120.1
OASPL	106.1	.0	106.1	.0	102.1	102.6	105.7	.0	105.7	139.6	.0	.0	.0	.0	.0	139.7

JETSTAR CRUISE NOISE CHECK CASE
TP'S 3A,3B,3C   MIC LOCATIONS 1 AND 3

FLIGHT CONDITION: ALT = 36000. MA = .700 POWER SET. CODE = 1.90

OBSERVER LOCATION NO. = 1

ENGINE NO. 1

FAN NOISE COMPONENTS

1/3 OCT. BAND SPL'S AND OASPL'S - DB RE 0.00002 N/M2

	*** INLET RADIATED NOISE ***				** EXHAUST DUCT ** * RADIATED NOISE *			
FREQ (HZ)	BROAD -BAND	DSCRT TONES	CMBNTN TONES	TOTAL	BROAD -BAND	DSCRT TONES	TOTAL	TOTAL FAN NOISE
50.	.0	.0	41.7	41.7	.0	.0	.0	41.7
63.	.0	.0	44.7	44.7	.0	.0	.0	44.7
80.	5.9	.0	47.8	47.8	.0	.0	.0	47.8
100.	12.6	.0	50.7	50.7	.0	.0	.0	50.7
125.	19.8	.0	53.6	53.6	.0	.0	.0	53.6
160.	27.4	.0	56.8	56.8	.0	.0	.0	56.8
200.	34.1	.0	59.8	59.8	.0	.0	.0	59.8
250.	40.3	.0	62.7	62.7	.0	.0	.0	62.7
315.	46.5	.0	65.8	65.8	.0	.0	.0	65.8
400.	52.4	.0	68.9	69.0	.0	.0	.0	69.0
500.	57.6	.0	72.0	72.1	.0	.0	.0	72.1
630.	62.6	.0	75.1	75.4	.0	.0	.0	75.4
800.	67.4	.0	78.0	78.4	.0	.0	.0	78.4
1000.	71.5	.0	81.0	81.4	.0	.0	.0	81.4
1250.	75.3	.0	84.0	84.5	.0	.0	.0	84.5
1600.	79.0	.0	86.9	87.5	.0	.0	.0	87.5
2000.	82.1	.0	89.7	90.4	.0	.0	.0	90.4
2500.	84.7	.0	92.6	93.3	.0	.0	.0	93.3
3150.	87.1	.0	89.6	91.6	.0	.0	.0	91.6
4000.	89.2	.0	86.5	91.1	.0	.0	.0	91.1
5000.	90.8	96.9	83.6	98.0	.0	.0	.0	98.0
6300.	92.1	.0	80.6	92.4	.0	.0	.0	92.4
8000.	93.1	.0	77.5	93.2	.0	.0	.0	93.2
10000.	93.6	95.9	74.6	97.9	.0	.0	.0	97.9
OASPL	99.6	99.5	97.4	103.7	.0	.0	.0	103.7

JETSTAR CRUISE NOISE CHECK CASE
TP'S 3A,3B,3C MIC LOCATIONS 1 AND 3

FLIGHT CONDITION: ALT = 36000. MA = .700 POWER SET. CODE = 1.00

OBSERVER LOCATION NO. = 1

ENGINE NO. 2

FAN NOISE COMPONENTS

1/3 OCT. BAND SPL'S AND OASPL'S - DB RE 0.00002 N/M2

	*** INLET RADIATED NOISE ***				** EXHAUST DUCT ** * RADIATED NOISE *			
FREQ (HZ)	BROAD -BAND	DSCRT TONES	CMBNTN TONES	TOTAL	BROAD -BAND	DSCRT TONES	TOTAL	TOTAL FAN NOISE
50.	.0	.0	40.3	40.3	.0	.0	.0	40.3
63.	.0	.0	43.4	43.4	.0	.0	.0	43.4
80.	5.0	.0	46.5	46.5	.0	.0	.0	46.5
100.	11.4	.0	49.4	49.4	.0	.0	.0	49.4
125.	18.5	.0	52.3	52.3	.0	.0	.0	52.3
160.	26.1	.0	55.5	55.5	.0	.0	.0	55.5
200.	32.8	.0	58.5	58.5	.0	.0	.0	58.5
250.	39.0	.0	61.4	61.4	.0	.0	.0	61.4
315.	45.2	.0	64.5	64.5	.0	.0	.0	64.5
400.	51.1	.0	67.6	67.7	.0	.0	.0	67.7
500.	56.3	.0	70.7	70.8	.0	.0	.0	70.8
630.	61.3	.0	73.8	74.1	.0	.0	.0	74.1
800.	66.1	.0	76.7	77.1	.0	.0	.0	77.1
1000.	70.2	.0	79.7	80.1	.0	.0	.0	80.1
1250.	74.0	.0	82.7	83.2	.0	.0	.0	83.2
1600.	77.7	.0	85.6	86.2	.0	.0	.0	86.2
2000.	80.7	.0	88.4	89.1	.0	.0	.0	89.1
2500.	83.4	.0	91.3	92.0	.0	.0	.0	92.0
3150.	85.8	.0	88.3	90.3	.0	.0	.0	90.3
4000.	87.9	.0	85.2	89.8	.0	.0	.0	89.8
5000.	89.5	95.6	82.3	96.7	.0	.0	.0	96.7
6300.	90.8	.0	79.3	91.1	.0	.0	.0	91.1
8000.	91.8	.0	76.2	91.9	.0	.0	.0	91.9
10000.	92.3	94.6	73.3	96.6	.0	.0	.0	96.6
OASPL	98.3	98.1	96.1	102.4	.0	.0	.0	102.4

WARNING - IN JET MIXING NOISE, ATTEMPT TO EXPAND LOW FREQ RANGE TO 50 HZ
EXCEEDED LIMITS OF THOMSON SPECTRUM SHAPES

WARNING - IN JET MIXING NOISE, ATTEMPT TO EXPAND LOW FREQ RANGE TO 50 HZ
EXCEEDED LIMITS OF THOMSON SPECTRUM SHAPES

JETSTAR CRUISE NOISE CHECK CASE
TP'S 3A,3B,3C MIC LOCATIONS 1 AND 3

FLIGHT CONDITION: ALT = 36000. MA = .700 POWER SET. CODE = 1.90

OBSERVER LOCATION NO. = 3

TOTAL ENGINE AND AIRFRAME NOISE

1/3 OCT. BAND SPL'S AND OASPL'S DB RE 0.00002 N/M2,

FREQ	FAN	FAN	FAN				JET MIXING NOISE			SHOCK BB		SHOCK SCREECH		AIRFRAME		
(HZ)	FWD	AFT	TOTAL	CMX	TURB	CORE	PRI	SEC	TOTAL	PRI	SEC	PRI	SEC	TEN	TBLN	TOTAL
50.	44.9	.0	44.9	.0	46.7	71.6	73.9	.0	73.9	95.1	.0	.0	.0	.0	.0	95.2
63.	47.9	.0	47.9	.0	50.1	75.6	75.8	.0	75.8	99.0	.0	.0	.0	.0	.0	99.1
80.	51.0	.0	51.0	.0	54.4	79.6	77.8	.0	77.8	102.7	.0	.0	.0	.0	.0	102.7
100.	53.9	.0	53.9	.0	58.1	82.6	79.6	.0	79.6	105.7	.0	.0	.0	.0	.0	105.8
125.	56.8	.0	56.8	.0	59.4	85.6	81.3	.0	81.3	108.4	.0	.0	.0	.0	.0	108.4
160.	60.1	.0	60.1	.0	61.3	88.6	83.1	.0	83.1	111.2	.0	.0	.0	.0	.0	111.2
200.	63.0	.0	63.0	.0	63.2	91.1	84.8	.0	84.8	112.7	.0	.0	.0	.0	.0	112.7
250.	66.0	.0	66.0	.0	64.9	93.1	86.0	.0	86.0	113.5	.0	.0	.0	.0	.0	113.5
315.	69.1	.0	69.1	.0	67.2	94.6	87.2	.0	87.2	114.5	.0	.0	.0	.0	.0	114.6
400.	72.5	.0	72.5	.0	69.7	95.6	88.4	.0	88.4	118.3	.0	.0	.0	.0	.0	118.4
500.	75.7	.0	75.7	.0	71.6	94.6	89.0	.0	89.0	126.1	.0	.0	.0	.0	.0	126.1
630.	79.1	.0	79.1	.0	73.6	93.1	89.6	.0	89.6	132.5	.0	.0	.0	.0	.0	132.5
800.	82.3	.0	82.3	.0	75.6	91.1	90.3	.0	90.3	133.5	.0	.0	.0	.0	.0	133.5
1000.	85.5	.0	85.5	.0	77.7	88.6	91.4	.0	91.4	131.3	.0	.0	.0	.0	.0	131.3
1250.	88.8	.0	88.8	.0	79.6	85.6	92.5	.0	92.5	131.3	.0	.0	.0	.0	.0	131.3
1600.	91.9	.0	91.9	.0	82.3	82.6	93.6	.0	93.6	130.5	.0	.0	.0	.0	.0	130.5
2000.	94.9	.0	94.9	.0	84.7	79.6	94.0	.0	94.0	129.5	.0	.0	.0	.0	.0	129.5
2500.	97.7	.0	97.7	.0	86.7	75.6	94.4	.0	94.4	128.4	.0	.0	.0	.0	.0	128.4
3150.	97.4	.0	97.4	.0	88.8	71.6	94.8	.0	94.8	127.3	.0	.0	.0	.0	.0	127.3
4000.	98.2	.0	98.2	.0	90.9	68.1	94.5	.0	94.5	126.1	.0	.0	.0	.0	.0	126.1
5000.	105.9	.0	105.9	.0	92.5	64.1	94.1	.0	94.1	124.8	.0	.0	.0	.0	.0	124.9
6300.	100.6	.0	100.6	.0	94.1	59.6	93.7	.0	93.7	123.6	.0	.0	.0	.0	.0	123.6
8000.	101.5	.0	101.5	.0	95.4	55.6	92.9	.0	92.9	122.3	.0	.0	.0	.0	.0	122.3
10000.	106.0	.0	106.0	.0	96.5	50.6	92.2	.0	92.2	121.0	.0	.0	.0	.0	.0	121.2
OASPL	111.1	.0	111.1	.0	101.9	102.8	104.8	.0	104.8	140.7	.0	.0	.0	.0	.0	140.7

JETSTAR CRUISE NOISE CHECK CASE
TP'S 3A,3B,3C   MIC LOCATIONS 1 AND 3

FLIGHT CONDITION: ALT = 36000.   MA = .700   POWER SET. CODE = 1.90

OBSERVER LOCATION NO. = 3

ENGINE NO. 1

FAN NOISE COMPONENTS

1/3 OCT. BAND SPL'S AND OASPL'S - DB RE 0.00002 N/M2

	*** INLET RADIATED NOISE ***				** EXHAUST DUCT ** * RADIATED NOISE *			
FREQ (HZ)	BROAD -BAND	DSCRT TONES	CMBNTN TONES	TOTAL	BROAD -BAND	DSCRT TONES	TOTAL	TOTAL FAN NOISE
50.	.0	.0	42.4	42.4	.0	.0	.0	42.4
63.	4.3	.0	45.5	45.5	.0	.0	.0	45.5
80.	11.2	.0	48.6	48.6	.0	.0	.0	48.6
100.	18.6	.0	51.5	51.5	.0	.0	.0	51.5
125.	25.9	.0	54.4	54.4	.0	.0	.0	54.4
160.	33.6	.0	57.6	57.6	.0	.0	.0	57.6
200.	40.3	.0	60.5	60.6	.0	.0	.0	60.6
250.	46.5	.0	63.5	63.6	.0	.0	.0	63.6
315.	52.7	.0	66.5	66.7	.0	.0	.0	66.7
400.	58.6	.0	69.7	70.1	.0	.0	.0	70.1
500.	63.8	.0	72.7	73.3	.0	.0	.0	73.3
630.	68.8	.0	75.9	76.7	.0	.0	.0	76.7
800.	73.6	.0	78.8	80.0	.0	.0	.0	80.0
1000.	77.7	.0	81.8	83.2	.0	.0	.0	83.2
1250.	81.5	.0	84.8	86.4	.0	.0	.0	86.4
1600.	85.2	.0	87.7	89.6	.0	.0	.0	89.6
2000.	88.3	.0	90.5	92.5	.0	.0	.0	92.5
2500.	90.9	.0	93.4	95.4	.0	.0	.0	95.4
3150.	93.3	.0	90.4	95.1	.0	.0	.0	95.1
4000.	95.4	.0	87.3	96.1	.0	.0	.0	96.1
5000.	97.0	102.7	84.4	103.8	.0	.0	.0	103.8
6300.	98.3	.0	81.4	98.4	.0	.0	.0	98.4
8000.	99.3	.0	78.3	99.3	.0	.0	.0	99.3
10000.	99.8	101.7	75.3	103.9	.0	.0	.0	103.9
OASPL	105.8	105.2	98.2	108.9	.0	.0	.0	108.9

JETSTAR CRUISE NOISE CHECK CASE
TP'S 3A,3B,3C   MIC LOCATIONS 1 AND 3

FLIGHT CONDITION: ALT = 36000.   MA = .700   POWER SET. CODE = 1.90

OBSERVER LOCATION NO. =   3

ENGINE NO.   2

FAN NOISE COMPONENTS

1/3 OCT. BAND SPL'S AND OASPL'S - DB RE 0.00002 N/M2

	*** INLET RADIATED NOISE ***				** EXHAUST DUCT ** * RADIATED NOISE *			
FREQ (HZ)	BROAD -BAND	DSCRT TONES	CMBNTN TONES	TOTAL	BROAD -BAND	DSCRT TONES	TOTAL	TOTAL FAN NOISE
50.	.0	.0	41.2	41.2	.0	.0	.0	41.2
63.	3.1	.0	44.2	44.2	.0	.0	.0	44.2
80.	9.4	.0	47.3	47.3	.0	.0	.0	47.3
100.	16.7	.0	50.2	50.2	.0	.0	.0	50.2
125.	24.0	.0	53.1	53.1	.0	.0	.0	53.1
160.	31.7	.0	56.4	56.4	.0	.0	.0	56.4
200.	38.3	.0	59.3	59.3	.0	.0	.0	59.3
250.	44.6	.0	62.2	62.3	.0	.0	.0	62.3
315.	50.7	.0	65.3	65.4	.0	.0	.0	65.4
400.	56.6	.0	68.5	68.7	.0	.0	.0	68.7
500.	61.8	.0	71.5	71.9	.0	.0	.0	71.9
630.	66.8	.0	74.7	75.3	.0	.0	.0	75.3
800.	71.6	.0	77.6	78.5	.0	.0	.0	78.5
1000.	75.7	.0	80.5	81.7	.0	.0	.0	81.7
1250.	79.5	.0	83.5	85.0	.0	.0	.0	85.0
1600.	83.3	.0	86.4	88.1	.0	.0	.0	88.1
2000.	86.3	.0	89.2	91.0	.0	.0	.0	91.0
2500.	89.0	.0	92.1	93.9	.0	.0	.0	93.9
3150.	91.4	.0	89.1	93.4	.0	.0	.0	93.4
4000.	93.5	.0	86.0	94.2	.0	.0	.0	94.2
5000.	95.1	100.7	83.1	101.8	.0	.0	.0	101.8
6300.	96.4	.0	80.1	96.5	.0	.0	.0	96.5
8000.	97.3	.0	77.0	97.4	.0	.0	.0	97.4
10000.	97.8	99.7	74.1	101.9	.0	.0	.0	101.9
OASPL	103.8	103.2	97.0	107.0	.0	.0	.0	107.0

WARNING - IN JET MIXING NOISE, ATTEMPT TO EXPAND LOW FREQ RANGE TO 50 HZ
EXCEEDED LIMITS OF THOMSON SPECTRUM SHAPES

WARNING - IN JET MIXING NOISE, ATTEMPT TO EXPAND LOW FREQ RANGE TO 50 HZ
EXCEEDED LIMITS OF THOMSON SPECTRUM SHAPES

JETSTAR CRUISE NOISE CHECK CASE
TP'S 3A,3B,3C   MIC LOCATIONS 1 AND 3

FLIGHT CONDITION: ALT = 36000.   MA = .750   POWER SET. CODE = 2.00

OBSERVER LOCATION NO. = 1

TOTAL ENGINE AND AIRFRAME NOISE

1/3 OCT. BAND SPL'S AND OASPL'S DB RE 0.00002 N/M2,

FREQ	FAN	FAN	FAN				JET MIXING NOISE			SHOCK BB		SHOCK SCREECH		AIRFRAME		
(HZ)	FWD	AFT	TOTAL	CMX	TURB	CORE	PRI	SEC	TOTAL	PRI	SEC	PRI	SEC	TEN	TBLN	TOTAL
50.	51.8	.0	51.8	.0	48.4	75.3	75.4	.0	75.4	101.6	.0	.0	.0	.0	.0	101.6
63.	54.8	.0	54.8	.0	51.6	79.3	77.3	.0	77.3	105.4	.0	.0	.0	.0	.0	105.4
80.	57.9	.0	57.9	.0	55.8	83.3	79.2	.0	79.2	108.9	.0	.0	.0	.0	.0	108.9
100.	60.8	.0	60.8	.0	60.0	86.3	81.1	.0	81.1	111.8	.0	.0	.0	.0	.0	111.8
125.	63.7	.0	63.7	.0	61.3	89.3	82.8	.0	82.8	114.5	.0	.0	.0	.0	.0	114.5
160.	66.9	.0	66.9	.0	63.1	92.3	84.7	.0	84.7	116.9	.0	.0	.0	.0	.0	116.9
200.	69.8	.0	69.8	.0	65.0	94.8	86.3	.0	86.3	117.9	.0	.0	.0	.0	.0	118.0
250.	72.8	.0	72.8	.0	66.7	96.8	87.5	.0	87.5	118.6	.0	.0	.0	.0	.0	118.7
315.	75.8	.0	75.8	.0	68.9	98.3	88.8	.0	88.8	120.3	.0	.0	.0	.0	.0	120.3
400.	78.9	.0	78.9	.0	71.6	99.3	90.0	.0	90.0	125.8	.0	.0	.0	.0	.0	125.8
500.	81.8	.0	81.8	.0	73.4	98.3	90.5	.0	90.5	133.6	.0	.0	.0	.0	.0	133.6
630.	84.9	.0	84.9	.0	75.4	96.8	90.9	.0	90.9	137.8	.0	.0	.0	.0	.0	137.8
800.	88.1	.0	88.1	.0	77.4	94.8	91.4	.0	91.4	136.9	.0	.0	.0	.0	.0	136.9
1000.	91.0	.0	91.0	.0	79.6	92.3	92.6	.0	92.6	135.1	.0	.0	.0	.0	.0	135.1
1250.	93.9	.0	93.9	.0	81.4	89.3	93.7	.0	93.7	135.0	.0	.0	.0	.0	.0	135.0
1600.	97.2	.0	97.2	.0	83.9	86.3	95.0	.0	95.0	134.4	.0	.0	.0	.0	.0	134.4
2000.	100.0	.0	100.0	.0	86.6	83.3	95.4	.0	95.4	132.8	.0	.0	.0	.0	.0	132.8
2500.	102.9	.0	102.9	.0	88.4	79.3	95.9	.0	95.9	132.0	.0	.0	.0	.0	.0	132.0
3150.	105.9	.0	105.9	.0	90.6	75.3	96.4	.0	96.4	130.8	.0	.0	.0	.0	.0	130.8
4000.	103.1	.0	103.1	.0	92.7	71.8	96.1	.0	96.1	129.5	.0	.0	.0	.0	.0	129.5
5000.	101.0	.0	101.0	.0	94.4	67.8	95.8	.0	95.8	128.2	.0	.0	.0	.0	.0	128.2
6300.	104.1	.0	104.1	.0	95.9	63.3	95.4	.0	95.4	126.9	.0	.0	.0	.0	.0	126.9
8000.	99.5	.0	99.5	.0	97.3	59.3	94.7	.0	94.7	125.7	.0	.0	.0	.0	.0	125.7
10000.	99.8	.0	99.8	.0	98.4	54.3	94.0	.0	94.0	124.5	.0	.0	.0	.0	.0	124.5
OASPL	111.9	.0	111.9	.0	103.8	106.4	106.3	.0	106.3	144.8	.0	.0	.0	.0	.0	144.8

JETSTAR CRUISE NOISE CHECK CASE
TP'S 3A,3B,3C   MIC LOCATIONS 1 AND 3

FLIGHT CONDITION: ALT = 36000.   MA = .750   POWER SET. CODE = 2.00

OBSERVER LOCATION NO. = 1

ENGINE NO. 1

FAN NOISE COMPONENTS

1/3 OCT. BAND SPL'S AND OASPL'S - DB RE 0.00002 N/M2

	*** INLET RADIATED NOISE ***				** EXHAUST DUCT ** * RADIATED NOISE *			
FREQ (HZ)	BROAD -BAND	DSCRT TONES	CMBNTN TONES	TOTAL	BROAD -BAND	DSCRT TONES	TOTAL	TOTAL FAN NOISE
50.	.0	.0	49.4	49.4	.0	.0	.0	49.4
63.	.0	.0	52.4	52.4	.0	.0	.0	52.4
80.	.0	.0	55.5	55.5	.0	.0	.0	55.5
100.	8.3	.0	58.4	58.4	.0	.0	.0	58.4
125.	15.4	.0	61.3	61.3	.0	.0	.0	61.3
160.	23.5	.0	64.5	64.5	.0	.0	.0	64.5
200.	30.5	.0	67.4	67.4	.0	.0	.0	67.4
250.	37.1	.0	70.3	70.3	.0	.0	.0	70.3
315.	43.7	.0	73.4	73.4	.0	.0	.0	73.4
400.	50.0	.0	76.5	76.5	.0	.0	.0	76.5
500.	55.6	.0	79.4	79.4	.0	.0	.0	79.4
630.	61.0	.0	82.5	82.5	.0	.0	.0	82.5
800.	66.2	.0	85.6	85.7	.0	.0	.0	85.7
1000.	70.7	.0	88.5	88.6	.0	.0	.0	88.6
1250.	74.8	.0	91.4	91.5	.0	.0	.0	91.5
1600.	79.0	.0	94.7	94.8	.0	.0	.0	94.8
2000.	82.4	.0	97.5	97.6	.0	.0	.0	97.6
2500.	85.5	.0	100.3	100.5	.0	.0	.0	100.5
3150.	88.3	.0	103.3	103.5	.0	.0	.0	103.5
4000.	90.8	.0	100.2	100.7	.0	.0	.0	100.7
5000.	92.8	.0	97.3	98.6	.0	.0	.0	98.6
6300.	94.5	99.6	94.3	101.7	.0	.0	.0	101.7
8000.	95.9	.0	91.2	97.1	.0	.0	.0	97.1
10000.	96.8	.0	88.3	97.4	.0	.0	.0	97.4
OASPL	102.0	99.6	108.1	109.5	.0	.0	.0	109.5

JETSTAR CRUISE NOISE CHECK CASE
TP'S 3A,3B,3C   MIC LOCATIONS 1 AND 3

FLIGHT CONDITION: ALT = 36000.   MA = .750   POWER SET. CODE = 2.00

OBSERVER LOCATION NO. = 1

ENGINE NO. 2

FAN NOISE COMPONENTS

1/3 OCT. BAND SPL'S AND OASPL'S - DB RE 0.00002 N/M2

	*** INLET RADIATED NOISE ***				** EXHAUST DUCT ** * RADIATED NOISE *			
FREQ (HZ)	BROAD -BAND	DSCRT TONES	CMBNTN TONES	TOTAL	BROAD -BAND	DSCRT TONES	TOTAL	TOTAL FAN NOISE
50.	.0	.0	48.1	48.1	.0	.0	.0	48.1
63.	.0	.0	51.1	51.1	.0	.0	.0	51.1
80.	.0	.0	54.2	54.2	.0	.0	.0	54.2
100.	7.2	.0	57.1	57.1	.0	.0	.0	57.1
125.	14.2	.0	60.0	60.0	.0	.0	.0	60.0
160.	22.2	.0	63.2	63.2	.0	.0	.0	63.2
200.	29.2	.0	66.1	66.1	.0	.0	.0	66.1
250.	35.8	.0	69.0	69.0	.0	.0	.0	69.0
315.	42.4	.0	72.1	72.1	.0	.0	.0	72.1
400.	48.7	.0	75.2	75.2	.0	.0	.0	75.2
500.	54.3	.0	78.1	78.1	.0	.0	.0	78.1
630.	59.7	.0	81.2	81.2	.0	.0	.0	81.2
800.	64.9	.0	84.3	84.4	.0	.0	.0	84.4
1000.	69.4	.0	87.2	87.3	.0	.0	.0	87.3
1250.	73.5	.0	90.1	90.2	.0	.0	.0	90.2
1600.	77.7	.0	93.4	93.5	.0	.0	.0	93.5
2000.	81.1	.0	96.1	96.3	.0	.0	.0	96.3
2500.	84.2	.0	99.0	99.2	.0	.0	.0	99.2
3150.	87.0	.0	102.0	102.2	.0	.0	.0	102.2
4000.	89.5	.0	98.9	99.4	.0	.0	.0	99.4
5000.	91.5	.0	96.0	97.3	.0	.0	.0	97.3
6300.	93.2	98.3	93.0	100.4	.0	.0	.0	100.4
8000.	94.6	.0	89.9	95.8	.0	.0	.0	95.8
10000.	95.5	.0	87.0	96.0	.0	.0	.0	96.0
OASPL	100.7	98.3	106.8	108.2	.0	.0	.0	108.2

WARNING - IN JET MIXING NOISE, ATTEMPT TO EXPAND LOW FREQ RANGE TO 50 HZ
EXCEEDED LIMITS OF THOMSON SPECTRUM SHAPES

WARNING - IN JET MIXING NOISE, ATTEMPT TO EXPAND LOW FREQ RANGE TO 50 HZ
EXCEEDED LIMITS OF THOMSON SPECTRUM SHAPES

JETSTAR CRUISE NOISE CHECK CASE
TP'S 3A,3B,3C   MIC LOCATIONS 1 AND 3

FLIGHT CONDITION: ALT = 36000.   MA = .750   POWER SET. CODE = 2.00

OBSERVER LOCATION NO. = 3

TOTAL ENGINE AND AIRFRAME NOISE

1/3 OCT. BAND SPL'S AND OASPL'S DB RE 0.00002 N/M2,

FREQ	FAN	FAN	FAN				JET MIXING NOISE			SHOCK BB		SHOCK SCREECH		AIRFRAME		
(HZ)	FWD	AFT	TOTAL	CMX	TURB	CORE	PRI	SEC	TOTAL	PRI	SEC	PRI	SEC	TEN	TBLN	TOTAL
50.	52.7	.0	52.7	.0	48.0	75.3	74.4	.0	74.4	102.4	.0	.0	.0	.0	.0	102.4
63.	55.7	.0	55.7	.0	51.2	79.3	76.3	.0	76.3	106.2	.0	.0	.0	.0	.0	106.2
80.	58.9	.0	58.9	.0	55.4	83.3	78.2	.0	78.2	109.6	.0	.0	.0	.0	.0	109.6
100.	61.8	.0	61.8	.0	59.6	86.3	80.1	.0	80.1	112.5	.0	.0	.0	.0	.0	112.5
125.	64.7	.0	64.7	.0	60.9	89.3	81.8	.0	81.8	115.2	.0	.0	.0	.0	.0	115.2
160.	67.9	.0	67.9	.0	62.7	92.3	83.7	.0	83.7	117.5	.0	.0	.0	.0	.0	117.5
200.	70.8	.0	70.8	.0	64.7	94.8	85.3	.0	85.3	118.5	.0	.0	.0	.0	.0	118.5
250.	73.7	.0	73.7	.0	66.3	96.8	86.5	.0	86.5	119.2	.0	.0	.0	.0	.0	119.2
315.	76.7	.0	76.7	.0	68.5	98.3	87.8	.0	87.8	121.1	.0	.0	.0	.0	.0	121.1
400.	79.9	.0	79.9	.0	71.2	99.3	89.0	.0	89.0	127.1	.0	.0	.0	.0	.0	127.1
500.	82.8	.0	82.8	.0	73.0	98.3	89.5	.0	89.5	134.9	.0	.0	.0	.0	.0	134.9
630.	85.9	.0	85.9	.0	75.0	96.8	89.9	.0	89.9	138.6	.0	.0	.0	.0	.0	138.6
800.	89.1	.0	89.1	.0	77.0	94.8	90.4	.0	90.4	137.5	.0	.0	.0	.0	.0	137.5
1000.	92.0	.0	92.0	.0	79.2	92.3	91.6	.0	91.6	135.9	.0	.0	.0	.0	.0	135.9
1250.	95.0	.0	95.0	.0	81.0	89.3	92.7	.0	92.7	135.8	.0	.0	.0	.0	.0	135.8
1600.	98.4	.0	98.4	.0	83.5	86.3	94.0	.0	94.0	135.2	.0	.0	.0	.0	.0	135.2
2000.	101.2	.0	101.2	.0	86.2	83.3	94.4	.0	94.4	133.6	.0	.0	.0	.0	.0	133.6
2500.	104.1	.0	104.1	.0	88.1	79.3	94.9	.0	94.9	132.8	.0	.0	.0	.0	.0	132.8
3150.	107.1	.0	107.1	.0	90.2	75.3	95.4	.0	95.4	131.6	.0	.0	.0	.0	.0	131.6
4000.	104.8	.0	104.8	.0	92.4	71.8	95.1	.0	95.1	130.3	.0	.0	.0	.0	.0	130.3
5000.	103.6	.0	103.6	.0	94.0	67.8	94.8	.0	94.8	129.0	.0	.0	.0	.0	.0	129.0
6300.	108.7	.0	108.7	.0	95.6	63.3	94.4	.0	94.4	127.7	.0	.0	.0	.0	.0	127.8
8000.	104.0	.0	104.0	.0	96.9	59.3	93.7	.0	93.7	126.5	.0	.0	.0	.0	.0	126.5
10000.	104.6	.0	104.6	.0	98.1	54.3	93.0	.0	93.0	125.3	.0	.0	.0	.0	.0	125.3
OASPL	114.5	.0	114.5	.0	103.4	106.5	105.3	.0	105.3	145.7	.0	.0	.0	.0	.0	145.7

JETSTAR CRUISE NOISE CHECK CASE
TP'S 3A,3B,3C   MIC LOCATIONS 1 AND 3

FLIGHT CONDITION: ALT = 36000.   MA = .750   POWER SET. CODE = 2.00

OBSERVER LOCATION NO. = 3

ENGINE NO. 1

FAN NOISE COMPONENTS

1/3 OCT. BAND SPL'S AND OASPL'S - DB RE 0.00002 N/M2

	*** INLET RADIATED NOISE ***				** EXHAUST DUCT ** * RADIATED NOISE *			
FREQ (HZ)	BROAD -BAND	DSCRT TONES	CMBNTN TONES	TOTAL	BROAD -BAND	DSCRT TONES	TOTAL	TOTAL FAN NOISE
50.	.0	.0	50.4	50.4	.0	.0	.0	50.4
63.	.0	.0	53.4	53.4	.0	.0	.0	53.4
80.	6.2	.0	56.5	56.5	.0	.0	.0	56.5
100.	13.3	.0	59.4	59.4	.0	.0	.0	59.4
125.	20.9	.0	62.3	62.3	.0	.0	.0	62.3
160.	29.0	.0	65.5	65.5	.0	.0	.0	65.5
200.	36.0	.0	68.5	68.5	.0	.0	.0	68.5
250.	42.6	.0	71.4	71.4	.0	.0	.0	71.4
315.	49.2	.0	74.4	74.4	.0	.0	.0	74.4
400.	55.5	.0	77.5	77.5	.0	.0	.0	77.5
500.	61.1	.0	80.4	80.5	.0	.0	.0	80.5
630.	66.5	.0	83.5	83.6	.0	.0	.0	83.6
800.	71.7	.0	86.6	86.8	.0	.0	.0	86.8
1000.	76.2	.0	89.5	89.7	.0	.0	.0	89.7
1250.	80.3	.0	92.4	92.7	.0	.0	.0	92.7
1600.	84.5	.0	95.7	96.0	.0	.0	.0	96.0
2000.	87.9	.0	98.5	98.8	.0	.0	.0	98.8
2500.	91.0	.0	101.4	101.7	.0	.0	.0	101.7
3150.	93.8	.0	104.4	104.7	.0	.0	.0	104.7
4000.	96.3	.0	101.3	102.5	.0	.0	.0	102.5
5000.	98.3	.0	98.3	101.3	.0	.0	.0	101.3
6300.	100.0	105.0	95.3	106.6	.0	.0	.0	106.6
8000.	101.4	.0	92.2	101.9	.0	.0	.0	101.9
10000.	102.3	.0	89.3	102.5	.0	.0	.0	102.5
OASPL	107.5	105.0	109.1	112.3	.0	.0	.0	112.3

JETSTAR CRUISE NOISE CHECK CASE
TP'S 3A,3B,3C   MIC LOCATIONS 1 AND 3

FLIGHT CONDITION: ALT = 36000.   MA = .750   POWER SET. CODE = 2.00

OBSERVER LOCATION NO. = 3

ENGINE NO. 2

FAN NOISE COMPONENTS

1/3 OCT. BAND SPL'S AND OASPL'S - DB RE 0.00002 N/M2

	*** INLET RADIATED NOISE ***				** EXHAUST DUCT ** * RADIATED NOISE *			
FREQ (HZ)	BROAD -BAND	DSCRT TONES	CMBNTN TONES	TOTAL	BROAD -BAND	DSCRT TONES	TOTAL	TOTAL FAN NOISE
50.	.0	.0	48.9	48.9	.0	.0	.0	48.9
63.	.0	.0	51.9	51.9	.0	.0	.0	51.9
80.	4.8	.0	55.1	55.1	.0	.0	.0	55.1
100.	11.5	.0	58.0	58.0	.0	.0	.0	58.0
125.	18.9	.0	60.9	60.9	.0	.0	.0	60.9
160.	27.0	.0	64.1	64.1	.0	.0	.0	64.1
200.	34.0	.0	67.0	67.0	.0	.0	.0	67.0
250.	40.7	.0	69.9	69.9	.0	.0	.0	69.9
315.	47.2	.0	72.9	72.9	.0	.0	.0	72.9
400.	53.6	.0	76.1	76.1	.0	.0	.0	76.1
500.	59.2	.0	79.0	79.0	.0	.0	.0	79.0
630.	64.6	.0	82.0	82.1	.0	.0	.0	82.1
800.	69.8	.0	85.2	85.3	.0	.0	.0	85.3
1000.	74.3	.0	88.1	88.2	.0	.0	.0	88.2
1250.	78.4	.0	91.0	91.2	.0	.0	.0	91.2
1600.	82.6	.0	94.3	94.5	.0	.0	.0	94.5
2000.	86.0	.0	97.0	97.4	.0	.0	.0	97.4
2500.	89.1	.0	99.9	100.3	.0	.0	.0	100.3
3150.	91.9	.0	102.9	103.2	.0	.0	.0	103.2
4000.	94.4	.0	99.8	100.9	.0	.0	.0	100.9
5000.	96.4	.0	96.9	99.7	.0	.0	.0	99.7
6300.	98.1	103.1	93.9	104.7	.0	.0	.0	104.7
8000.	99.4	.0	90.8	100.0	.0	.0	.0	100.0
10000.	100.3	.0	87.9	100.6	.0	.0	.0	100.6
OASPL	105.6	103.1	107.7	110.6	.0	.0	.0	110.6

WARNING - IN JET MIXING NOISE, ATTEMPT TO EXPAND LOW FREQ RANGE TO 50 HZ
EXCEEDED LIMITS OF THOMSON SPECTRUM SHAPES

WARNING - FOR SHOCK BROADBAND NOISE, SOURCE = 7 ,THE STROUHAL PARAMETER
OF 1/3 O.B. NO. 24 IS OUTSIDE RANGE OF MASTER SPECTRA

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WARNING - IN JET MIXING NOISE, ATTEMPT TO EXPAND LOW FREQ RANGE TO 50 HZ
          EXCEEDED LIMITS OF THOMSON SPECTRUM SHAPES


WARNING - FOR SHOCK BROADBAND NOISE, SOURCE = 7 ,THE STROUHAL PARAMETER
           OF 1/3 O.B. NO. 24 IS OUTSIDE RANGE OF MASTER SPECTRA
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JETSTAR CRUISE NOISE CHECK CASE
TP'S 3A,3B,3C   MIC LOCATIONS 1 AND 3

FLIGHT CONDITION: ALT = 36000.   MA = .800   POWER SET. CODE = 2.10

OBSERVER LOCATION NO. = 1

TOTAL ENGINE AND AIRFRAME NOISE

1/3 OCT. BAND SPL'S AND OASPL'S DB RE 0.00002 N/M2,

FREQ	FAN	FAN	FAN				JET MIXING NOISE			SHOCK BB		SHOCK SCREECH		AIRFRAME		
(HZ)	FWD	AFT	TOTAL	CMX	TURB	CORE	PRI	SEC	TOTAL	PRI	SEC	PRI	SEC	TEN	TBLN	TOTAL
50.	53.3	.0	53.3	.0	50.1	79.5	75.7	.0	75.7	108.9	.0	.0	.0	.0	.0	109.0
63.	56.3	.0	56.3	.0	53.2	83.5	77.6	.0	77.6	112.5	.0	.0	.0	.0	.0	112.5
80.	59.5	.0	59.5	.0	57.3	87.5	79.6	.0	79.6	115.9	.0	.0	.0	.0	.0	115.9
100.	62.4	.0	62.4	.0	62.0	90.5	81.4	.0	81.4	118.7	.0	.0	.0	.0	.0	118.7
125.	65.3	.0	65.3	.0	63.3	93.5	83.2	.0	83.2	121.3	.0	.0	.0	.0	.0	121.3
160.	68.5	.0	68.5	.0	65.0	96.5	85.1	.0	85.1	123.2	.0	.0	.0	.0	.0	123.2
200.	71.4	.0	71.4	.0	67.0	99.0	86.8	.0	86.8	124.0	.0	.0	.0	.0	.0	124.0
250.	74.3	.0	74.3	.0	68.6	101.0	88.0	.0	88.0	124.7	.0	.0	.0	.0	.0	124.8
315.	77.4	.0	77.4	.0	70.8	102.5	89.2	.0	89.2	127.4	.0	.0	.0	.0	.0	127.4
400.	80.5	.0	80.5	.0	73.5	103.5	90.5	.0	90.5	134.9	.0	.0	.0	.0	.0	134.9
500.	83.5	.0	83.5	.0	75.3	102.5	90.8	.0	90.8	141.6	.0	.0	.0	.0	.0	141.6
630.	86.6	.0	86.6	.0	77.3	101.0	91.2	.0	91.2	143.4	.0	.0	.0	.0	.0	143.4
800.	89.8	.0	89.8	.0	79.3	99.0	91.6	.0	91.6	141.2	.0	.0	.0	.0	.0	141.2
1000.	92.7	.0	92.7	.0	81.5	96.5	92.7	.0	92.7	140.6	.0	.0	.0	.0	.0	140.6
1250.	95.8	.0	95.8	.0	83.3	93.5	93.9	.0	93.9	139.9	.0	.0	.0	.0	.0	139.9
1600.	99.2	.0	99.2	.0	85.7	90.5	95.2	.0	95.2	139.2	.0	.0	.0	.0	.0	139.2
2000.	101.7	.0	101.7	.0	88.5	87.5	95.8	.0	95.8	137.8	.0	.0	.0	.0	.0	137.8
2500.	104.5	.0	104.5	.0	90.3	83.5	96.3	.0	96.3	136.8	.0	.0	.0	.0	.0	136.8
3150.	107.5	.0	107.5	.0	92.5	79.5	96.9	.0	96.9	135.7	.0	.0	.0	.0	.0	135.7
4000.	104.9	.0	104.9	.0	94.7	76.0	96.6	.0	96.6	134.3	.0	.0	.0	.0	.0	134.3
5000.	103.2	.0	103.2	.0	96.4	72.0	96.4	.0	96.4	133.0	.0	.0	.0	.0	.0	133.0
6300.	106.7	.0	106.7	.0	97.9	67.5	96.1	.0	96.1	131.8	.0	.0	.0	.0	.0	131.8
8000.	102.6	.0	102.6	.0	99.3	63.5	95.4	.0	95.4	130.5	.0	.0	.0	.0	.0	130.5
10000.	103.0	.0	103.0	.0	100.5	58.5	94.8	.0	94.8	129.5	.0	.0	.0	.0	.0	129.5
OASPL	114.0	.0	114.0	.0	105.8	110.6	106.8	.0	106.8	150.3	.0	.0	.0	.0	.0	150.3

JETSTAR CRUISE NOISE CHECK CASE
TP'S 3A,3B,3C MIC LOCATIONS 1 AND 3

FLIGHT CONDITION: ALT = 36000. MA = .800 POWER SET. CODE = 2.10

OBSERVER LOCATION NO. = 1

ENGINE NO. 1

FAN NOISE COMPONENTS

1/3 OCT. BAND SPL'S AND OASPL'S - DB RE 0.00002 N/M2

	*** INLET RADIATED NOISE ***				** EXHAUST DUCT ** * RADIATED NOISE *			
FREQ (HZ)	BROAD -BAND	DSCRT TONES	CMBNTN TONES	TOTAL	BROAD -BAND	DSCRT TONES	TOTAL	TOTAL FAN NOISE
50.	.0	.0	50.9	50.9	.0	.0	.0	50.9
63.	.0	.0	53.9	53.9	.0	.0	.0	53.9
80.	4.7	.0	57.0	57.0	.0	.0	.0	57.0
100.	11.3	.0	60.0	60.0	.0	.0	.0	60.0
125.	18.8	.0	62.9	62.9	.0	.0	.0	62.9
160.	26.9	.0	66.1	66.1	.0	.0	.0	66.1
200.	33.9	.0	69.0	69.0	.0	.0	.0	69.0
250.	40.5	.0	71.9	71.9	.0	.0	.0	71.9
315.	47.1	.0	75.0	75.0	.0	.0	.0	75.0
400.	53.4	.0	78.1	78.1	.0	.0	.0	78.1
500.	59.0	.0	81.1	81.1	.0	.0	.0	81.1
630.	64.4	.0	84.1	84.2	.0	.0	.0	84.2
800.	69.6	.0	87.4	87.4	.0	.0	.0	87.4
1000.	74.1	.0	90.2	90.3	.0	.0	.0	90.3
1250.	78.2	.0	93.2	93.4	.0	.0	.0	93.4
1600.	82.4	.0	96.6	96.8	.0	.0	.0	96.8
2000.	85.8	.0	99.1	99.3	.0	.0	.0	99.3
2500.	88.9	.0	101.9	102.1	.0	.0	.0	102.1
3150.	91.7	.0	104.9	105.1	.0	.0	.0	105.1
4000.	94.2	.0	101.8	102.5	.0	.0	.0	102.5
5000.	96.2	.0	98.9	100.8	.0	.0	.0	100.8
6300.	97.9	102.2	95.9	104.3	.0	.0	.0	104.3
8000.	99.3	.0	92.8	100.1	.0	.0	.0	100.1
10000.	100.2	.0	89.9	100.6	.0	.0	.0	100.6
OASPL	105.4	102.2	109.7	111.6	.0	.0	.0	111.6

JETSTAR CRUISE NOISE CHECK CASE
TP'S 3A,3B,3C MIC LOCATIONS 1 AND 3

FLIGHT CONDITION: ALT = 36000. MA = .800 POWER SET. CODE = 2.10

OBSERVER LOCATION NO. = 1

ENGINE NO. 2

FAN NOISE COMPONENTS

1/3 OCT. BAND SPL'S AND OASPL'S - DB RE 0.00002 N/M2

	*** INLET RADIATED NOISE ***				** EXHAUST DUCT ** * RADIATED NOISE *			
FREQ (HZ)	BROAD -BAND	DSCRT TONES	CMBNTN TONES	TOTAL	BROAD -BAND	DSCRT TONES	TOTAL	TOTAL FAN NOISE
50.	.0	.0	49.6	49.6	.0	.0	.0	49.6
63.	.0	.0	52.6	52.6	.0	.0	.0	52.6
80.	3.9	.0	55.7	55.7	.0	.0	.0	55.7
100.	10.1	.0	58.6	58.6	.0	.0	.0	58.6
125.	17.5	.0	61.6	61.6	.0	.0	.0	61.6
160.	25.6	.0	64.8	64.8	.0	.0	.0	64.8
200.	32.6	.0	67.7	67.7	.0	.0	.0	67.7
250.	39.2	.0	70.6	70.6	.0	.0	.0	70.6
315.	45.8	.0	73.6	73.7	.0	.0	.0	73.7
400.	52.1	.0	76.8	76.8	.0	.0	.0	76.8
500.	57.7	.0	79.7	79.8	.0	.0	.0	79.8
630.	63.1	.0	82.8	82.9	.0	.0	.0	82.9
800.	68.3	.0	86.1	86.1	.0	.0	.0	86.1
1000.	72.8	.0	88.9	89.0	.0	.0	.0	89.0
1250.	76.9	.0	91.9	92.1	.0	.0	.0	92.1
1600.	81.1	.0	95.3	95.5	.0	.0	.0	95.5
2000.	84.5	.0	97.8	98.0	.0	.0	.0	98.0
2500.	87.6	.0	100.6	100.8	.0	.0	.0	100.8
3150.	90.4	.0	103.6	103.8	.0	.0	.0	103.8
4000.	92.9	.0	100.5	101.2	.0	.0	.0	101.2
5000.	94.9	.0	97.6	99.5	.0	.0	.0	99.5
6300.	96.6	100.9	94.6	103.0	.0	.0	.0	103.0
8000.	98.0	.0	91.5	98.8	.0	.0	.0	98.8
10000.	98.9	.0	88.5	99.3	.0	.0	.0	99.3
OASPL	104.1	100.9	108.4	110.3	.0	.0	.0	110.3

WARNING - IN JET MIXING NOISE, ATTEMPT TO EXPAND LOW FREQ RANGE TO 50 HZ
EXCEEDED LIMITS OF THOMSON SPECTRUM SHAPES

WARNING - FOR SHOCK BROADBAND NOISE, SOURCE = 7 ,THE STROUHAL PARAMETER
OF 1/3 O.B. NO. 24 IS OUTSIDE RANGE OF MASTER SPECTRA

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WARNING - IN JET MIXING NOISE, ATTEMPT TO EXPAND LOW FREQ RANGE TO 50 HZ
          EXCEEDED LIMITS OF THOMSON SPECTRUM SHAPES

WARNING - FOR SHOCK BROADBAND NOISE, SOURCE = 7 ,THE STROUHAL PARAMETER
           OF 1/3 O.B. NO. 24 IS OUTSIDE RANGE OF MASTER SPECTRA
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JETSTAR CRUISE NOISE CHECK CASE
TP'S 3A,3B,3C MIC LOCATIONS 1 AND 3

FLIGHT CONDITION: ALT = 36000. MA = .800 POWER SET. CODE = 2.10

OBSERVER LOCATION NO. = 3

TOTAL ENGINE AND AIRFRAME NOISE

1/3 OCT. BAND SPL'S AND OASPL'S DB RE 0.00002 N/M2,

FREQ	FAN	FAN	FAN				JET MIXING NOISE			SHOCK BB		SHOCK SCREECH		AIRFRAME		
(HZ)	FWD	AFT	TOTAL	CMX	TURB	CORE	PRI	SEC	TOTAL	PRI	SEC	PRI	SEC	TEN	TBLN	TOTAL
50.	54.8	.0	54.8	.0	49.6	79.2	74.6	.0	74.6	109.4	.0	.0	.0	.0	.0	109.4
63.	57.9	.0	57.9	.0	52.7	83.2	76.5	.0	76.5	113.0	.0	.0	.0	.0	.0	113.0
80.	61.0	.0	61.0	.0	56.7	87.2	78.5	.0	78.5	116.3	.0	.0	.0	.0	.0	116.3
100.	63.9	.0	63.9	.0	61.4	90.2	80.3	.0	80.3	119.1	.0	.0	.0	.0	.0	119.1
125.	66.8	.0	66.8	.0	62.7	93.2	82.1	.0	82.1	121.7	.0	.0	.0	.0	.0	121.7
160.	70.0	.0	70.0	.0	64.5	96.2	84.0	.0	84.0	123.5	.0	.0	.0	.0	.0	123.5
200.	72.9	.0	72.9	.0	66.5	98.7	85.7	.0	85.7	124.3	.0	.0	.0	.0	.0	124.3
250.	75.9	.0	75.9	.0	68.1	100.7	86.9	.0	86.9	125.1	.0	.0	.0	.0	.0	125.1
315.	78.9	.0	78.9	.0	70.2	102.2	88.1	.0	88.1	128.0	.0	.0	.0	.0	.0	128.0
400.	82.1	.0	82.1	.0	73.0	103.2	89.4	.0	89.4	135.7	.0	.0	.0	.0	.0	135.7
500.	85.0	.0	85.0	.0	74.7	102.2	89.7	.0	89.7	142.3	.0	.0	.0	.0	.0	142.3
630.	88.2	.0	88.2	.0	76.8	100.7	90.0	.0	90.0	143.8	.0	.0	.0	.0	.0	143.8
800.	91.5	.0	91.5	.0	78.7	98.7	90.4	.0	90.4	141.6	.0	.0	.0	.0	.0	141.6
1000.	94.4	.0	94.4	.0	81.0	96.2	91.6	.0	91.6	141.2	.0	.0	.0	.0	.0	141.2
1250.	97.5	.0	97.5	.0	82.7	93.2	92.8	.0	92.8	140.4	.0	.0	.0	.0	.0	140.4
1600.	100.9	.0	100.9	.0	85.2	90.2	94.1	.0	94.1	139.6	.0	.0	.0	.0	.0	139.6
2000.	103.4	.0	103.4	.0	88.0	87.2	94.6	.0	94.6	138.3	.0	.0	.0	.0	.0	138.3
2500.	106.3	.0	106.3	.0	89.8	83.2	95.2	.0	95.2	137.3	.0	.0	.0	.0	.0	137.3
3150.	109.3	.0	109.3	.0	91.9	79.2	95.7	.0	95.7	136.2	.0	.0	.0	.0	.0	136.2
4000.	107.2	.0	107.2	.0	94.2	75.7	95.5	.0	95.5	134.8	.0	.0	.0	.0	.0	134.8
5000.	106.3	.0	106.3	.0	95.9	71.7	95.2	.0	95.2	133.5	.0	.0	.0	.0	.0	133.5
6300.	111.4	.0	111.4	.0	97.4	67.2	95.0	.0	95.0	132.2	.0	.0	.0	.0	.0	132.3
8000.	107.2	.0	107.2	.0	98.8	63.2	94.3	.0	94.3	131.0	.0	.0	.0	.0	.0	131.0
10000.	107.9	.0	107.9	.0	99.9	58.2	93.6	.0	93.6	130.0	.0	.0	.0	.0	.0	130.0
OASPL	117.2	.0	117.2	.0	105.2	110.4	105.7	.0	105.7	150.8	.0	.0	.0	.0	.0	150.8

JETSTAR CRUISE NOISE CHECK CASE
TP'S 3A,3B,3C   MIC LOCATIONS 1 AND 3

FLIGHT CONDITION: ALT = 36000.   MA = .800   POWER SET. CODE = 2.10

OBSERVER LOCATION NO. = 3

ENGINE NO. 1

FAN NOISE COMPONENTS

1/3 OCT. BAND SPL'S AND OASPL'S - DB RE 0.00002 N/M2

	*** INLET RADIATED NOISE ***				** EXHAUST DUCT ** * RADIATED NOISE *			
FREQ (HZ)	BROAD -BAND	DSCRT TONES	CMBNTN TONES	TOTAL	BROAD -BAND	DSCRT TONES	TOTAL	TOTAL FAN NOISE
50.	.0	.0	52.5	52.5	.0	.0	.0	52.5
63.	.0	.0	55.5	55.5	.0	.0	.0	55.5
80.	8.9	.0	58.6	58.6	.0	.0	.0	58.6
100.	16.4	.0	61.5	61.5	.0	.0	.0	61.5
125.	24.1	.0	64.4	64.4	.0	.0	.0	64.4
160.	32.2	.0	67.7	67.7	.0	.0	.0	67.7
200.	39.2	.0	70.6	70.6	.0	.0	.0	70.6
250.	45.9	.0	73.5	73.5	.0	.0	.0	73.5
315.	52.4	.0	76.5	76.5	.0	.0	.0	76.5
400.	58.8	.0	79.7	79.7	.0	.0	.0	79.7
500.	64.3	.0	82.6	82.7	.0	.0	.0	82.7
630.	69.8	.0	85.7	85.8	.0	.0	.0	85.8
800.	75.0	.0	88.9	89.1	.0	.0	.0	89.1
1000.	79.4	.0	91.8	92.0	.0	.0	.0	92.0
1250.	83.6	.0	94.8	95.1	.0	.0	.0	95.1
1600.	87.8	.0	98.2	98.6	.0	.0	.0	98.6
2000.	91.2	.0	100.6	101.1	.0	.0	.0	101.1
2500.	94.3	.0	103.5	104.0	.0	.0	.0	104.0
3150.	97.1	.0	106.5	107.0	.0	.0	.0	107.0
4000.	99.6	.0	103.4	104.9	.0	.0	.0	104.9
5000.	101.6	.0	100.5	104.1	.0	.0	.0	104.1
6300.	103.3	107.6	97.4	109.2	.0	.0	.0	109.2
8000.	104.6	.0	94.3	105.0	.0	.0	.0	105.0
10000.	105.5	.0	91.4	105.7	.0	.0	.0	105.7
OASPL	110.8	107.6	111.3	114.9	.0	.0	.0	114.9

JETSTAR CRUISE NOISE CHECK CASE
TP'S 3A,3B,3C MIC LOCATIONS 1 AND 3

FLIGHT CONDITION: ALT = 36000. MA = .800 POWER SET. CODE = 2.10

OBSERVER LOCATION NO. = 3

ENGINE NO. 2

FAN NOISE COMPONENTS

1/3 OCT. BAND SPL'S AND OASPL'S - DB RE 0.00002 N/M2

	*** INLET RADIATED NOISE ***				** EXHAUST DUCT ** * RADIATED NOISE *			
FREQ (HZ)	BROAD -BAND	DSCRT TONES	CMBNTN TONES	TOTAL	BROAD -BAND	DSCRT TONES	TOTAL	TOTAL FAN NOISE
50.	.0	.0	51.0	51.0	.0	.0	.0	51.0
63.	.0	.0	54.1	54.1	.0	.0	.0	54.1
80.	7.2	.0	57.2	57.2	.0	.0	.0	57.2
100.	14.6	.0	60.1	60.1	.0	.0	.0	60.1
125.	22.2	.0	63.0	63.0	.0	.0	.0	63.0
160.	30.3	.0	66.2	66.2	.0	.0	.0	66.2
200.	37.3	.0	69.1	69.1	.0	.0	.0	69.1
250.	44.0	.0	72.1	72.1	.0	.0	.0	72.1
315.	50.5	.0	75.1	75.1	.0	.0	.0	75.1
400.	56.9	.0	78.2	78.3	.0	.0	.0	78.3
500.	62.4	.0	81.2	81.2	.0	.0	.0	81.2
630.	67.8	.0	84.3	84.4	.0	.0	.0	84.4
800.	73.0	.0	87.5	87.6	.0	.0	.0	87.6
1000.	77.5	.0	90.4	90.6	.0	.0	.0	90.6
1250.	81.7	.0	93.4	93.6	.0	.0	.0	93.6
1600.	85.9	.0	96.7	97.1	.0	.0	.0	97.1
2000.	89.3	.0	99.2	99.6	.0	.0	.0	99.6
2500.	92.4	.0	102.0	102.5	.0	.0	.0	102.5
3150.	95.2	.0	105.0	105.5	.0	.0	.0	105.5
4000.	97.7	.0	101.9	103.3	.0	.0	.0	103.3
5000.	99.7	.0	99.0	102.4	.0	.0	.0	102.4
6300.	101.4	105.7	96.0	107.4	.0	.0	.0	107.4
8000.	102.7	.0	92.9	103.1	.0	.0	.0	103.1
10000.	103.6	.0	90.0	103.8	.0	.0	.0	103.8
OASPL	108.9	105.7	109.8	113.2	.0	.0	.0	113.2

COMPARISONS WITH MEASURED DATA

One of the objectives of the present effort was to compare acoustic measurements made in flight with predictions of the Cruise Noise Prediction Program. As a result of these comparisons, it was planned to modify and improve the prediction program where necessary and where possible with the available data. This effort, as anticipated, was significantly constrained by time and budget.

The measured data provided for these comparisons consist of 50 Hz bandwidth sound pressure levels recorded at 5 microphone locations on the NASA/Dryden JetStar. The data covered the frequency range of the predictions (50 to 10,000 Hz) and beyond to about 20,000 Hz. Three of the microphones were mounted approximately 3 feet apart (spanwise) on the upper surface leading edge section just outboard of the wing slipper tank. For reference herein, these microphones are numbered 1 to 3 beginning with the outboard microphone. One of the remaining microphones was located on the slipper tank and the other inside the inlet of engine number 1. The data from the slipper tank microphone were reported to be erroneous and were not used for comparisons. Data were supplied for three test flights and about 18 test conditions per flight. The test points (altitude, Mach number, power setting, C_L, etc) were essentially the same for each flight. They covered the range from ground, static operation to cruise at 40,000 feet. Spectral data were supplied for only one of the three flights so the data of this flight were selected for comparison purposes. The overall sound pressure levels (reported for all flights) indicated no significant difference in measured noise levels among the three flights.

Cruising flight at 36,000 feet was, somewhat arbitrarily, selected as the baseline flight condition. Figure 5 shows the measured and predicted acoustic signature at microphone number 1 for the baseline case at an engine pressure ratio of 1.9. The predicted levels shown are 1/3 octave-band sound pressure levels corrected for bandwidth to obtain 50 Hz bandwidth levels. As shown, the spectrum shapes are similar but the predicted levels run about 15 db higher than measured. The predicted component noise levels for this case are shown in Figure 6. Jet shock broadband noise is seen to dominate the predicted noise spectrum. Figure 7 provides a comparison for the baseline case at a higher cruise Mach number and power setting. For this flight condition, the predicted and measured spectra have moved farther apart. Also, note that the measured compressor tone which showed reasonable agreement with predicted tones in Figure 5 has disappeared in Figure 7. Comparisons made at other flight conditions and microphone locations on the wing show similar results. As a point of reference, Figure 8 presents a comparison for static, ground operation. Under these conditions, the comparison shows fairly good agreement. At the present, the reasons for the differences seen here in the cruise environment have not been identified. It was hoped that Mach number and power setting effects could be derived from the measured data. Unfortunately, it appears that the flight cases which might provide an isolated effect of either parameter have turbulent flow occurring at the microphone locations. The flight data included a notation as to the occurrence of laminar or turbulent flow at each microphone location for each test point. The measured noise spectra seem to confirm these observations. This, in effect, has "washed-out" the noise signature impinging from outside the boundary layer, i.e. the acoustic record appears to be dominated by the fluid pressure fluctuations of the turbulent flow. This problem also occurs in attempting to compare cases with and without shocks (or supercritical nozzle pressure ratios).

In an alternate approach, perturbations to the prediction procedures have been made in an attempt to produce agreement with measured data. The results of this investigation are inconclusive. For example, removing the shock noise or the convective amplification effect from the predictions removes most of the differences seen in the noise comparisons above. However, as noted, these individual effects are not verifiable from the measured data. Consequently, it is suggested that more flight noise data be obtained with an improved (but as yet undefined) noise data acquisition system. Hopefully this will occur eventually.

Several areas have been identified as possible contributors to the apparent lack of agreement seen in these comparisons. These areas have been explored to only a limited extent due to budget constraints. They include (1) the shock noise prediction, (2) the convective amplification correction, (3) the altitude correction, and (4) shielding effects. These, of course, are not the only possibilities, but appear to be the most obvious or promising in terms of producing explanations for the results seen here. Another area of interest is the compressor noise and its tones as noted previously. A brief discussion of these aspects of the prediction procedure follow.

Jet shock-associated broadband noise clearly dominates the predicted noise spectra of the JetStar at cruise conditions. Unfortunately, as noted previously, it appears that the noise spectra from test points without shocks, which might allow source separation of shock noise, are not available. Otherwise, there is no clear reason to suspect the basic shock prediction procedure. High forward speed, as mentioned before, is not expected to significantly affect the shock noise source strength or frequency content, but this remains to be shown. Another possibility is shielding of shock noise by the engine nacelle. If the source were located nearer the nozzle exit than predicted, as may be possible with the JetStar nozzle, significant shielding could occur. This is especially true since the source emission angles for radiation to the wing microphone positions at cruise are very small.

Predictions were generated with shock noise excluded to show how the comparisons might look if shock noise was being severely over predicted at the measurement locations. The results are shown in Figure 9. In the absence of shock noise, the predictions run, on the average, only a few dB below the measured data. However, the trends with increasing

Mach number and power setting are still reversed. As discussed below, aerodynamic shielding may be a factor in this difference in trends.

Convective amplification is a phenomenon associated with motion of an acoustic source relative to the surrounding medium. Its effect on aircraft noise radiation patterns has been demonstrated but only for Mach numbers up to about 0.25. In the absence of data for higher Mach numbers, the correction for this effect is assumed to apply at transonic Mach numbers as well. This results in rather large corrections to the predicted noise levels at cruise conditions, e.g. an increase of 28 dB in front of a source and a 10 dB reduction behind a source at 0.80 Mach number. Obviously, this extrapolation to cruise Mach numbers needs experimental verification or redefinition. Until these data become available, this correction must be viewed with some skepticism. As noted above, the present data do not appear to provide valid aircraft noise signatures with aircraft Mach number as the only variable. As was done in the case of shock noise, several computer runs were made excluding the correction for convective amplification. The results are seen in Figure 9, and continue to show an increase in level with Mach number and power setting. The levels agree with the measured data at 0.70 Mach number but overall average about 4 to 5 dB higher than measured.

The effect of cruise altitude has been accounted for in the present procedure by applying a sound level correction based on the ratio of the local characteristic acoustic impedance (ρc) to that at sea level, standard day ($\rho_o c_o$). The correction applied is 10 $\log_{10}$ ($\rho c / \rho_o c_o$). However, it now appears that this correction procedure requires further investigation and possible modification, especially in light of the present comparisons. The correction which may be more appropriate here is in fact given in Section 3.4.2 of Reference 1. This correction, 20 $\log_{10}$ ($\rho c^2 / \rho_o c_o^2$), will result in about a 7 dB reduction in the program predictions at 36,000 ft. However, it may turn out that the proper correction will be a function of the nature of the noise source (monopole, dipole, or quadrapole). Alternatively, the problem may be resolved by further investigation into the applicability of the basic prediction procedures to the high altitude environment. It is anticipated that further investigation will show the later correction above to be more applicable to cruise noise predictions and, consequently, a correction to the program would be in order.

Shielding effects are believed to play a key role in the differences between measured and predicted noise levels seen in the present study. The most influential shielding effects, however, are not structural but appear to be the result of the boundary layer and induced flow field over the wing. Previous JetStar aerodynamic studies and data in the literature indicate that the supersonic flow region over the upper wing surface may extend to at least a height equivalent to about 20% of wing chord. This effect may be expected to result in a significant shielding effect with the shielding effect increasing as the Mach number goes up. Considering the geometry of the engine/microphone locations for the present case, this may be at least a partial explanation for the observed decrease in the measured noise levels with increasing Mach number and power setting and the observed differences in measured and predicted noise levels. Unfortunately, methods for predicting this effect are not presently available. Furthermore, as stated previously, the present procedure was developed for free-field conditions. The effects of refraction, for example, in the wing flow field and boundary layer are not included. Even in the absence of a supersonic flow region on the wing, for our engine/wing/microphone arrangement, refraction in the boundary layer can be expected to produce some shielding. Considering the complexity of the mechanisms involved, which are not predictable with any confidence with available procedures, and their potential importance, the structural shielding procedure of Reference 2 does not seem applicable. Consequently, a shielding routine has not been developed for the prediction program.

In conclusion, the results of the comparisons made to date clearly show that further investigations are required to explain the differences seen in the measured and predicted noise levels. It is believed, at this point, that the experimental isolation of the effects discussed in this section will go a long way toward resolving these differences, and that the prediction program presented here will form an adequate basis for aircraft preliminary design work.

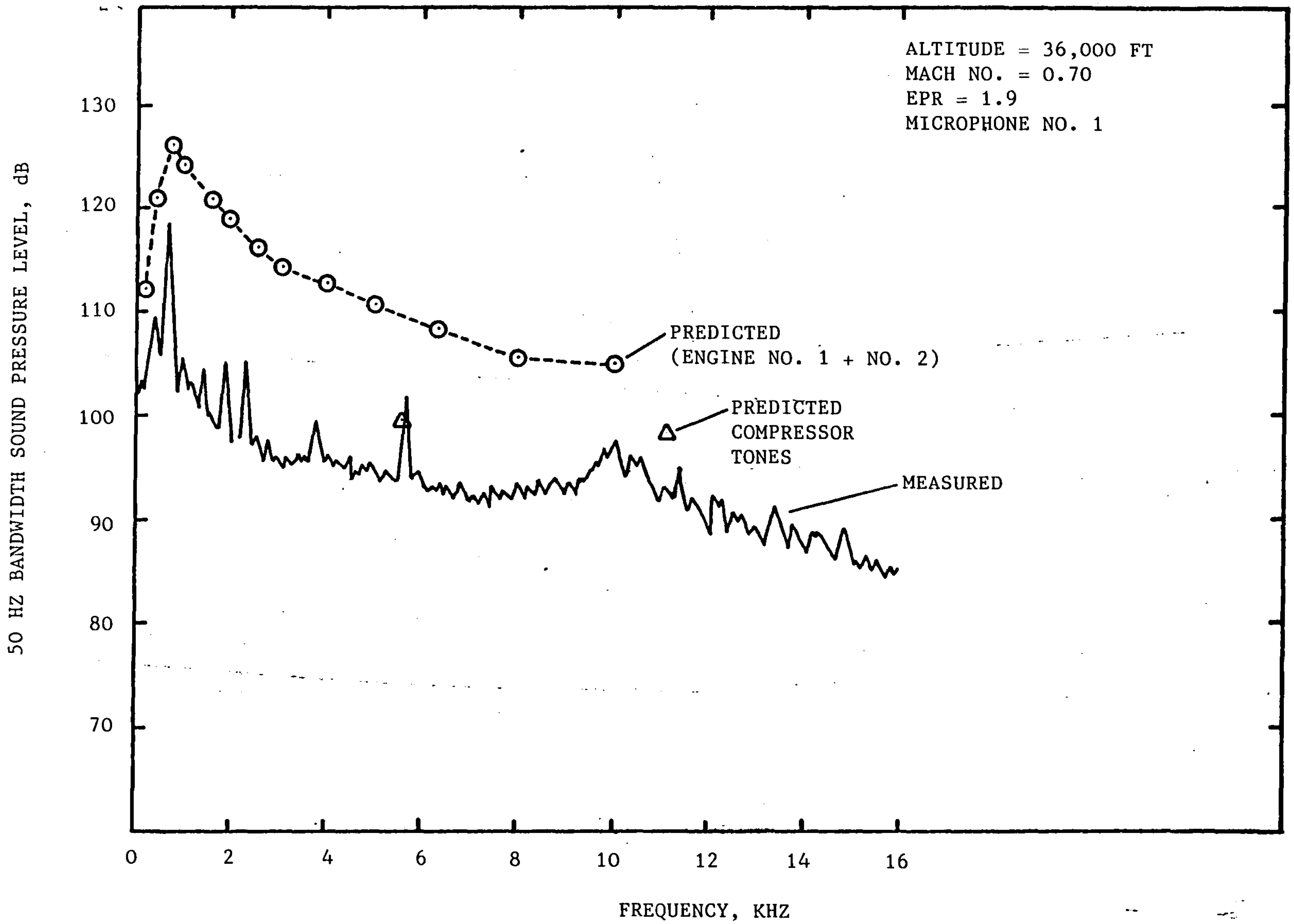

Figure 5. Comparison of measured and predicted noise levels for Lockheed JetStar at cruise conditions.

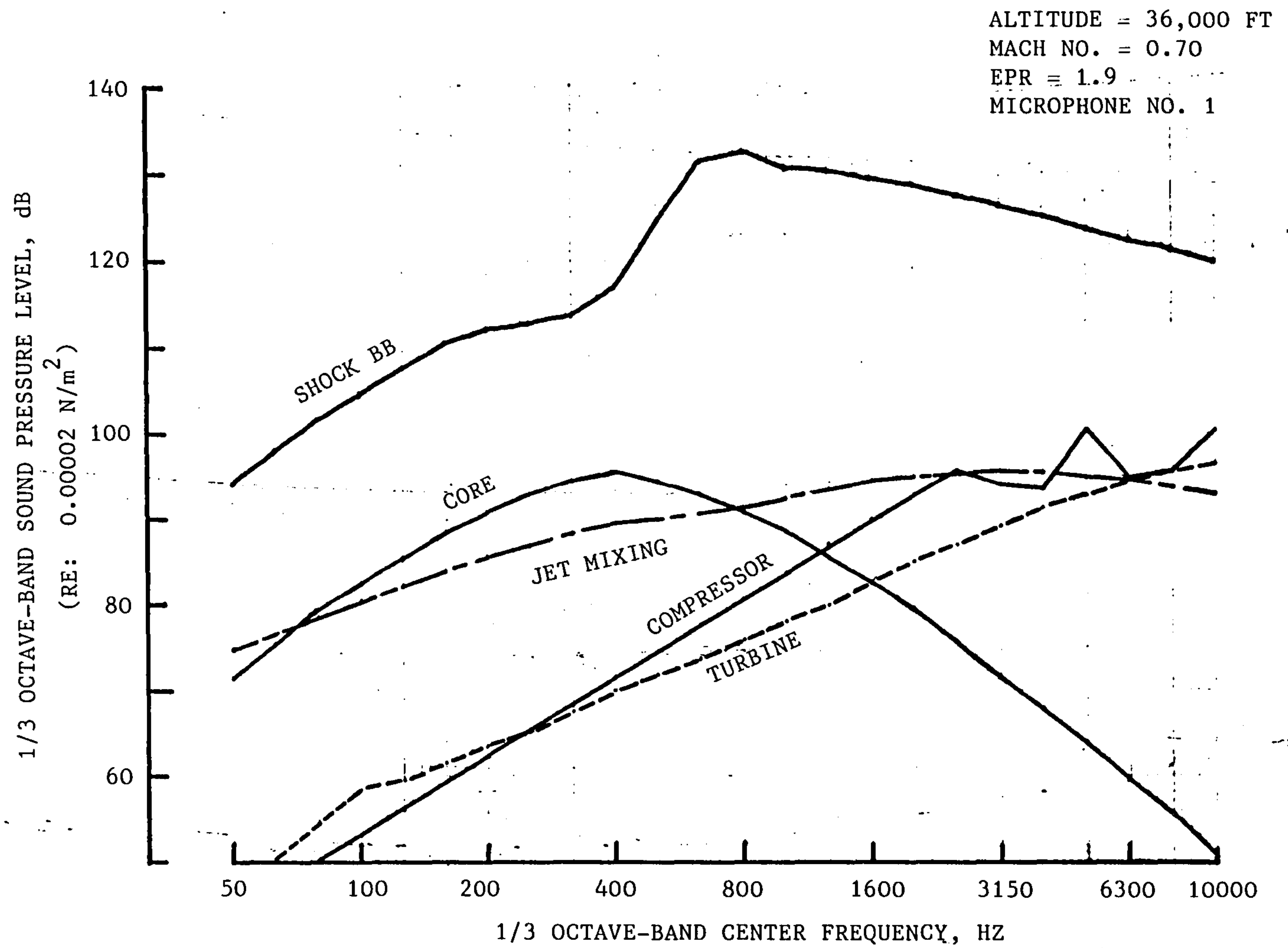

Figure 6. Noise source component breakdown for predicted JetStar noise at cruise conditions; corresponds to total predicted noise of Figure 5.

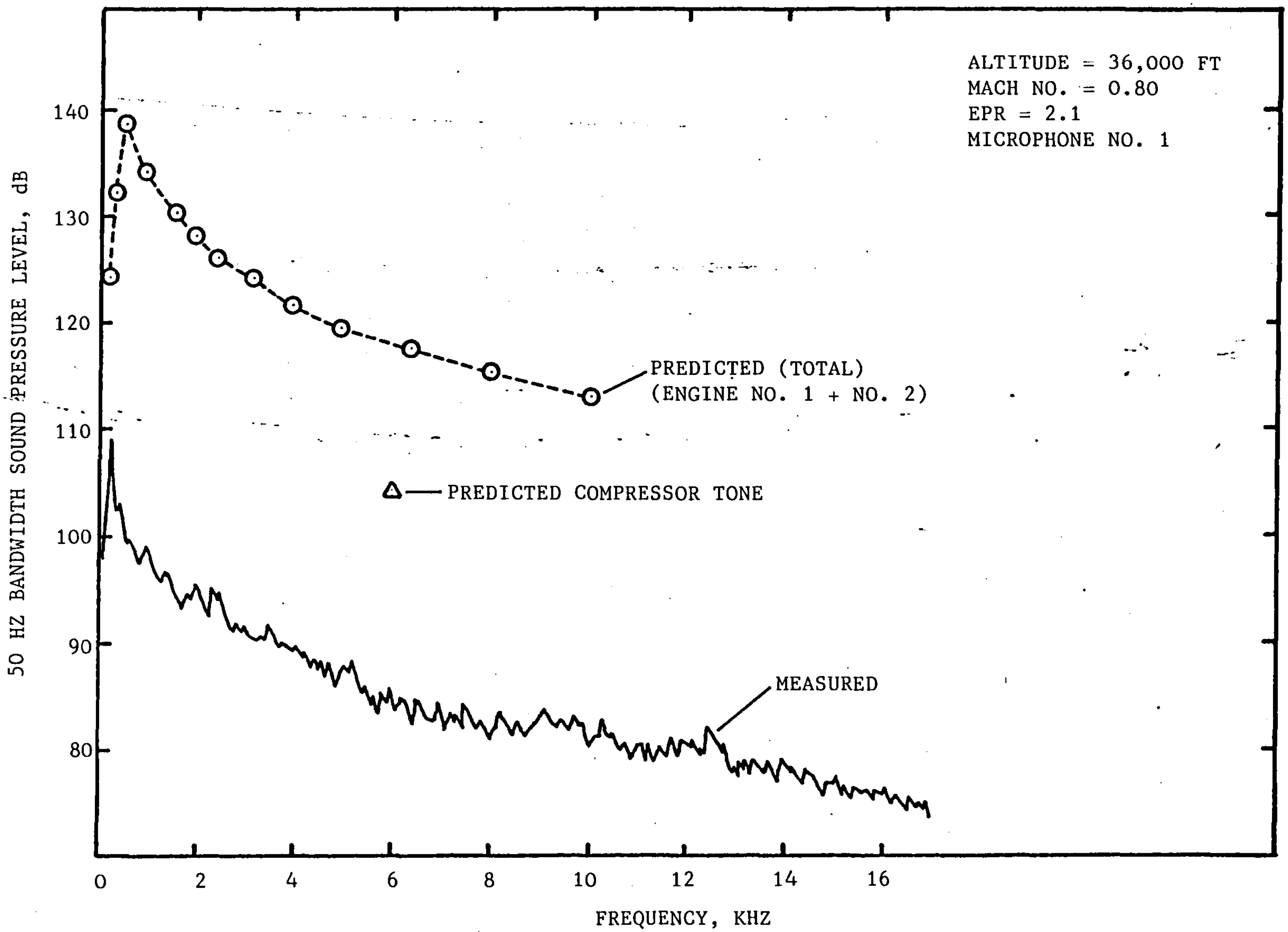

Figure 7. Comparison of measured and predicted noise levels for Lockheed JetStar at cruise conditions.

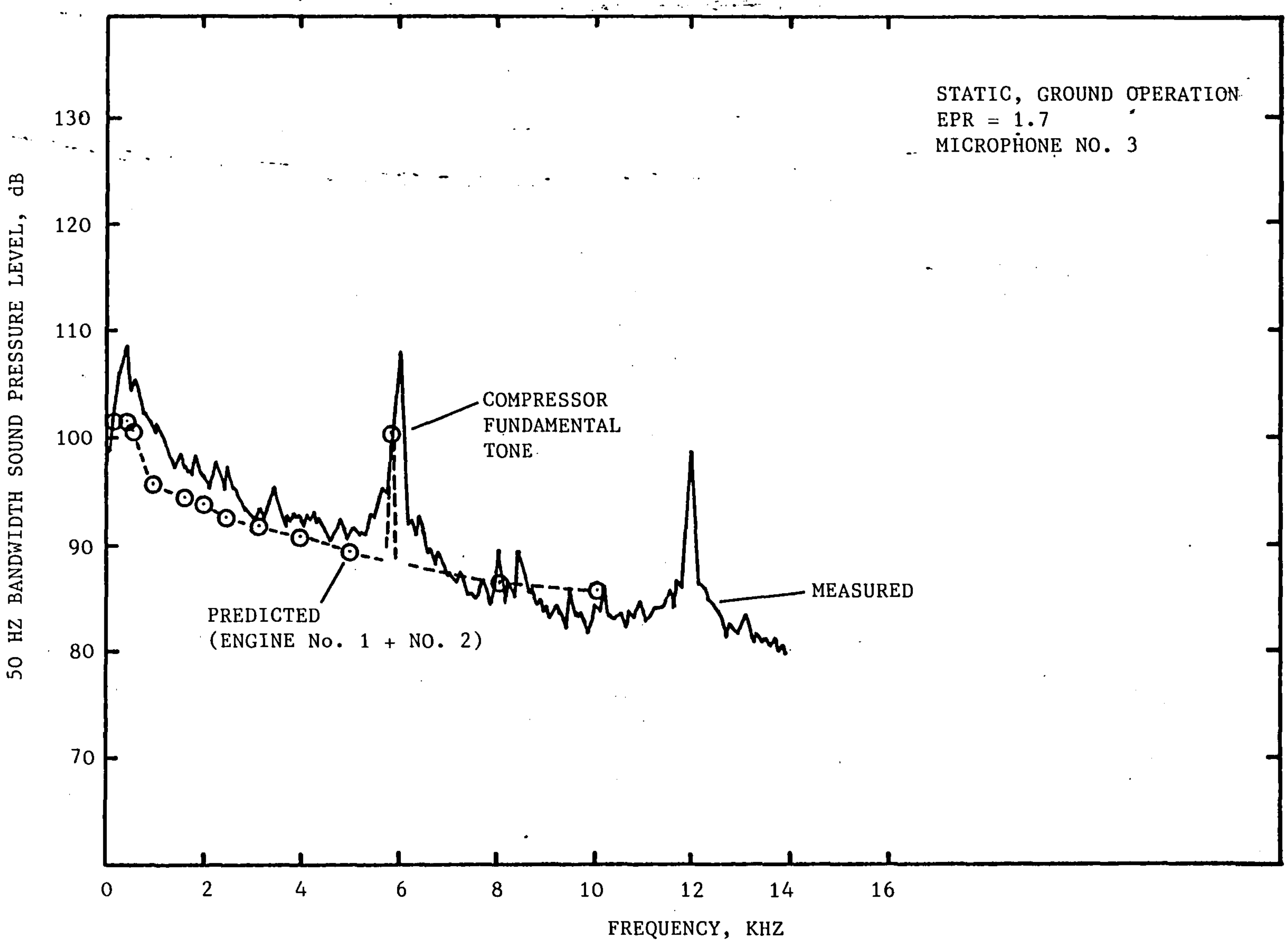

Figure 8. Comparison of measured and predicted noise levels for Lockheed JetStar during static, ground operation.

ALTITUDE = 36,000 FT

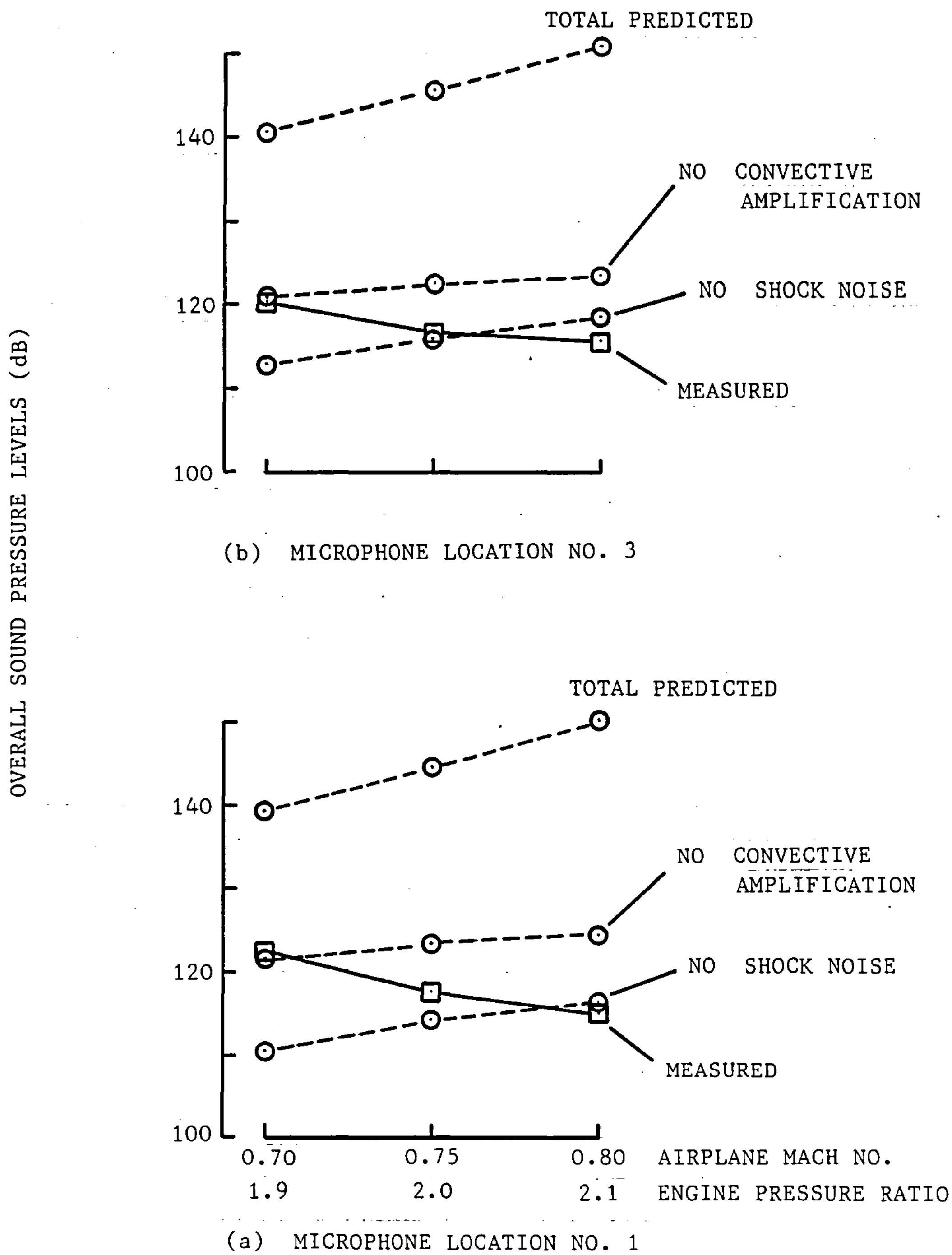

Figure 9. Effect of shock noise and convective amplification on noise comparisons.

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15. Supplementary Notes

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16. Abstract

A computer program for the prediction of aircraft near-field noise at cruise has been developed from existing technology. The prediction procedures employed are considered to be the best available from current and evolving technology. The program has been derived directly from the computational algorithms described in a companion volume, NASA CR-159105. Discussions of the prediction methods and their selection are presented in NASA CR-159104. The prediction program provides for the inclusion, at the user's option, of each noise source considered significant (particularly for the application of laminar flow control criteria).

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