AD-A094 298 GENERAL ELECTRIC CO CINCINNATI OH AIRCRAFT ENGINE GROUP F/G 20/1
HIGH VELOCITY JET NOISE SOURCE LOCATION AND REDUCTION. TASK 6. --ETC(U)
MAR 79 P R GLIEBE, R E MOTSINGER, A SIECKMAN DOT-OS-30034

UNCLASSIFIED R79AEG290 FAA-RD-76-79-6A NL

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PHOTOGRAPH THIS SHEET

AD A094298

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INVENTORY

GENERAL ELECTRIC CO CINCINNATI OHIO AIRCRAFT ENGINE GROUP
HIGH VELOCITY JET NOISE SOURCE LOCATION AND REDUCTION. TASK 6. SUPPLEMENT - COMPUTER PROGRAMS: ENGINEERING CORRELATION(M*S) JET NOISE PREDICATION METHOD and UNIFIED AEROACOUSTIC PREDICTION MODEL (M*G*B) FOR NOZZLES OF ARBITRARY SHAPE. FINAL REPT. MAR.'79 REPT NO. R79AEG290
CONTRACT DOT-OS-30034 FAA-RD-76-79-6A

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DTIC FORM OCT 79 70A

DOCUMENT PROCESSING SHEET

REPORT NO. FAA-RD-76-79, VIa

R79AEG290

HIGH VELOCITY JET NOISE SOURCE LOCATION AND REDUCTION

TASK 6 SUPPLEMENT - COMPUTER PROGRAMS: ENGINEERING CORRELATION (M*S) JET NOISE PREDICTION METHOD and UNIFIED AEROACOUSTIC PREDICTION MODEL (M*G*B) FOR NOZZLES OF ARBITRARY SHAPE

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MARCH 1979

FINAL REPORT

Document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22161.

Prepared for

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
Systems Research & Development Service
Washington, D.C. 20590

NOTICE

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FAA-RD-76-79, VIa		

4. Title and Subtitle
HIGH VELOCITY JET NOISE SOURCE LOCATION AND REDUCTION, TASK 6 SUPPLEMENT - Computer Programs: Engineering Correlation (M*S) Jet Noise Prediction Method and Unified Aeroacoustic Prediction Model (M*G*B) for Nozzles of Arbitrary Shape

5. Report Date
March 1979

6. Performing Organization Code

7. Author(s)
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8. Performing Organization Report No.
R79AEG290

9. Performing Organization Name and Address
General Electric Company
Group Advanced Engineering Division
Aircraft Engine Group
Cincinnati, Ohio 45215

10. Work Unit No.

11. Contract or Grant No.
DOT-OS-30034

12. Sponsoring Agency Name and Address
U.S. Department of Transportation
Federal Aviation Administration
Systems Research and Development Service
Washington, D.C. 20590

13. Type of Report and Period Covered
July 1973 - July 1978

14. Sponsoring Agency Code

15. Supplementary Notes This report is in partial fulfillment of the Subject Program. Related documents to be issued in the course of the program include Final Reports of the following tasks: Task 1 - Activation of Facilities and Validation of Source Location Techniques; Task 1 Supplement - Certification of the General Electric Jet Noise Anechoic Facility; Task 2 - Theoretical Developments and Basic Experiments; Task 2 Supplement - Computer Program for Calculating the Aeroacoustic Characteristics of Jets from Nozzles of Arbitrary Shape; Task 3 - Experimental Investigation of Suppression Principles; Task 4 - Development/Evaluation of Techniques for In-flight/Investigation; Task 5 - Investigation of In-Flight Aeroacoustic Effects; Task 6 - Noise Abatement Nozzle Design Guide. FAA Program Manager, Mr. R.S. Zuckerman

16. Abstract

This General Supplement Report documents two (2) Computerized Jet Noise Prediction Techniques: the Engineering Method (M*S) and the Unified Aeroacoustic Prediction Model (M*G*B). A complete description of the computer programs is provided, including examples of input preparation and output cases, plus a listing of the FORTRAN computer code.

The comprehensive, empirical, jet noise prediction method (M*S) has been developed by correlating extensive data from this program and available data from other published sources. The data were correlated by means of basic engineering principles and physical parameters. The resulting (M*S) prediction method includes unsuppressed conical nozzles; multitube and multichute single- and dual-flow suppressed nozzles; and multitube/multichute nozzles with hardwall and treated sectors.

A unified aerodynamic/acoustic prediction technique has also been developed (M*G*B) for assessing the noise characteristics of suppressor nozzles. The technique utilizes an extension of Reichardt's method so as to provide predictions of the jet plume flow field. The turbulent fluctuations in the mixing regions of the jet are assumed to be the primary source of noise generation, as in Classical Theories of Jet Noise. The alteration of the generated noise by the jet plume itself as it propagates through the jet to the farfield is modeled utilizing the high-frequency shielding theory based on Lilley's equation. These basic modeling elements have been coupled together in a discrete volume-element formulation. The individual volume elements are assumed to be uncorrelated with each other, so that the total contribution to the farfield is simply the sum of the individual volume element contributions.

The programs presented herein are primarily directed toward prediction of high-velocity jet noise (1500-2900 feet per second) for arbitrary nozzle shapes, including sound pressure level spectra at any observer location. Static as well as in-flight capability is included in both models, albeit the "flight" data base and subsequent verification are quite limited.

17. Key Words (Suggested by Author(s))
M*G*B, M*S
Jet Noise, Suppressors, Ejectors, Jet Flows, Turbulence, Acoustics, In-Flight Effects, Prediction Method(s).

18. Distribution Statement
Document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22161.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price*
		206	

* For sale by the National Technical Information Service, Springfield, Virginia 22151

NASA-C-168 (Rev. 6-71)

METRIC CONVERSION FACTORS

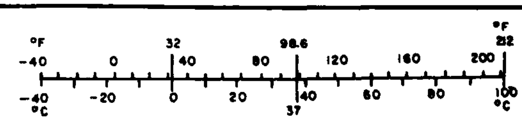
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



PREFACE

This report describes the work performed under the DOT/FAA High-Velocity Jet Noise Source Location and Reduction Program (Contract DOT-OS-30034).

- Investigation, including scaling effects, of the aerodynamic and acoustic mechanisms of various jet noise suppressors.
- Analytical and experimental studies of the acoustic source distribution in such suppressors, including identification of source location, nature, and strength and noise reduction potential.
- Investigation of in-flight effects on the aerodynamic and acoustic performance of these suppressors.

The results of these investigations led to the preparation of a design guide report for predicting the overall characteristics of suppressor concepts, from models to full scale, from static to in-flight conditions, as well as a quantitative and qualitative prediction of the phenomena involved.

The work effort in this program was organized under the following major Tasks, each of which is reported in a separate Final Report:

Task 1 - Activation of Facilities and Validation of Source Location Techniques.

Task 2 - Theoretical Developments and Basic Experiments.

Task 3 - Experimental Investigation of Suppression Principles.

Task 4 - Development and Evaluation of Techniques for In-Flight Investigation.

Task 5 - Investigation of In-Flight Aeroacoustic Effects on Suppressed Exhausts.

Task 6 - Preparation of Noise Abatement Nozzle Design Guide Report.

Task 1 was an investigative and survey effort designed to identify acoustic facilities and test methods best suited to jet noise studies.

Task 2 was a theoretical effort complemented by theory verification experiments which extended across the entire contract period of performance.

Task 3 represented a substantial contract effort to gather various test data on a wide range of high-velocity jet noise suppressors. These data, intended to help identify five optimum nozzles for in-flight testing in Task 5, provided an extensive high quality data bank useful to the preparation of the Task 6 design guide as well as for future studies.

Task 4 was similar to Task 1, except that it dealt with the specific test facility requirements, measurement techniques, and analytical methods necessary to evaluate the in-flight noise characteristics of simple and complex suppressor nozzles. This effort provided the capability to conduct the flight effects test program of Task 5.

Task 6 embodies the salient results of Task 2, 3, 4 and 5, and combines them with other contractor results into a noise abatement nozzle design guide which permits acoustic and performance prediction of future high-speed engine-suppressor installations.

The present volume, a supplement to the design guide, documents two jet noise prediction methods developed under the contract: the engineering correlation of (M*S) model and the unified aeroacoustic model (M*G*B) (each capable of accounting for flight effects). The objective of this report is to provide users with a description of the methods and associated computational procedures in sufficient detail that either method can be implemented and utilized as a useful engineering tool. The empirical M*S method is capable of predicting static and in-flight acoustic characteristics of multi-element suppressors applicable to both advanced turbojet and variable-cycle engines. The theoretically based M*G*B method is capable of predicting static and in-flight aerodynamic and acoustic characteristics of jets from nozzles of arbitrary shape, and as such provides more insight into the fundamental mechanisms involved in a given configuration's noise signature.

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1.0 SUMMARY

This supplement to the Task 6, Noise Abatement Nozzle Design Guide documents two computerized jet noise prediction techniques: the engineering correlation method, and the unified aeroacoustic prediction model. A complete description of the computer programs are provided, including examples of input preparation and output cases, plus a listing of the FORTRAN computer code.

1.1 THE ENGINEERING CORRELATION (M*S) METHOD

A comprehensive, empirical, jet-noise-prediction method has been developed by correlating extensive data from this program with available data from other published sources. This engineering correlation prediction model has been designated as the M*S model (after the authors: Motsinger and Sieckman) for ease of reference, as well as to distinguish it from the more theoretical prediction model (M*G*B) developed by authors Mani, Gliebe and Balsa.

The data were correlated by means of basic engineering principles and physical parameters. The resulting M*S prediction methods includes unsuppressed conical nozzles; multitube and multichute, single and dual-flow, suppressed nozzles; and multitube/chute nozzles with hardwall and treated ejectors.

1.2 THE UNIFIED AEROACOUSTIC PREDICTION (M*G*B) METHOD

A unified aerodynamic/acoustic prediction technique has been developed for assessing the noise characteristics of suppressor nozzles. The technique utilizes an extension of Reichardt's method so as to provide predictions of the jet plume flow field (velocity, temperature and turbulence intensity distributions). The turbulent fluctuations produced in the mixing regions of the jet are assumed to be the primary source of noise generation, as in the classical theories of jet noise. The altering of the generated noise by the jet plume itself as it propagates through the jet to the farfield observer (sound/flow interaction or fluid shielding) is modeled utilizing the high-frequency shielding theory based on Lilley's equation.

These basic modeling elements (flow field prediction, turbulent mixing noise generation, and sound/flow interaction) have been coupled together in a discrete volume-element formulation. The jet plume is divided into elemental volumes, each roughly the size of a representative turbulence correlation volume appropriate to that particular location in the plume. Each volume element is assigned its own characteristic frequency, spectrum, and acoustic intensity. The sound/flow interaction effects for each volume element are evaluated from the flow environment of the element. The individual volume elements are assumed to be uncorrelated with each other, so that the total contribution to the farfield is simply the sum of the individual volume element contributions.

The programs presented herein are primarily directed toward prediction of high-velocity jet noise (1500-2900 feet per second) for arbitrary nozzle shapes, including sound pressure level spectra at any observer location. Static as well as in-flight capability is included in both models; however, the flight data base and subsequent verifications are somewhat limited at the time of this program's conclusion.

2.0 INTRODUCTION

Many jet noise suppressor nozzles have been designed utilizing intuitive notions of how to suppress jet noise which have demonstrated substantial noise reduction, but often at the expense of considerable thrust loss as well as increased engine weight, manufacturing cost, and complexity. Seemingly minor changes in suppressor nozzle design, for the purpose of improving thrust performance, often result in substantial loss of noise suppression. It is therefore highly desirable to have available a quantitative prediction technique for estimating the aerodynamic flow field and acoustic characteristics of suppressor-type nozzle configurations, so that design and optimization studies can be made prior to construction and testing in order to minimize the time and cost of development. Ideally, any technique should be sensitive to the controllable design variables and contain a little empiricism as possible. When empiricism is necessary, it should be based more or less on physical characteristics (flow, acoustic propagation, etc.) engineering principles rather than on geometric parameters.

The computer programs included herein represent a conventional engineering correlation technique and a more theoretical approach derived from engineering principles. The design engineer can exercise either or both models, depending on the type of results required. The correlation method provides a preliminary design prediction of aerodynamic and acoustic performance; the theoretical M*G*B method provides a means of assessing the relative importance of various jet noise mechanisms.

Section 3.0 describes the computer program for the engineering correlation jet noise prediction method (M*S model); Section 4.0 presents the computer program for the unified aeroacoustic prediction method (M*G*B model).

3.0 ENGINEERING CORRELATION (M*S) JET NOISE PREDICTION COMPUTER PROGRAM

3.1 INTRODUCTION

This section documents the computer program for the prediction of jet noise by the engineering correlation method (M*S). The mathematical model appears in detail in Reference 1. A description of the computer program is provided herein including examples of input preparation and output cases, plus a listing of the FORTRAN computer code.

The computer program is written in FORTRAN Y language. It has been programmed for use on both the GE/Honeywell 6080 and the CDC 7600 computers.

The range of valid application of the program, the limiting assumptions, and documentation of the data base used for developing the correlation can be found in both the Task 3 (Reference 1) and Task 6 (Reference 2) reports.

3.2 PROGRAM NOMENCLATURE

Table 3-1 defines the FORTRAN symbols used in the program. The listing and descriptions of input variables are given in the Input Description section.

3.3 DESCRIPTION OF PROGRAM AND SUBROUTINES

Table 3-2 gives a description of the overall flow of the computer program including all routines used in each step. Figure 3-1 gives a detailed flow chart of the computer program logic. A description of the main program and each of the subroutines is given in the following paragraphs.

M*S Routine - This routine reads the input curves needed for the various prediction routines. Depending on nozzle type it reads the nozzle input, initializes variables, and computes flow parameters and flow and physical geometries. The computation of gamma (ratio of specific heats) involves an iteration using input temperature and pressure ratio. The output and use of prediction subroutines are controlled by this routine.

Following the preliminary calculations, control is routed through the multielement, conical, or dual-flow section of the program. In the multielement part, calculations are first made for the postmerged noise. The coefficients for the Potter and Crocker equation are set up, and, because it is a third-order equation (after simplification), a Newtonian convergence routine is used to determine the first root. Density and diameter are then calculated and a check is made for other possible roots. Static and total

Table 3-1. Definition of FORTRAN Symbols.

FORTRAN Symbol	Meaning	Related Subroutines
A	Ejector treatment parameters	MS, EJECTS
AA8, A8	Inner nozzle flow area	MS, SHKSUB
AJ	Acoustic angle, degrees	MS, SUB3, SUB5 EXTP, SHKSUB, EJECTS
AJA	Jet plume spreading angle, radians	
AJR	Acoustic angle, radians	MS, EXTP, EJECTS
ALT	Input altitude or arc distance	MS, EXTP
AN	Noy Weighting	PNLPT
AN1	Number of elements	MS
ASK	Intermediate variable	PNTT8
A0	Ambient speed of sound	MS, SUB1 SHKSUB, PNTT8
A1	Intermediate variable	MS, EJECTS
A1	Ratio of merged to exit area	MS
A2	Ratio of merged to exit area	EJECTS
A3	Single-flow nozzle total exit area	MS
A3	Intermediate variable	EJECTS
A4	Intermediate variable	MS
A4	Ejector treatment PWL Insertion loss	EJECTS
A5	Area of multielement merged stream	MS
A5	Ejector treatment SPL insertion loss at given acoustic angle	EJECTS
A6	Ratio of ejector inlet area to nozzle total area	MS, EJECTS
A7	Multielement nozzle area ratio	MS
A9	Outer nozzle flow area	MS
B	Shock strength parameter, β	SHKSUB
B1	Intermediate variable	EXTP
B2	Intermediate variable	EXTP
B3	Intermediate variable	EXTP
B8	Tube or chute/spoke cant angle, radians	MS
B9	Tube or chute/spoke cant angle, degrees	MS
C	Normalized OASPL jet mixing noise curve-fit coefficients	MS, SUB1
CJ	Ten dB down value for EPNL	PNTT8
CMAX	Intermediate tone correction	TPNLC
C1	Jet mixing noise OASPL corrections	MS, SUB1
C1J	Intermediate variable	EXTP, SHKSUB
C2	Jet mixing noise relative velocity exponents	MS, SUB1
C3	Inner stream specific heat	MS
C4	Outer stream specific heat	MS
C9	Local speed of sound	MS, SHKSUB

Table 3-1. Definition of FORTRAN Symbols (Continued).

FORTRAN Symbol	Meaning	Related Subroutines
D	Intermediate variable	MS, PNTT8
DE	Hard-wall ejector reference effect at θ_T	EJECTS
DEK	Flight Effect at 90° on Shock Cell Noise	SHKSUB
DEN	Density correction $(\rho_j/\rho_o)^\omega$	SUB1
DIS	Intermediate variable	EXTP
DJ	Characteristic element dimension	MS
DN	Nozzle outer diameter	MS
DOP	Doppler Factor	EXTP
DT	Tube diameter	MS
DUM	Intermediate variable	SUB1
D0	Shock-noise normalization parameter	SHKSUB
D1	Reference far-field distance	MS, EXTP, SHKSUB
D2	Hard-wall ejector reference effect	EJECTS
D3	Ejector radius or diameter	EJECTS
D4	Equivalent area diameter	MS, EJECTS
D5	Merged flow diameter	MS
D7	Initial time for EPNL	PNTT8
D8	Nozzle characteristic dimension for shock noise	MS, SHKSUB
D9	Final time for EPNL	PNTT8
E	Jet mixing noise spectral distribution at θ	SUB1
E	Intermediate Variable	EXTP
E1	Ejector effect	EJECTS
E3	EPNL	PNTT8
E9	EGA indicator	MS, EXTP, PNTT8
F	Center frequency	MS, EXTP, SHKSUB PNTT8, EJECTS
F	Intermediate variable	TPNLC
FP	Peak frequency	EJECTS
F0	Critical frequency for effective number of elements	MS
F1	Intermediate variable	MS, SHKSUB
F2	Intermediate variable	MS, SHKSUB
F3	Intermediate variable	SHKSUB
G	Shock-cell noise prediction input curve	MS, SHKSUB
GJ	Critical refraction angle indicator	MS
G1	Intermediate variable	SHKSUB
G2	Outer stream ratio of specific heats, γ	MS
G3	EGA at output distance	EXTP
G8	Intermediate γ	MS
G9	Inner stream ratio of specific heats, γ	MS
H	Output sideline or arc distance	MS, EXTP, PNTT8
H1	Intermediate variable	SHKSUB
I	Index	MS, SUB1, SUB5, SUB4, SUB2, SUB6, EXTP, SHKSUB, TPNLC, PNTT8, EJECTS

Table 3-1. Definition of FORTRAN Symbols (Continued).

FORTRAN Symbol	Meaning	Related Subroutines
IDCASE	Case Description	MS
IDENT	Run Description	MS
IM	Intermediate variable	MS
IP	Intermediate variable	EJECTS
II	Indicator	TPNLC
IIAS	Noise component identification	MS, PNTT8
IICASE	Case Description	MS, PNTT8
IIP	Intermediate variable	MS
ISPLF	Intermediate variable	TPNLC
J	Index	All Subroutines
JJ	Index	PNTT8, EJECTS
K	Index	SUB1, SUB3
KK	Jet mixing noise spectral distribution curve-fit coefficients	MS, SUB1
KSTART	Index	SHKSUB
KT	Intermediate variable	PNTT8
K0	Intermediate variable	MS
K1	Extrapolation indicator	MS, SUB3
K2	Intermediate variable	MS
K6	Intermediate variable	SUB1, EJECTS
K7	Shock-noise case indicator	MS
K8	Index	SHKSUB, EJECTS
K9	Print Indicator	MS
L	PNL calculation coefficients	MS, PNLPT
L1	Output acoustic range	EXTP
L2	Reflected axial source location	EJECTS
L3	Ejector length	EJECTS
L8	Ejector length effect	EJECTS
L9	Ejector length to suppressor nozzle equivalent diameter	
M	Mach number	MS, EJECTS
MP	Maximum PNL	PNTT8
MM	Intermediate variable	MS
N	Number of elements in nozzle	MS
NFLT	Flight Effects Exponent Indicator	MS, SUB1
N1	Angle indicator	MS, SUB1
O	OASPL	SUB1, SUB3, PNTT8
OJ	Critical refraction angle	MS, EJECTS
O9	OAPWL	SUB5, SUB6, PNTT8
P	PNL	SUB3, PNTT8
PA	Air attenuation	EXTP
PJ	Intermediate variable	MS
PTCOR	Tone correction	TPNLC
PO	Ambient static pressure	MS

Table 3-1. Definition of FORTRAN Symbols (Continued).

FORTRAN Symbol	Meaning	Related Subroutines
PI	π (3.14159)	EXTP, SHKSUB
P3	Frequency	EXTP, EJECTS
P4	Inner nozzle total to ambient pressure ratio	MS
P5	Outer nozzle total to ambient pressure ratio	MS
P9	Nozzle total to ambient pressure ratio	MS
Q	Spherical spreading effect	EXTP
Q1	Intermediate variable	MS, PNTT8
Q2	Jet mixing noise normalization parameter	SUB1
R	Intermediate storage variable	SUB4, SUB6
RJ	Ambient density	MS, SUB1
RJ1	Intermediate variable	SUB1, PNTT8
RP	Centerbody plug radius	MS
RS, RR	Specific resistance	EJECTS
RVE	Flight Effects	SUB1
RX	Specific reactance	EJECTS
R1	Tube equivalent radius	MS
R2	Nozzle outer diameter	MS
R3	Inner flow density	MS
R4	Chute/spoke outer flow width	MS
R5	Outer flow density	MS
R6	Chute/spoke inner flow width	MS
R7	Outer nozzle duct height	MS, SUB1
R8	Outer nozzle radius ratio	MS
R9	Centerbody plug radius	MS
S	Predicted SPL	MS, SUB1, SUB3, SUB5, SUB4, SUB2, SUB6, SHKSUB, PNTT8
SBAR	Intermediate variable	TPNLC
SC	Intermediate variable	TPNLC
SJ	Intermediate variable	MS, PNTT8
SL	Input sideline distance	MS, EXTP
SP	Intermediate variable	TPNLC
SPL	Intermediate variable	TPNLC
SPLP	Intermediate variable	TPNLC
SPLPP	Intermediate variable	TPNLC
SS	Outer chute/spoke width	MS
SX	Source location	MS
S1	Shock-cell noise prediction input curves	MS, SHKSUB
S1J	Outer element spacing to characteristic diameter ratio	MS
S2J	Relative source strength	EJECTS

Table 3-1. Definition of FORTRAN Symbols (Continued).

FORTRAN Symbol	Meaning	Related Subroutines
S6	Nozzle outer radius	MS, EJECTS
T	Temperature	SUB1
T	PNL	SUB3
T	Flyover time	PNTT8
TC	Cutoff effect	MS
TC2	Intermediate variable	TPNLC
TC3	Intermediate variable	TPNLC
TJ	Intermediate variable	PNLPT, PNTT8
TT	Intermediate variable	PNTT8
TT3, T3	Nozzle total temperature	MS
TT4, T4	Inner nozzle total temperature	MS
TT5, T5	Outer nozzle total temperature	MS, SUB1
TZ	Initial time for EPNL	PNTT8
T0	Ambient temperature	MS, SUB1, PNTT8
T1	Intermediate variable	PNTT8, EJECTS
T2	Intermediate variable	MS
T8	Total temperature	MS, SUB1
U	Arc or sideline indicator	MS, EXTP, PNTT8
U3	Nozzle fully expanded velocity	MS
U5	Outer nozzle fully expanded velocity	MS
V	Intermediate variable	SUB3, PNLPT
VJ	Suppressor merged velocity	MS
V0	Aircraft velocity	MS, SUB1, SHKSUB, PNTT8
V1	Ratio of merged velocity to exit velocity	MS
V6	Intermediate variable	MS
V7	Intermediate variable	MS
V8	Fully expanded jet velocity input to jet mixing noise routine	MS, SUB1
V9	Fully expanded jet velocity input to shock-cell noise routine	MS, SHKSUB
W	Density exponent curve-fit coefficients	MS, SUB1
WE	Density exponent	SUB1
WJ	Intermediate variable	SUB1, PNTT8
W4	Inner stream weight flow	MS
W5	Outer stream weight flow	MS
W8	Weight flow	MS, SUB1
X	Source location	MS, EJECTS
X	SPL	SUB3, EXTP, PNLPT
XJ	Intermediate variable	SUB1, EJECTS
XM	Point of merging	MS
X0	Potter and Crocker equation coefficient	MS
X1	Potter and Crocker equation coefficient	MS
X2	Potter and Crocker equation coefficient	MS

Table 3-1. Definition of FORTRAN Symbols (Concluded).

FORTRAN Symbol	Meaning	Related Subroutines
X3	Potter and Crocker equation coefficient	MS
X4	Specific reactance	EJECTS
Y	PWL	SUB5, SUB4, SUB6, PNTT8
YJ	Intermediate variable	SUB5, EJECTS
Y1	Intermediate variable	MS, SUB4, SUB6
Y1J	Intermediate variable	MS
Y2	Intermediate variable	MS
Y9	Nozzle type indicator	MS, SUB1
ZI	Intermediate variable	SHKSUB
ZJ	Intermediate variable	EXTP, EJECTS
ZK	Intermediate variable	SHKSUB
ZZ	Effective number of elements effect	MS
Z1	Intermediate variable	SUB1, PNTT8
Z2	Intermediate variable	MS
Z3	Intermediate variable	MS, PNTT8
Z5	Number of rows of tubes	MS
Z8	Effective number of elements adder	MS
Z9	Total number of elements adder	MS
Z9	Constant	MS, SUB2

Table 3-2. Overall Flow of Program.

1. Read Input Curves (M*S).

2. Read Input and Calculate Flow Parameters for each Stream (M*S).

<u>The Following through 11 are used or Skipped as Necessary.</u>

3. Determine Postmerged Noise (M*S, SUB1, SUB5).

4. Determine Premerged Noise (M*S, SUB1).

5. Determine Premerged Cutoff and Shielding Effects (M*S).

6. Calculate Ejector Effects and Correct the Premerged Noise (M*S, EJECTS, SUB5).

7. Sum the Premerged and Postmerged Noise (SUB6).

8. Calculate Shock Noise for Outer Stream and Apply Cutoff, Shielding, and Ejector Effects (M*S, SHKSUB, EJECTS, SUB5).

9. Add to the Sum of Premerged and Postmerged (SUB6).

10. Calculate Shock Noise for Inner Stream (M*S, SHKSUB, SUB5).

11. Add to the Sum of Premerged and Postmerged and Outer Stream Shock (SUB6).

12. Extrapolate and Calculate OASPL, PNL and PNLT (this may be done after each Component is Calculated for Print Purposes) (SUB3).

13. Print Output and Calculate EPNL (PNTT8).

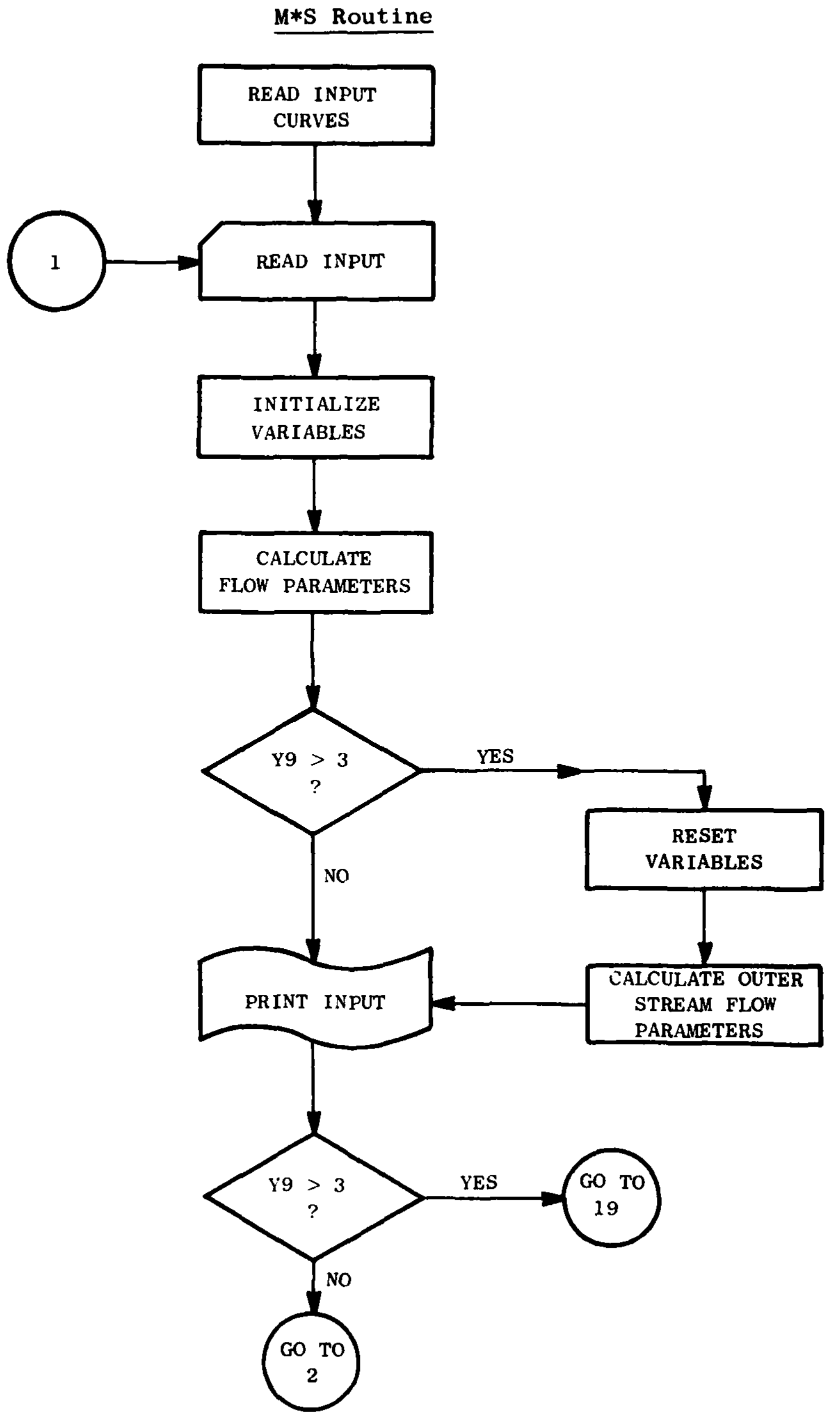


Figure 3-1. Computer Program Flow Chart.

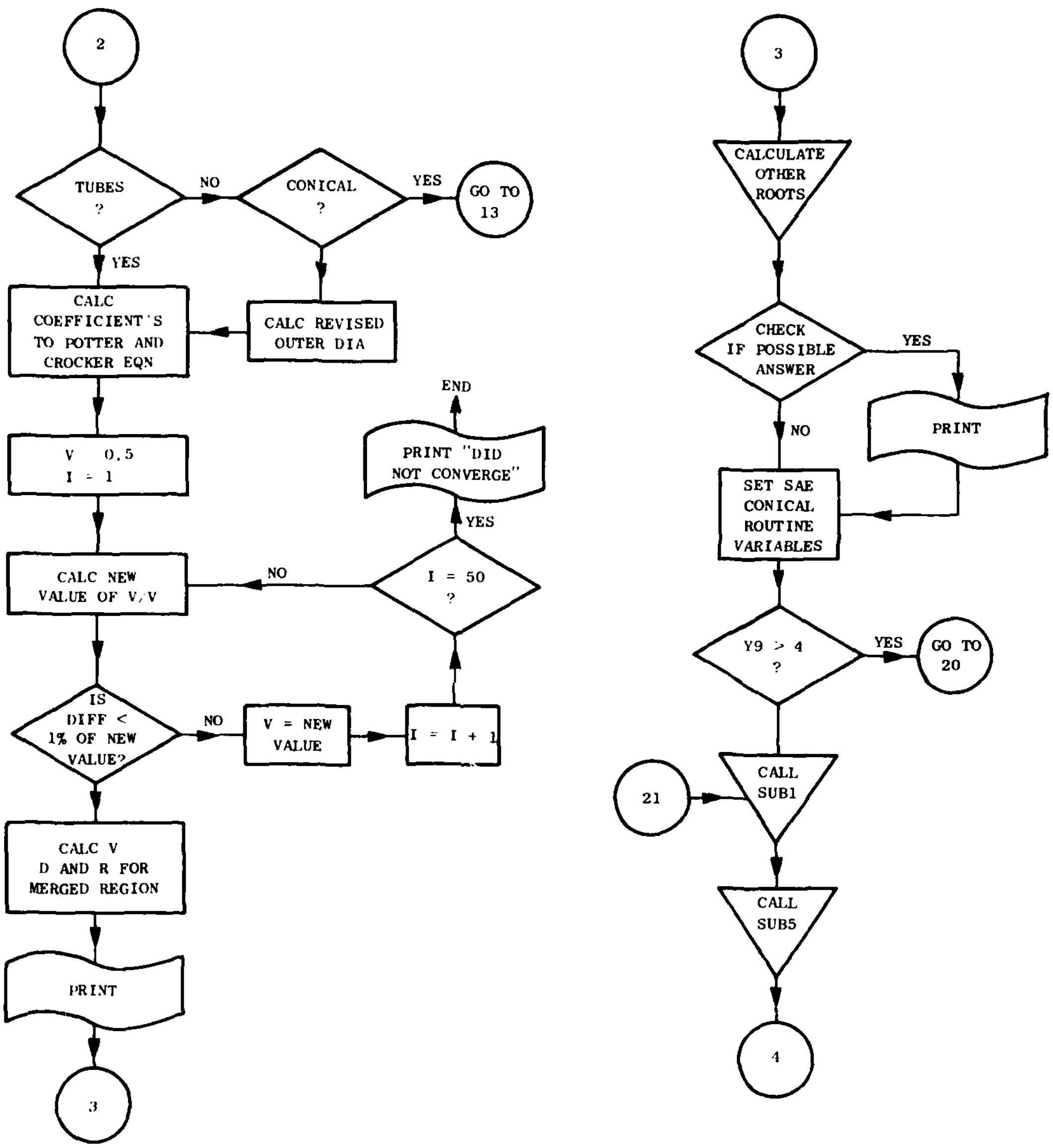


Figure 3-1. Computer Program Flow Chart (Continued).

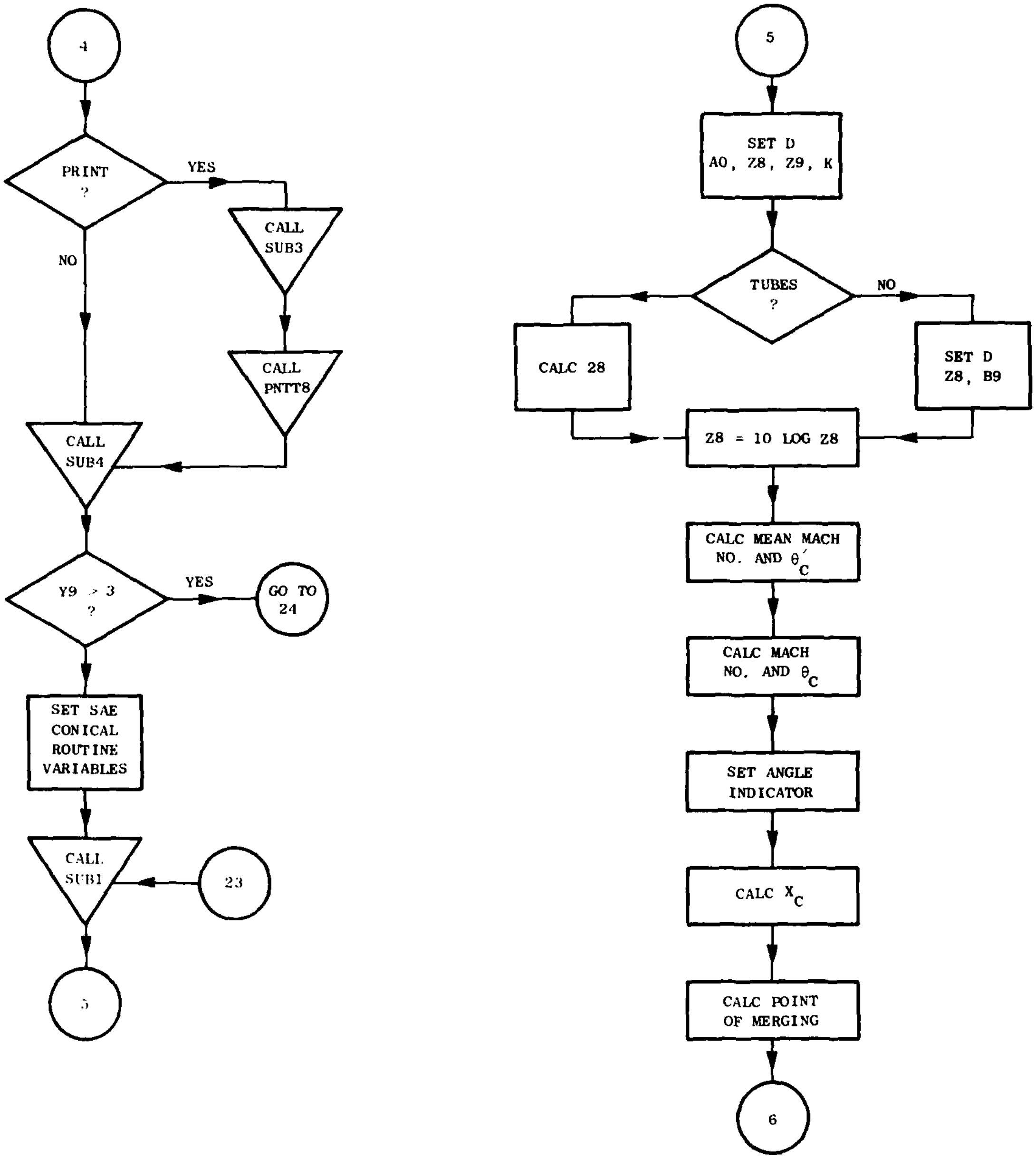


Figure 3-1. Computer Program Flow Chart (Continued).

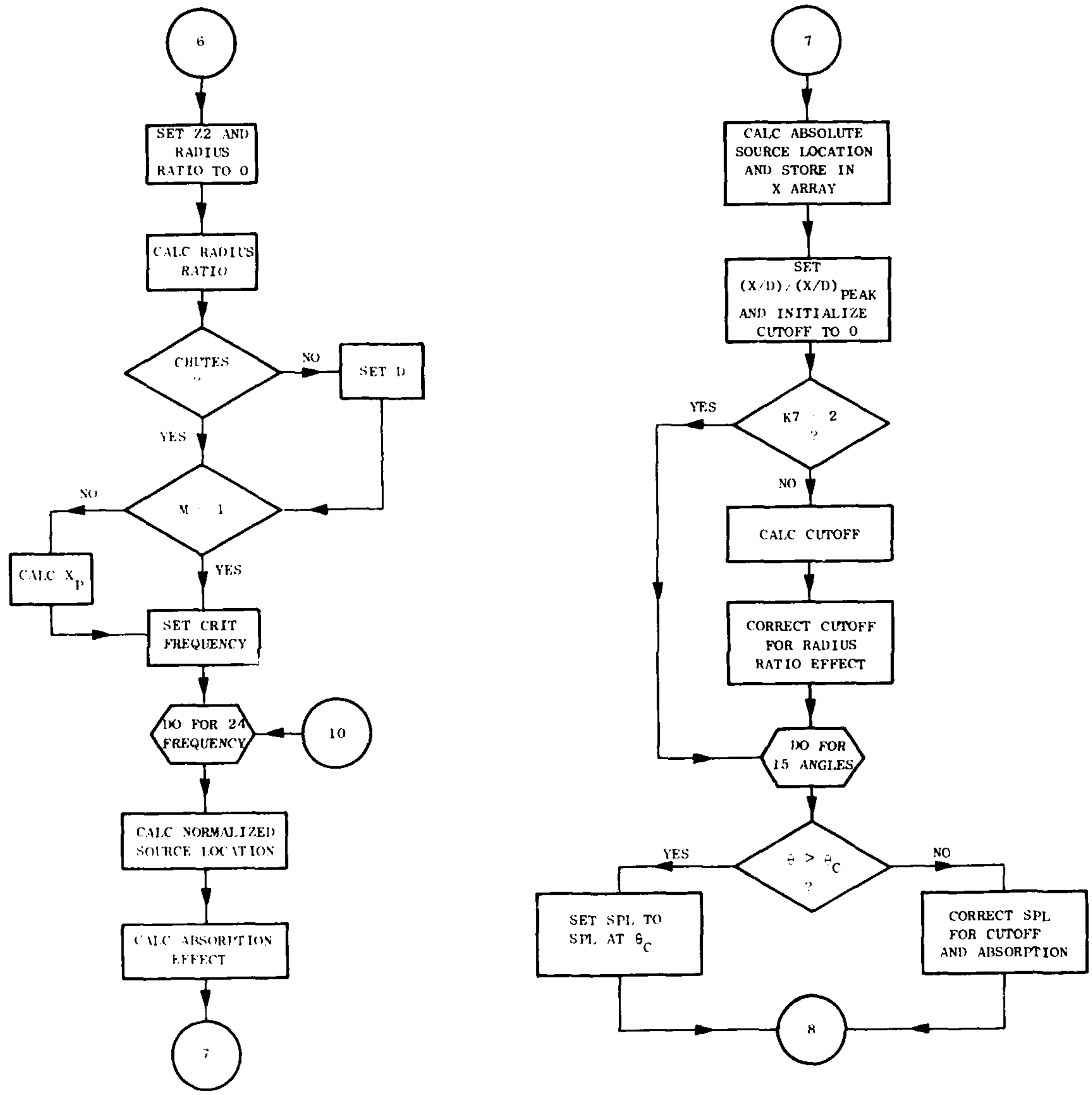


Figure 3-1. Computer Program Flow Chart (Continued).

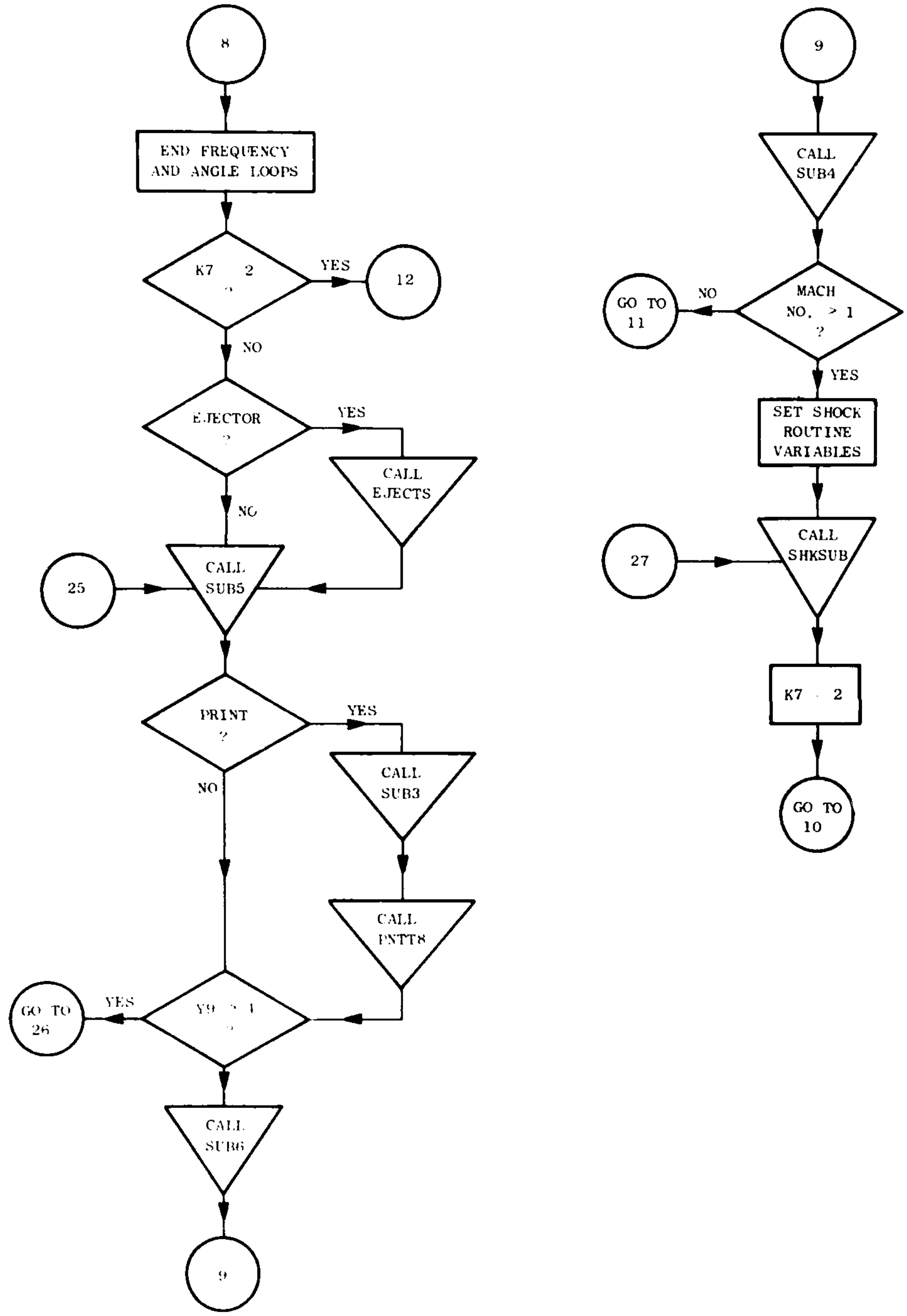


Figure 3-1. Computer Program Flow Chart (Continued).

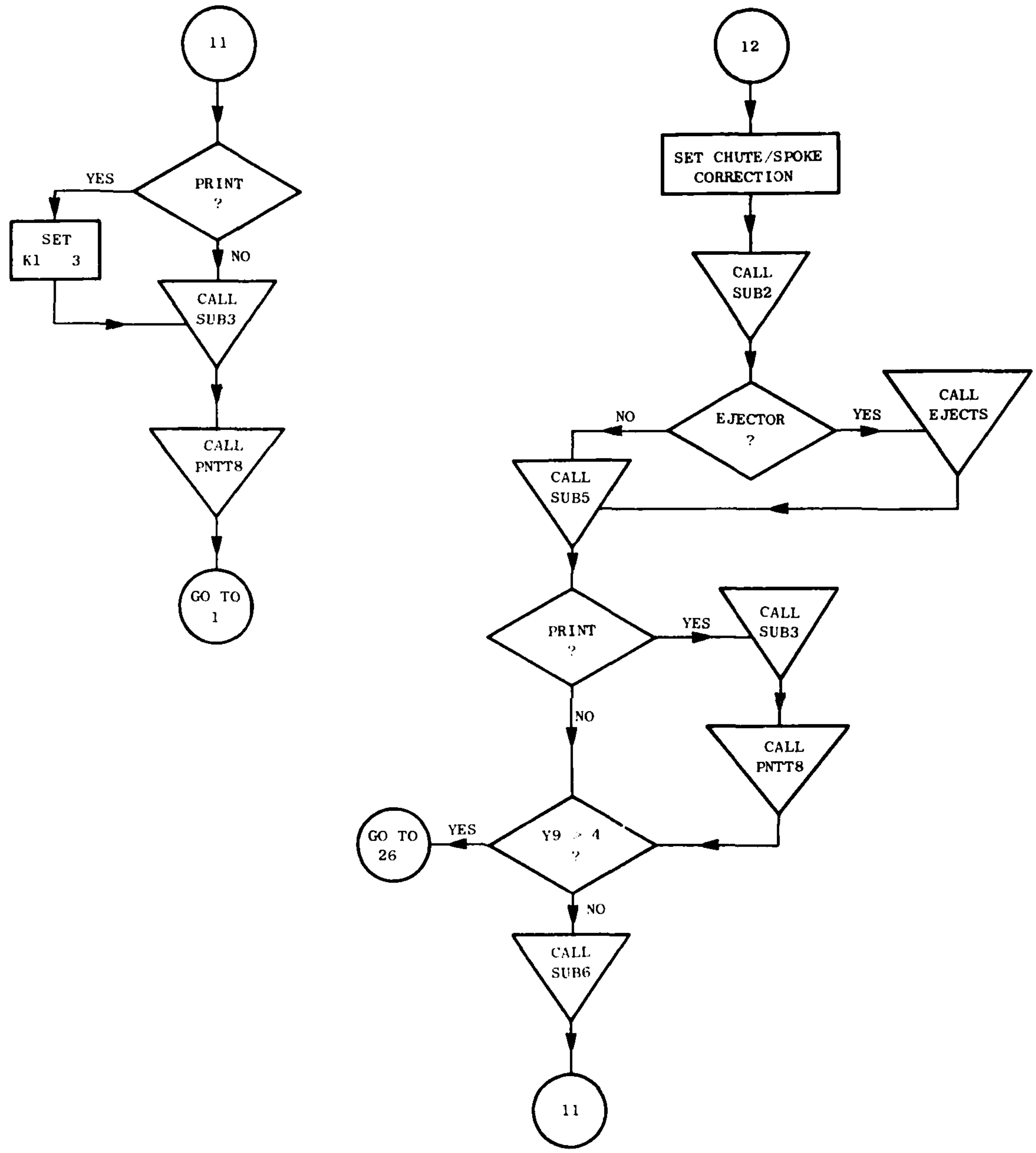


Figure 3-1. Computer Program Flow Chart (Continued).

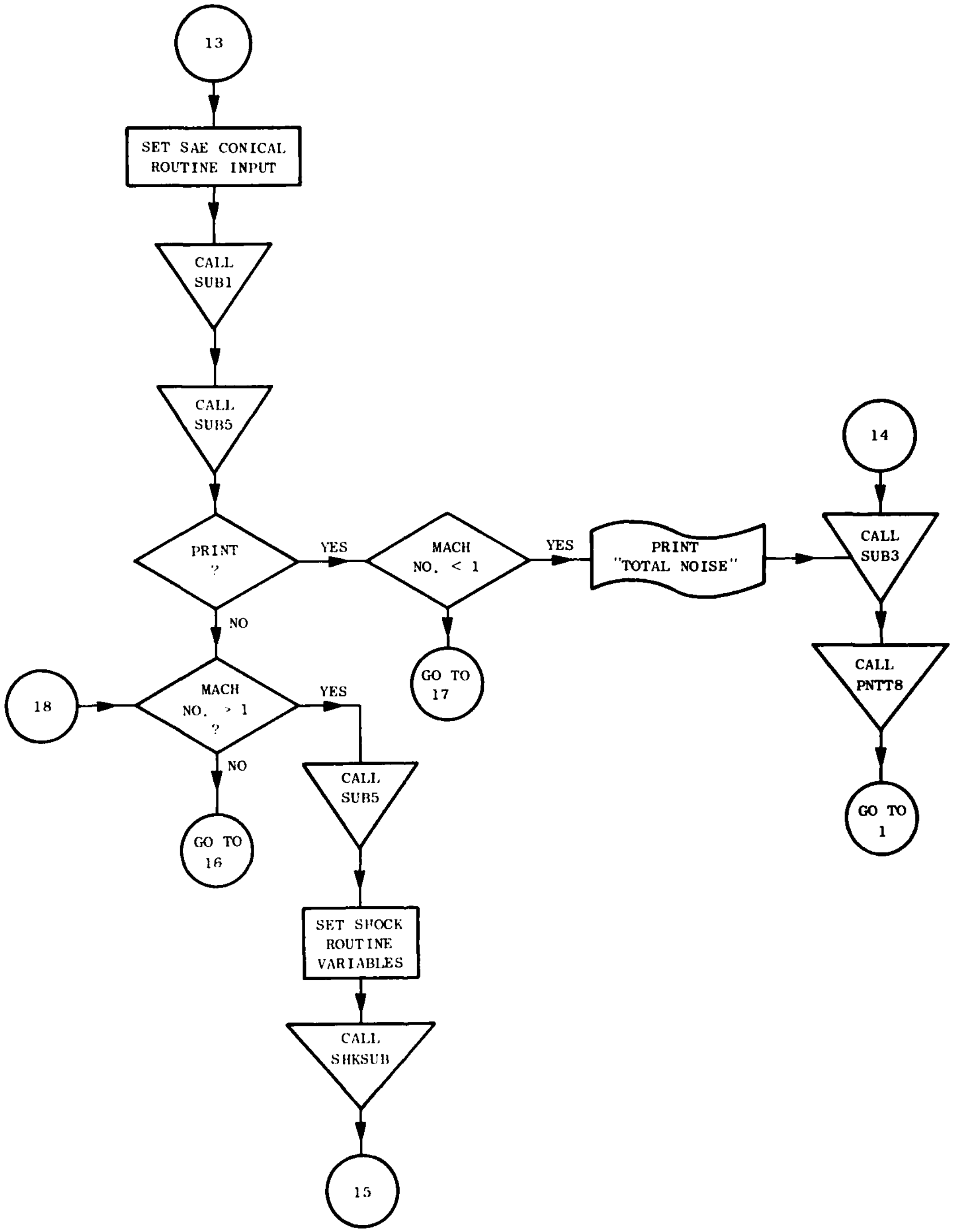


Figure 3-1. Computer Program Flow Chart (Continued).

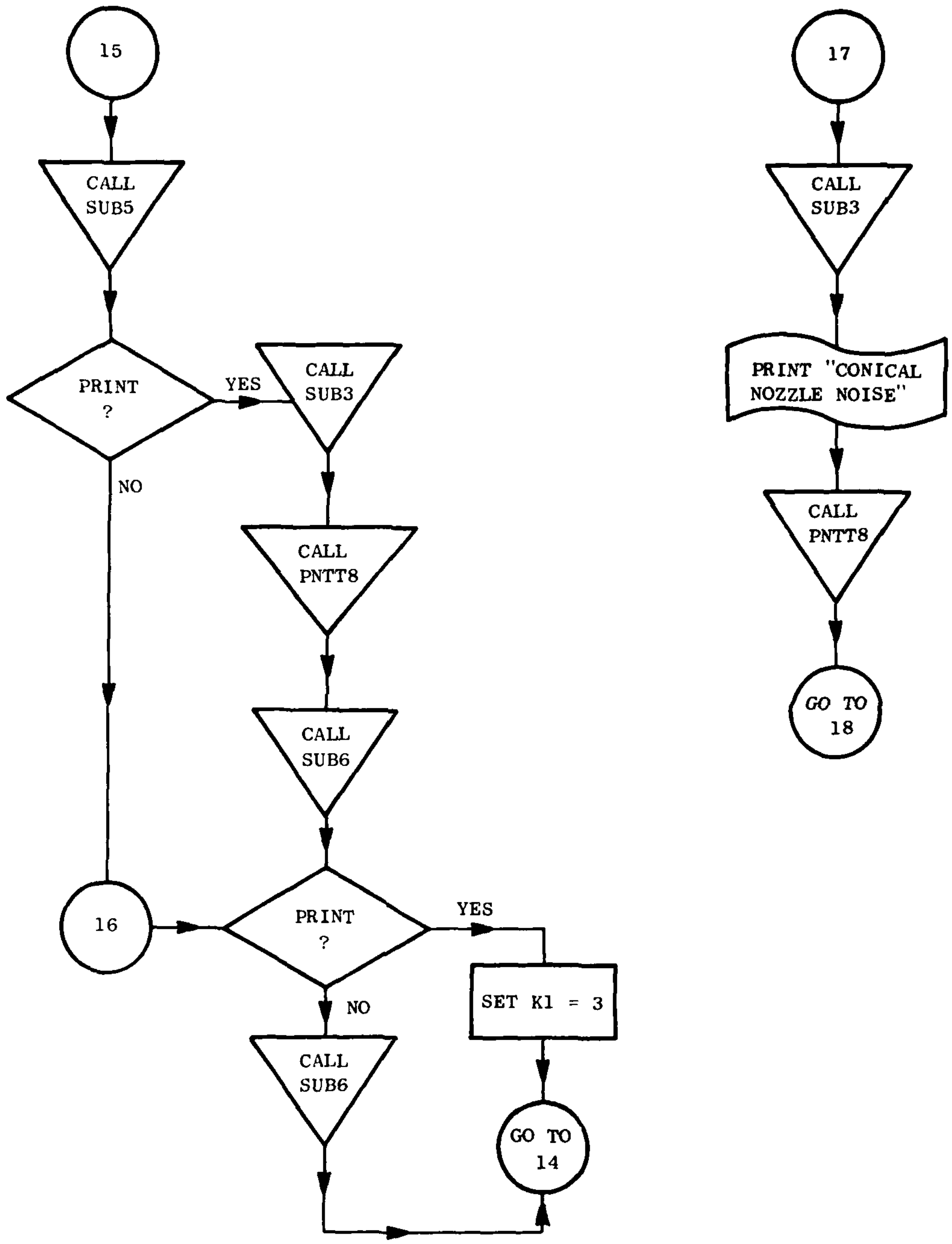


Figure 3-1. Computer Program Flow Chart (Continued).

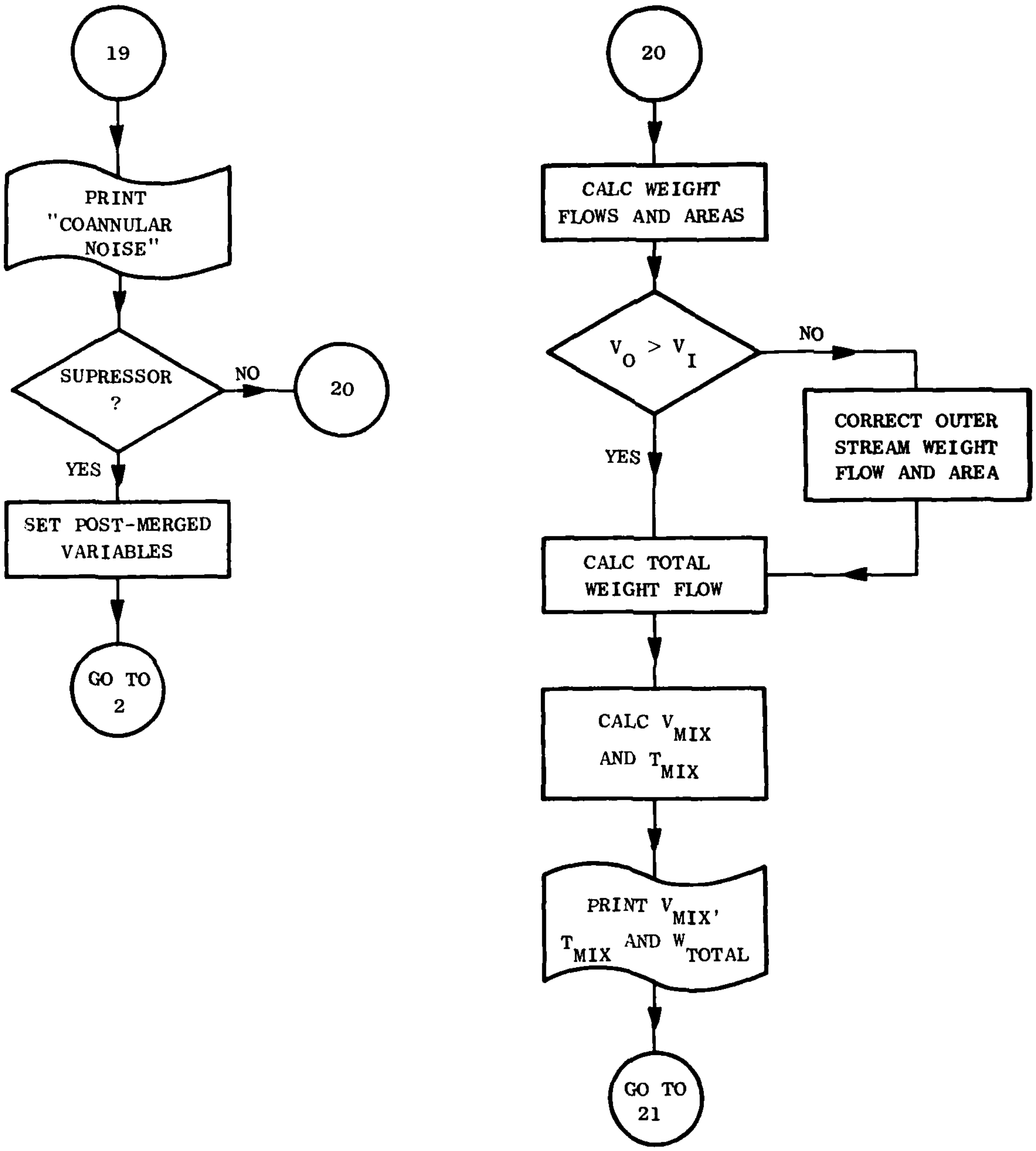


Figure 3-1. Computer Program Flow Chart (Continued).

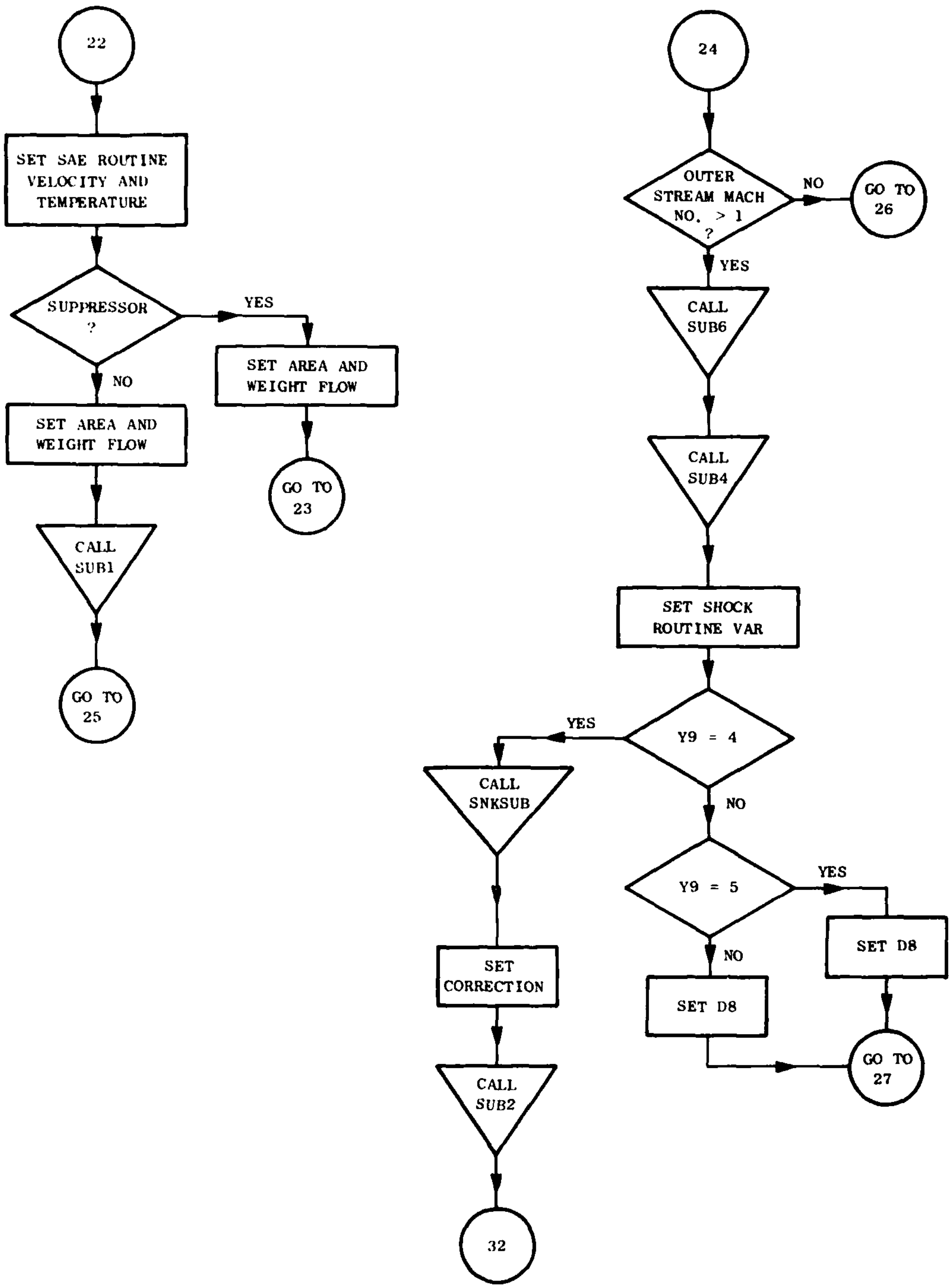


Figure 3-1. Computer Program Flow Chart (Continued).

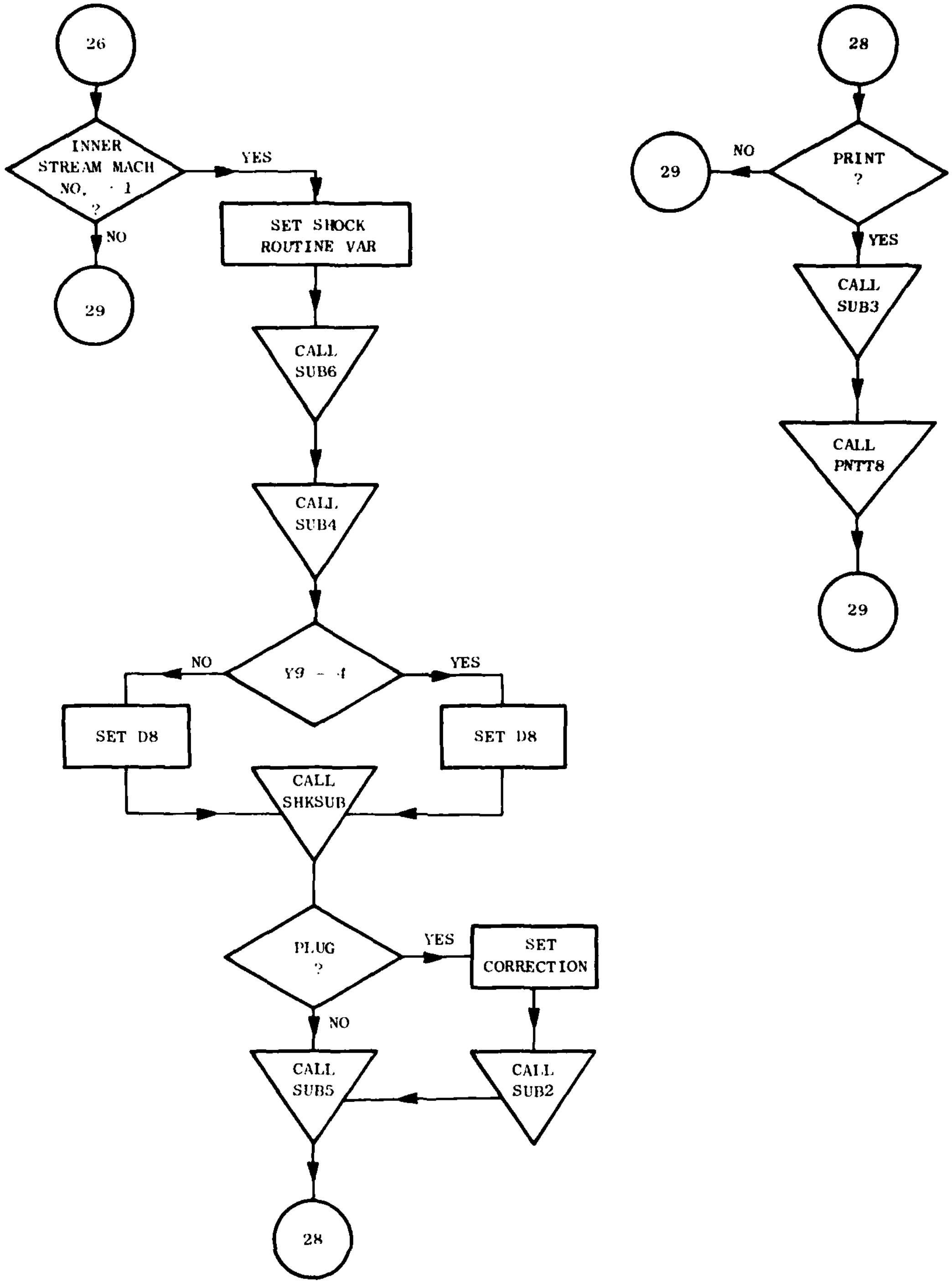


Figure 3-1. Computer Program Flow Chart (Continued).

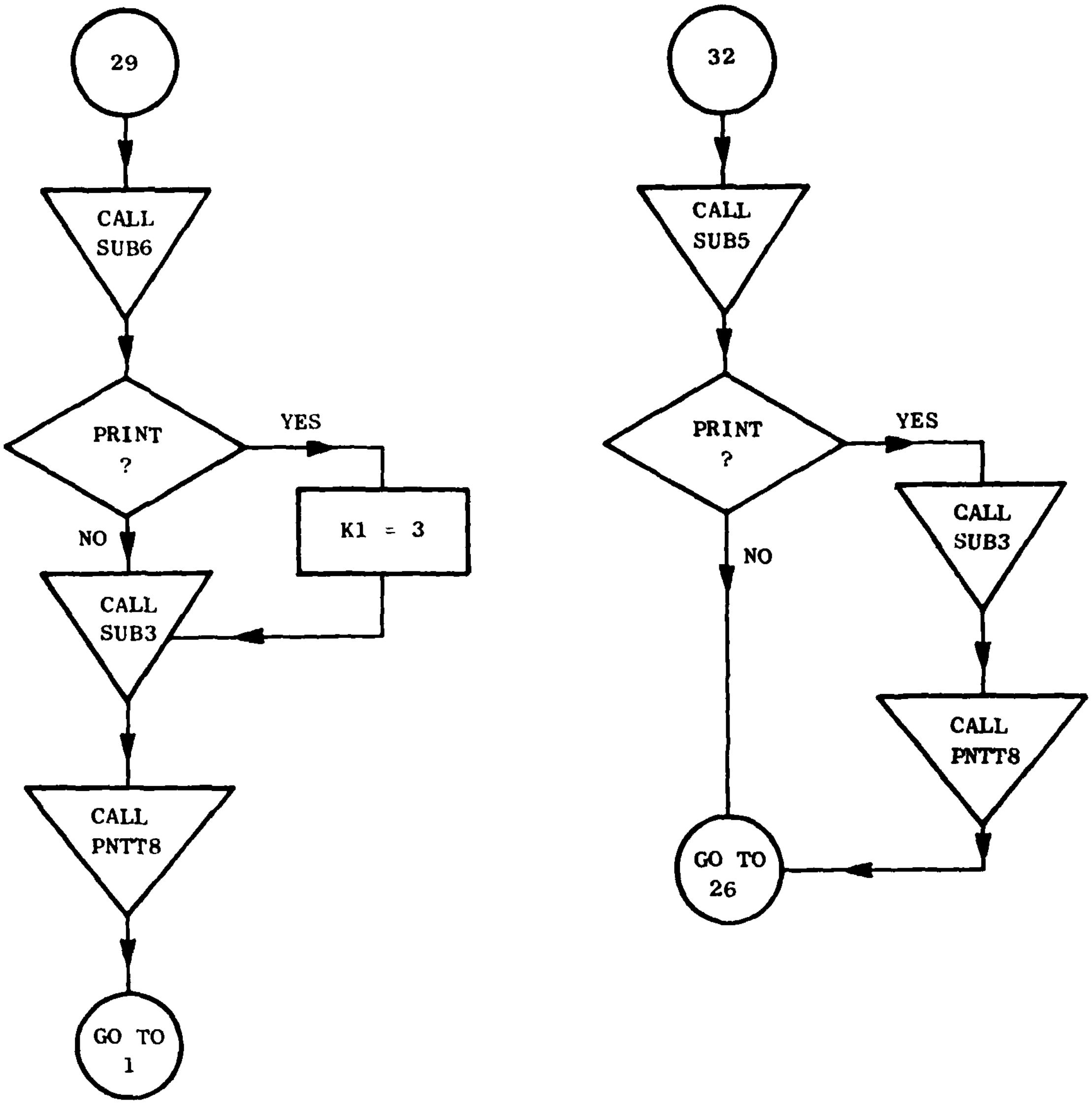


Figure 3-1. Computer Program Flowchart (Continued).

a) SUBROUTINE SUB1

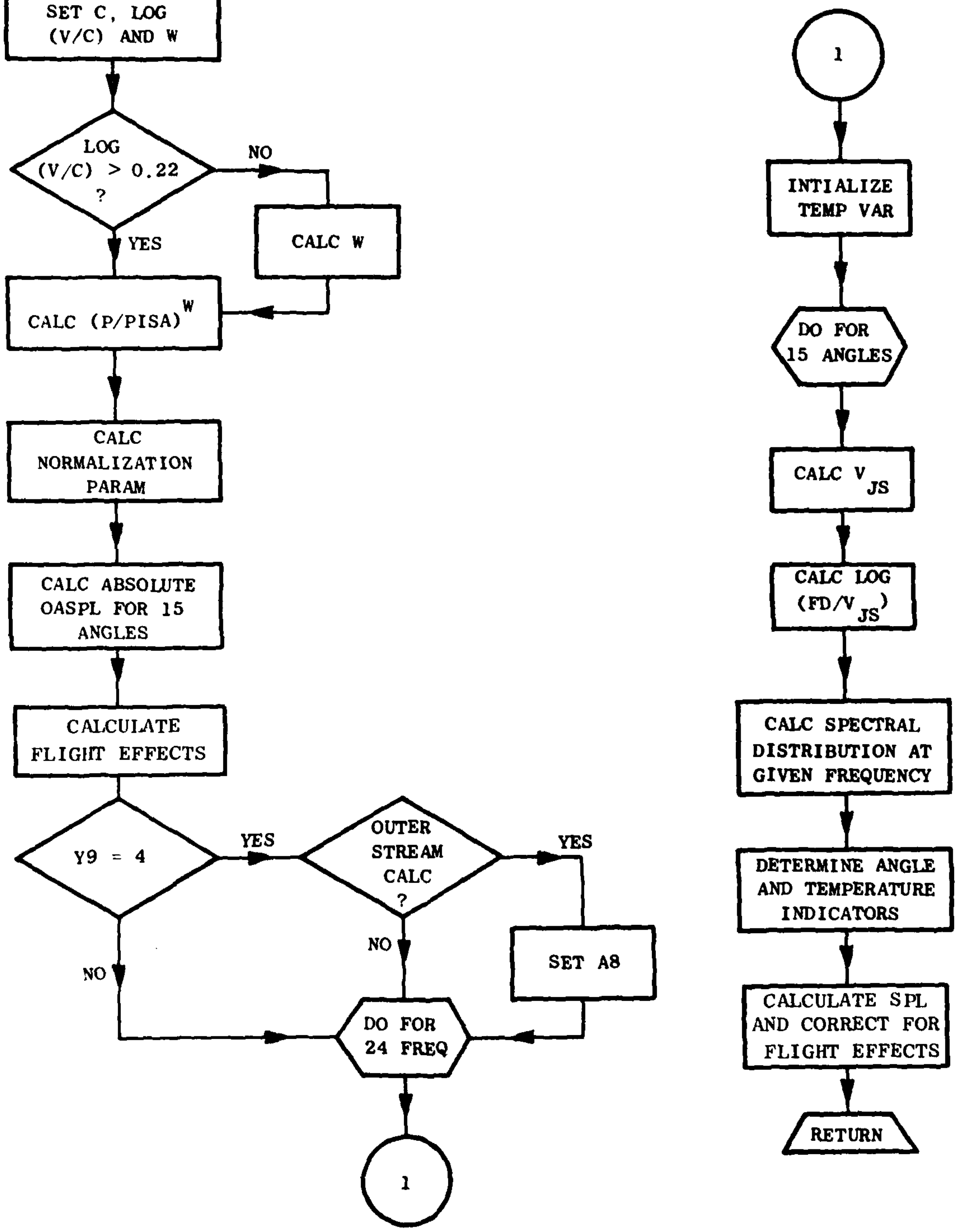


Figure 3-1. Computer Program Flow Chart (Continued).

b) SUBROUTINE SUB3

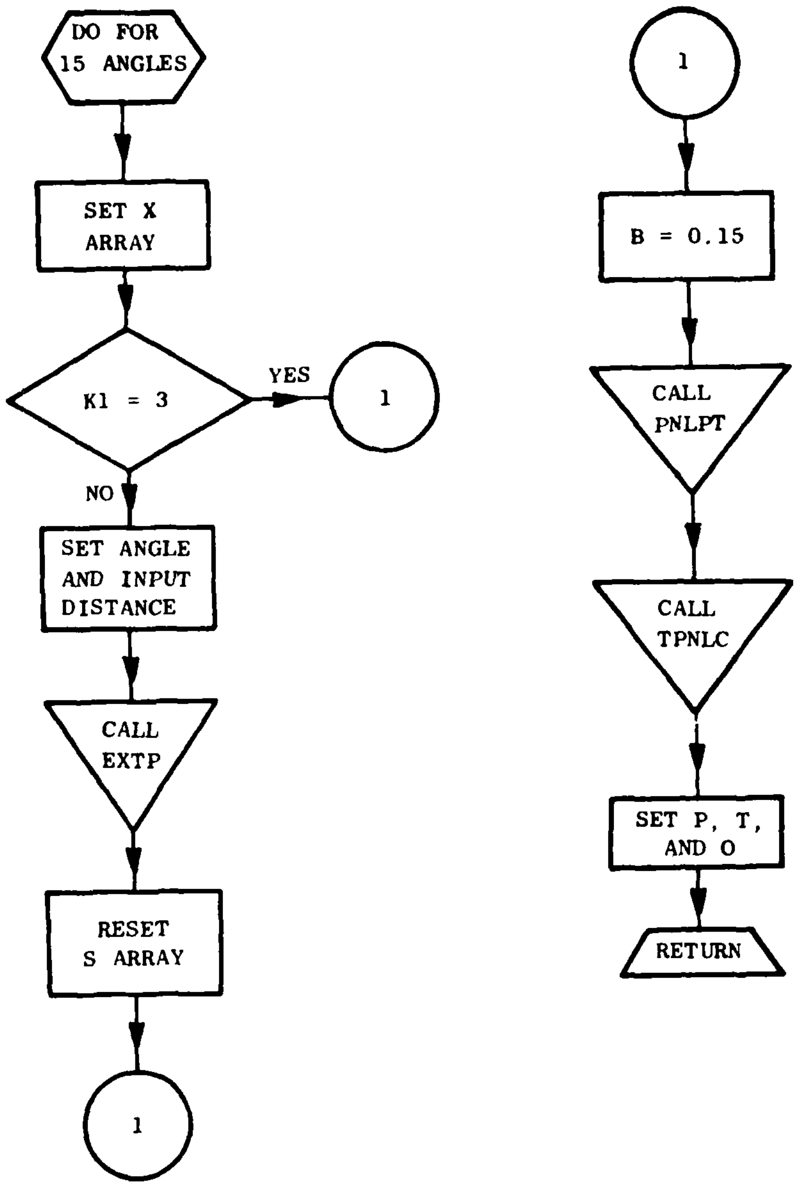


Figure 3-1. Computer Program Flowchart (Continued).

c) SUBROUTINE SUB5

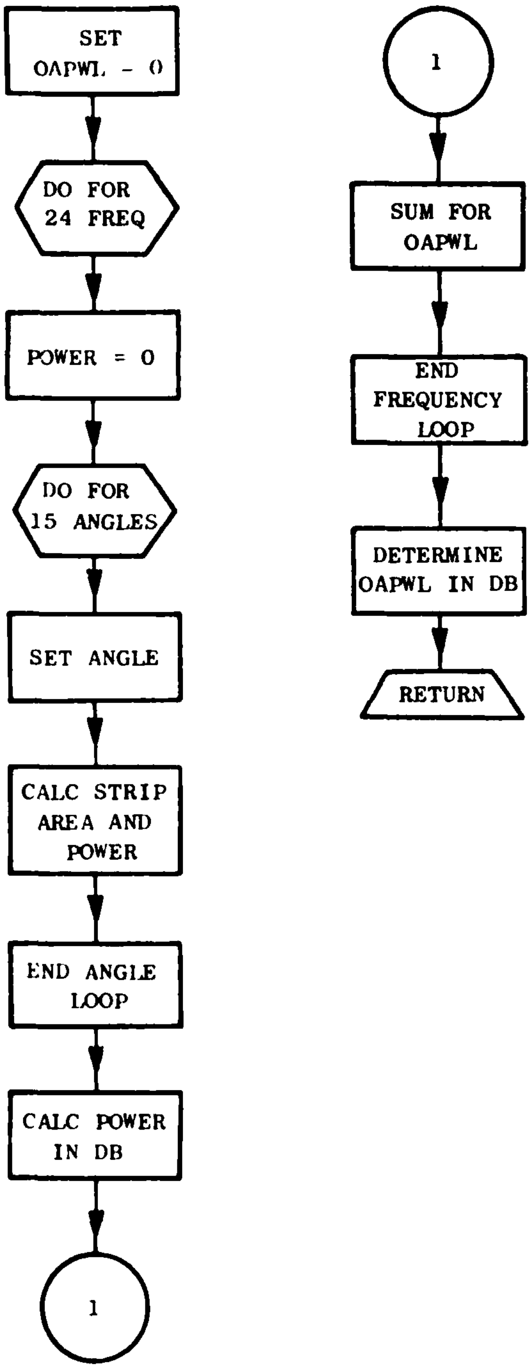


Figure 3-1. Computer Program Flowpath (Continued).

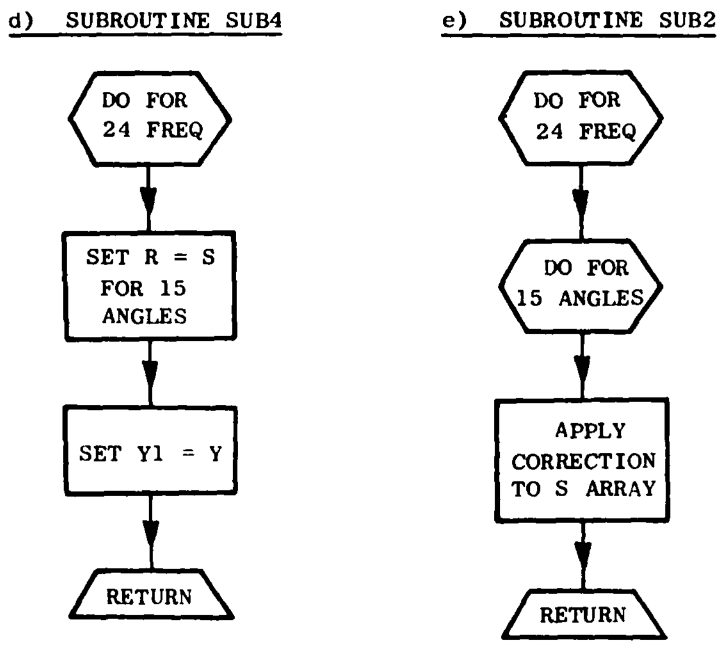


Figure 3-1. Computer Program Flowchart (Continued).

i) SUBROUTINE SUB6

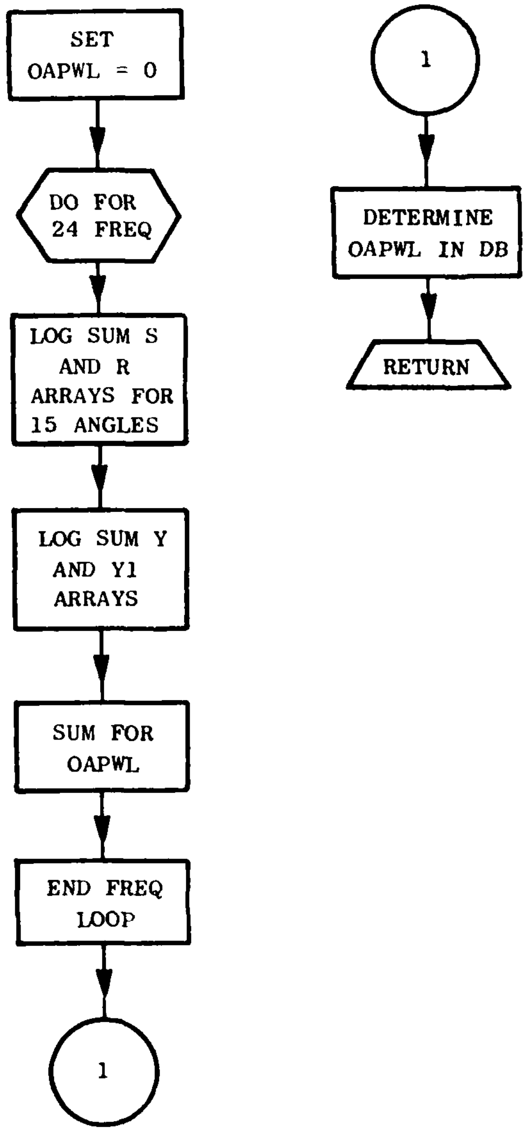


Figure 3-1. Computer Program Flowchart (Continued).

g) SUBROUTINE EXTP

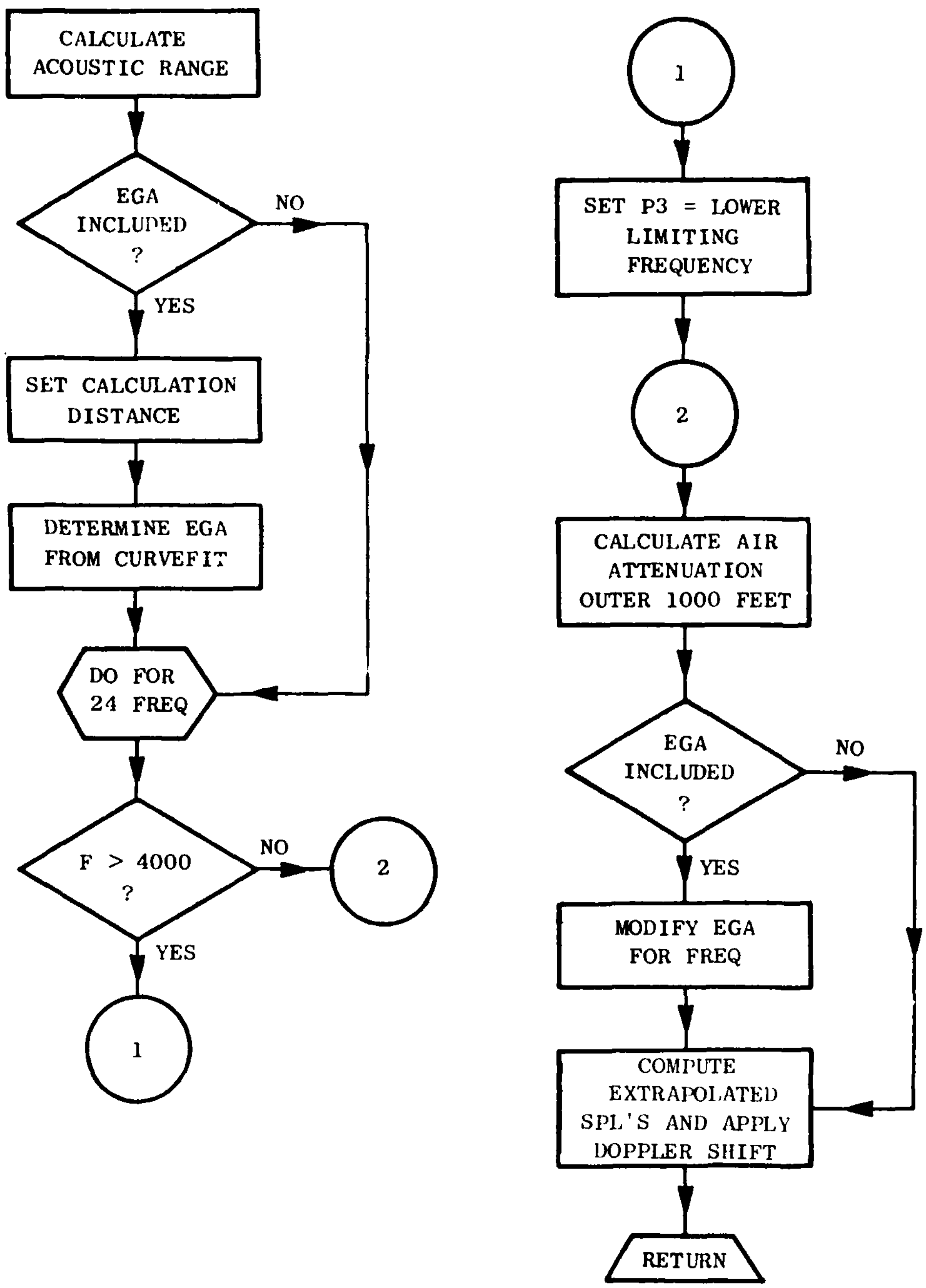


Figure 3-1. Computer Program Flowchart (Continued).

h) SUBROUTINE PNTT8

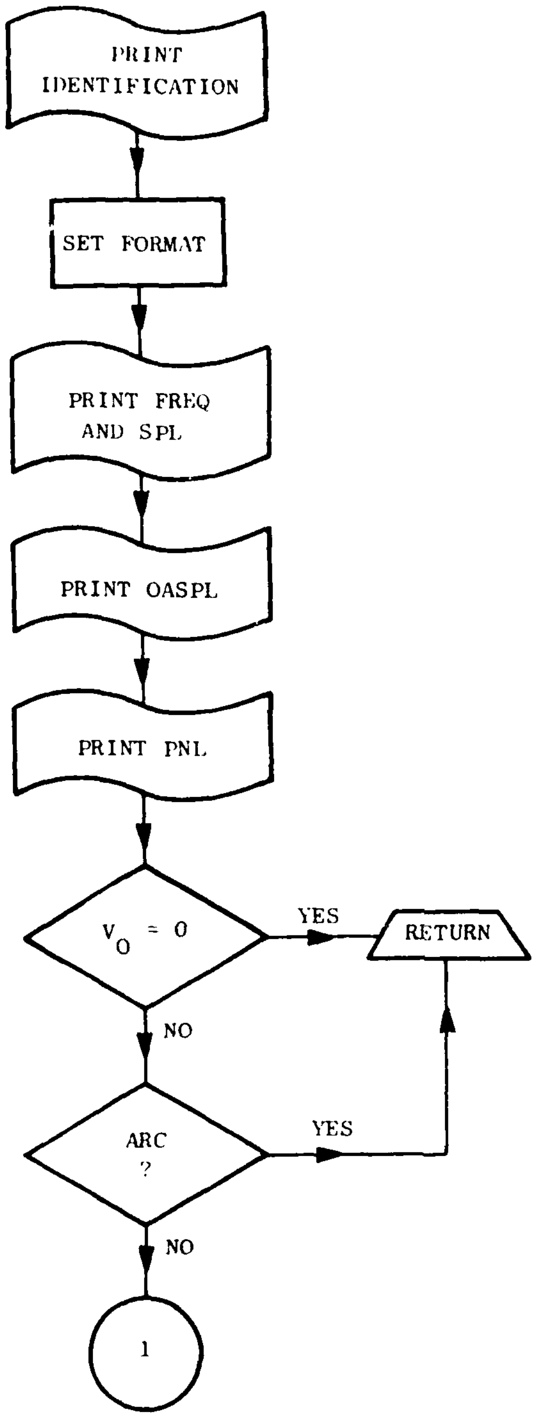


Figure 3-1. Computer Program Flowchart (Continued).

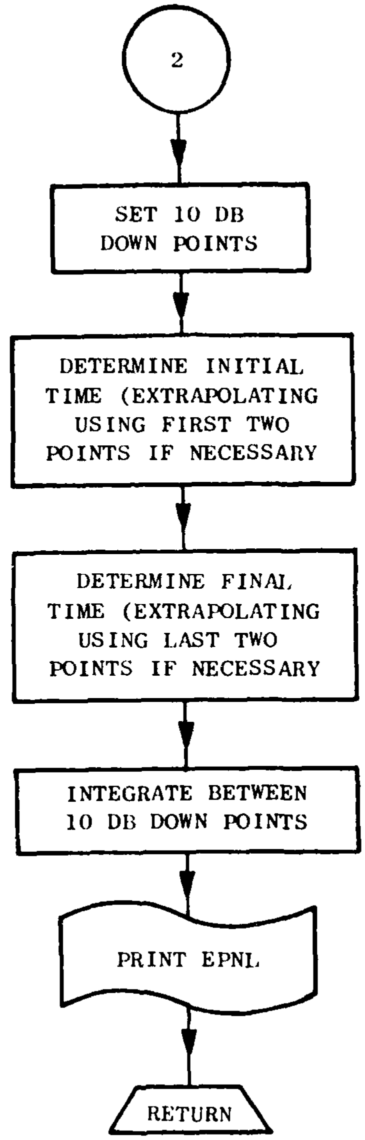


Figure 3-1. Computer Program Flowchart (Continued).

i) SUBROUTINE EJECTS

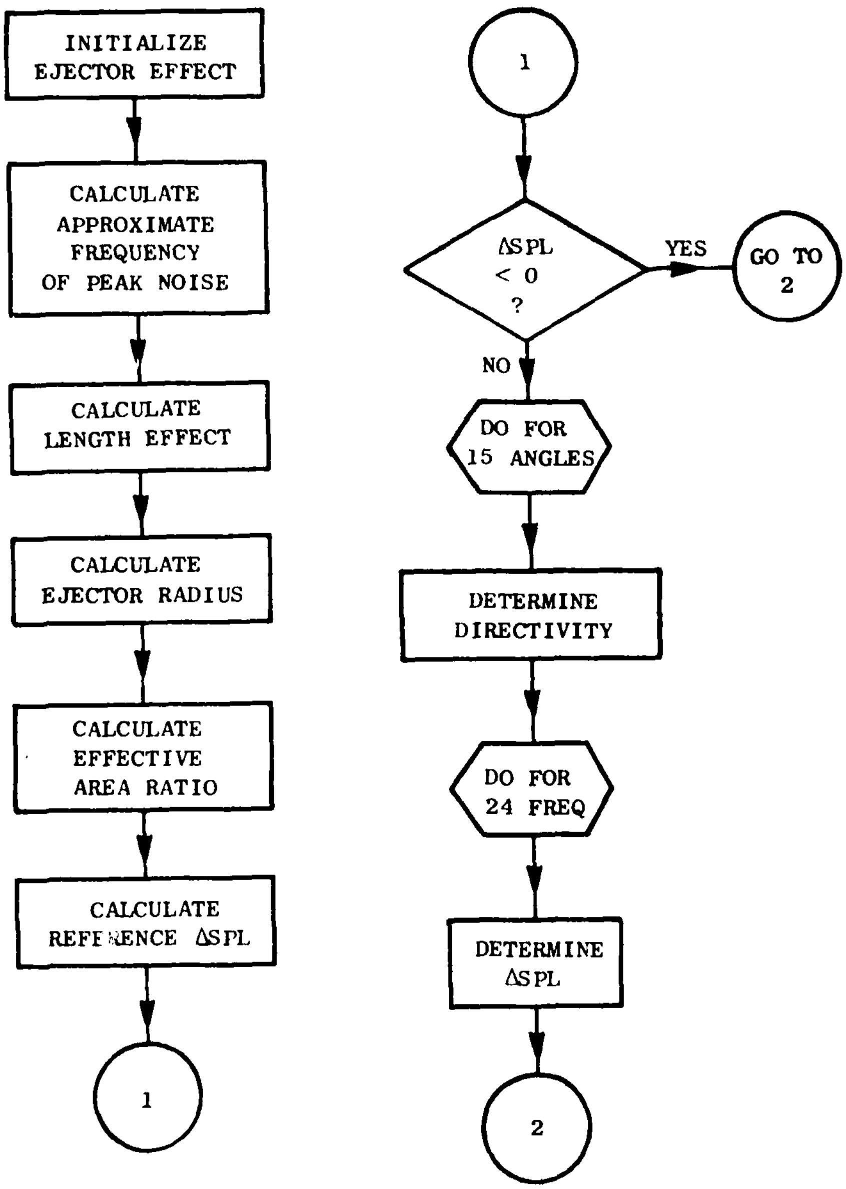


Figure 3-1. Computer Program Flowchart (Continued).

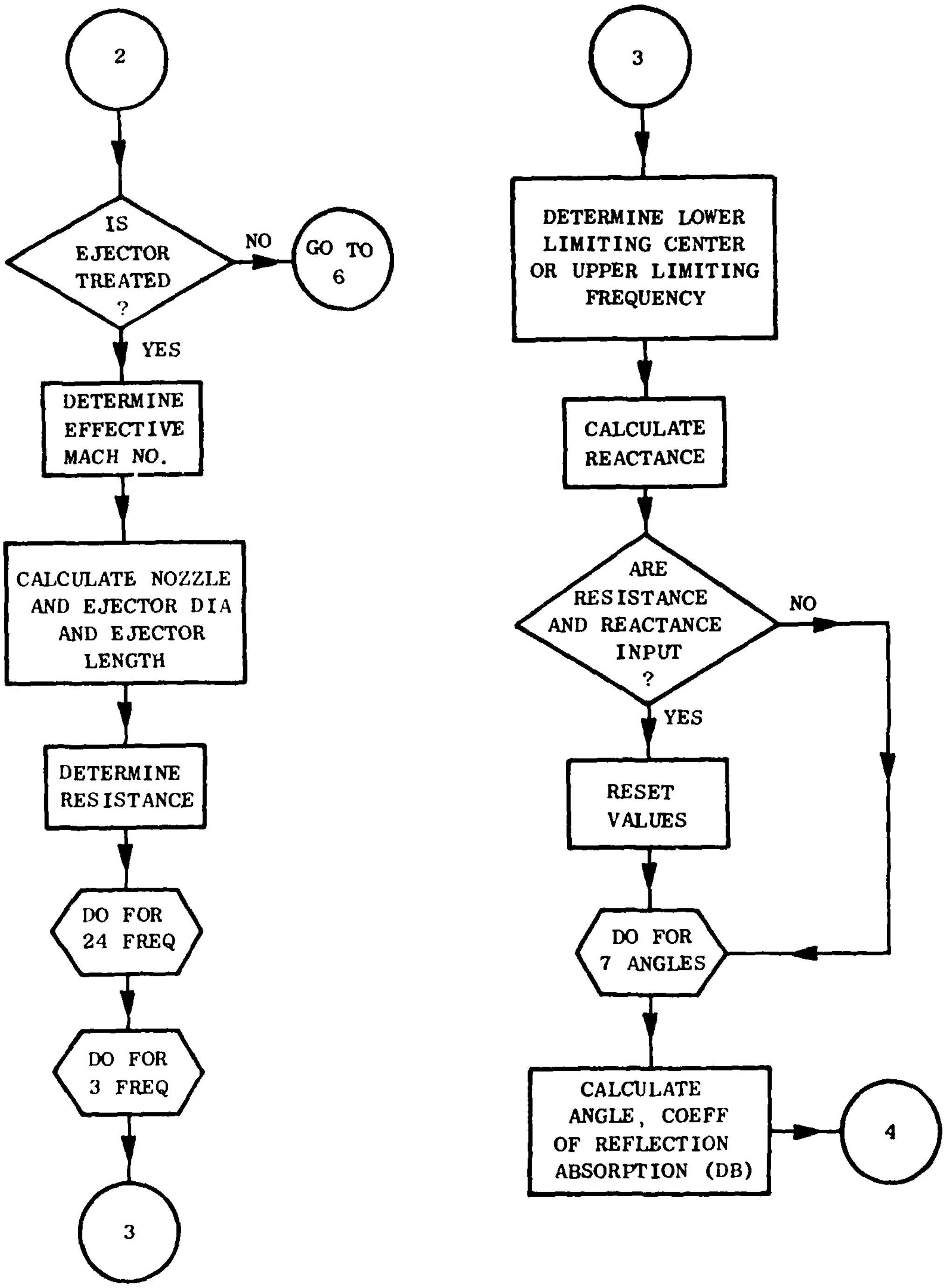
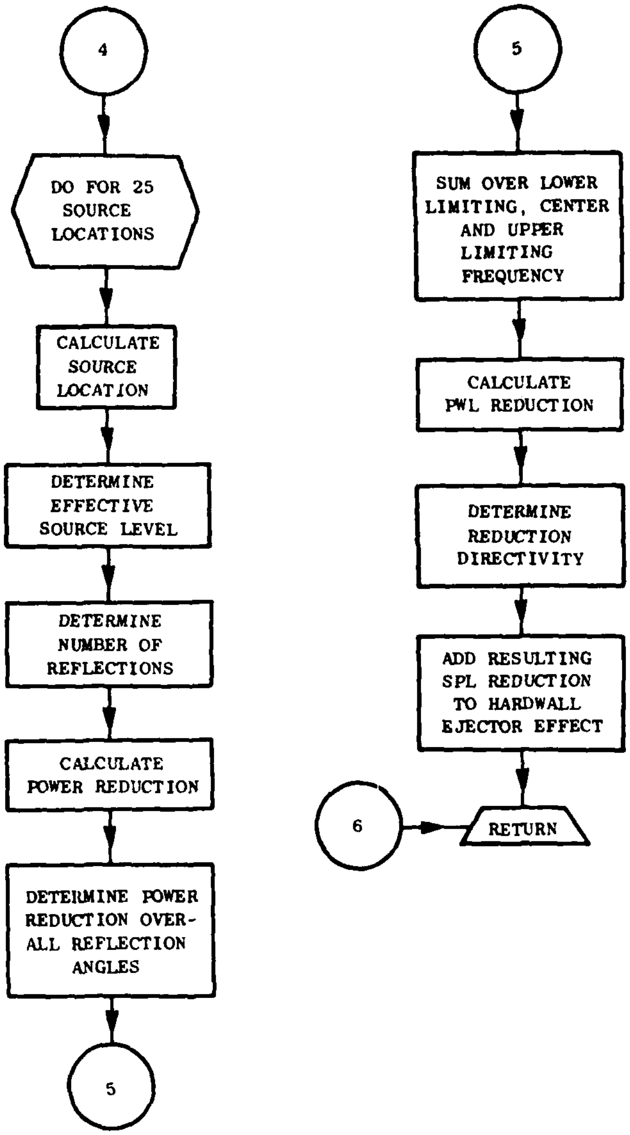


Figure 3-1. Computer Program Flowchart (Continued).



NO FLOW CHART IS SUPPLIED FOR THE FOLLOWING ROUTINES BECAUSE OF THE COMPLETE NATURE OF THEIR DOCUMENTATION IN PUBLISHED LITERATURE

- SHKSUB
- PNLPT
- TPNLC

Figure 3-1. Computer Program Flow Chart (Concluded).

temperature are determined, the input variables to the conical nozzle noise routine are set, the noise is calculated, and flight effects are applied if necessary. This component is then extrapolated and (if desired) printed.

The premerged noise is then calculated. The effective number of tubes and the critical angle are determined. Then the length of the potential core, X_c, the point of merging (used for cutoff only), and the radius ratio are determined. The axial location of the beginning of peak noise generation, X_p, and the critical frequency for absorption are calculated before entering the frequency loop to calculate source locations, absorption effects, and cutoff effects. These are then applied to all angles forward of critical with angles aft of critical set equal to critical angle SPL. Ejector effects are determined and applied before extrapolation and (if desired) printed. Shock-cell noise (if applicable) is determined after summing the premerged and postmerged components. It is then corrected for ejector effects and flight effects, whereupon multielement corrections are applied, extrapolated, printed, and added to the other components. The total is then extrapolated (if required) and printed, and a return is made for the next case.

The conical part of the routine calculates the conical mixing noise and shock noise, applies flight effects, extrapolates and prints them separately if desired, sums them, and prints the total; after which, a return is made for the next case.

The coannular part uses the premerged and postmerged routines of the multielement part if a suppressor is involved. Variables are set, and, if a suppressor is involved, the postmerged routine of the multielement part is entered to calculate merged flow conditions. Mixed conditions are then determined and the merged noise is calculated, extrapolated, and printed (if desired).

The premerged noise is now calculated in accordance with whether a suppressor is present or not. This component is extrapolated, printed if desired, and added to the postmerged. Outer-stream, shock-cell noise is determined, depending on whether a suppressor is present or not, extrapolated, printed (if desired), and added to the other components. Finally, the inner stream shock is computed, extrapolated, printed (if desired), and added to the other components. The total is then extrapolated as required, and printed; and control is returned for the next case.

SUB1 Subroutine - This subroutine provides SAE ARP 876 (1975 revision) conical nozzle noise predictions and determines and applies mixing noise flight effects. Use and limitations are as described in the aforementioned documents. Output from this routine is on a one-foot arc. Basically, polynominal curve fits of the data in SAE ARP 876 (1975 revision) were used. A correction was made to the predicted OASPL to increase the accuracy of the routine based on available data on suppressor nozzles. This correction amounts to +1 dB at all angles and frequencies.

SUB3 Subroutine - This routine resets the variables for input into the extrapolation and PNL calculation subroutines. It determines whether extrapolation is required and calls EXTP. PNLPT is called to determine PNL and OASPL. TPNLC is called from PNLPT to determine PNLT. The variables are then reset maintaining the newly calculated values.

SUB5 Subroutine - This routine calculates sound power level from sound pressure level for each one-third-octave band, and then antilogarithmically sums them to obtain the overall levels.

SUB4 Subroutine - This routine places previously calculated sound pressure level and sound power level in other variable name storage for future use in the program.

SUB2 Subroutine - This routine adds a constant value to the one-third-octave band SPL at all angles and frequencies.

SUB6 Subroutine - This routine antilogarithmically sums different SPL and PWL spectra to obtain a total spectra, and then sums the total PWL spectrum to obtain OAPWL.

EXTP Subroutine - This routine extrapolates an input spectrum to a desired acoustic range using the inverse-square law (spherical spreading), air attenuation per SAE ARP 866 (Reference 3), and, if desired, extra ground attenuation (EGA) per the routine presented in SAE AIR 923 (Reference 4). A curve fit of the 59° F, 70% relative humidity, standard-day-air attenuation is used, as well as curve fits for EGA. The routine automatically accounts for range changes from angle to angle on a sideline and includes the option of a 100-ft layer of EGA, full EGA, or no EGA as per SAE AIR 923.

SHKSUB Subroutine - This routine predicts shock-cell noise by the procedure defined in SAE ARP 876 (1976 proposed revision). Output from this routine is on a one-foot arc. The definition of D8 was varied to allow calculations for nonround nozzles. Shock-cell noise flight effects are determined and applied in this section.

PNLPT Subroutine - This routine sums the SPL in a given sp.ctrum antilogarithmically to obtain OASPL and uses the procedure defined in SAE ARP 865A (Reference 31) to calculate PNL.

TPNLC Subroutine - This routine calculated tone-corrected PNL via Section B36.3 of the FAA Noise Certification Document (Nov. 17, 1969) as a function of the uncorrected one-third-octave spectrum SPL.

PNTT8 Subroutine - This routine sets the format and prints the noise output from the main program. It prints the identification of the noise output and one-third-octave band SPL and PWL for 24 frequencies and 15 angles (20° to 160° to the inlet) as well as OASPL, PNL, and PNLT for each angle.

The second part of the routine calculates EPNL (if required) according to the procedure described in FAR Part 36, using PNL rather than PNLT. Times associated with given acoustic angles for a level flyover (assuming the engine centerline is parallel to the ground) are determined first. Peak PNL, the associated time, and the 10-dB down levels are determined. Initial and final times are then determined by linear interpolation (using, when necessary, extrapolation using the first or last two points). The PNL history is then integrated between the 10-dB down points by summing half-second increments (determined by linear interpolation) to obtain the duration correction. This is added to the maximum PNL to obtain EPNL; the EPNL is then printed. It should also be noted that the program automatically calculates an EPNL for static sideline cases assuming a 300 ft/sec flyover velocity.

EJECTS Subroutine - This routine first determines the effect of a hard-wall ejector of given geometry in terms of the reference SPL. Directivity and spectral effects are then determined. If no treatment is present in the ejector, control is returned to the main program. If treatment is present, an impedance prediction routine for SDOF treatment (single degree of freedom) is entered. The resistance and reactance of the treatment panel is determined; this yields a coefficient of absorption. The location of a given source and the strength relative to the peak are then calculated. The coefficient of absorption multiplied by the number of reflections for a given acoustic angle plus the relative source strength when summed over all sources yields an SPL reduction. This, when integrated over all angles, gives a sound power insertion loss. This reduction is log-averaged over the lower limiting, center, and upper limiting frequencies for the given one-third-octave band. The sound power insertion loss is then converted into a delta SPL for each acoustic angle and added to the hard-wall effect. Control is then returned to the main program.

3.4 INPUT DESCRIPTION

The input data are supplied through NAMELIST input format. Any number of successive cases can be run consecutively, limited only by the users execution time available. Each successive case requires only the INPUT NAMELIST. The data from preceding cases remain in storage; thus, only those variables which are to be changed from the preceding case input value need be included in the INPUT file of succeeding cases.

The input format is given in Table 3-3. The definitions of each of the input variables given in Table A-3 are given in Table 3-4. All variables are preset to zero before the first-case input is read. Only the input variables listed under a nozzle type in Table 3-3 need be input for any case. Notes on the input follow the tables. Further descriptions of input variables are given in Figures 3-2 and 3-3.

3.4.1 Notes on Input

1. The ALT variable is used as the main distance indicator; therefore, for ground static arc or sideline cases the distance of interest is input through this variable, and the SL variable is set to zero. In flyover cases, ALT is used as the altitude indicator, and SL is used as the sideline distance.

2. EGA is "Extra Ground Attenuation" as defined in SAE AIR 923 "Method for Calculating the Attenuation of Aircraft Ground to Ground Noise Propagation During Takeoff and Landing." The "100-ft layer" is defined in Figure 3 of the above-mentioned document.

3. Major nozzle dimensions are input in feet; element or ejector-treatment dimensions are input in inches. This alleviates inputting very small numbers (i.e., 0.1 inch versus 0.0083 foot).

4. Cant angles for multitube and multichute/spoke nozzles are defined in Figure 3-4.

5. The "A" variables are input as 10 if treatment other than SDOF is used. In this case RR and RX must be input.

6. The specific resistances and reactances of the treatment used in the ejector are input through the RR and RX variables. Values at the lower limiting, upper limiting, and midpoint frequencies are used. For ease of input, the program assumes the value at the upper limiting frequency of one one-third-octave band to be equal to the value at the lower limiting frequency of the next highest band. Therefore, only 49 values must be input.

3.5 OUTPUT DESCRIPTION

The output format is generally self-explanatory. The input is printed out using the nomenclature defined in Table 3-5. Output flow conditions follow. Finally, SPL and PWL spectra, OASPL, OAPWL, PNL, PNLT, and EPNL are printed as required.

A warning flag is built into the iterations for gamma and merged velocity. The flag message for either iteration is: DID NOT CONVERGE; and when it appears the run terminates. Gross input errors have been the only cause of this message encountered in the development of the program.

At the beginning of each run, an unlimited number of cards can be input for the run identification. (A case identification card is available before each case also). The format for each card is:

60 - Character Title Card, Columns 1-60

To enter the case section of the input the following card is required:

CASES (Starting in Column 2)

The run or case identification cards may be omitted but the "CASES" card must be present. The case identification is saved and will be printed on succeeding cases unless another case identification card is read.

Table 3-3. Input Format.

(FOR CONICAL NOZZLES)

```
Column
2
↓
(60-Character Identification Card, Columns 1-60)

$ INPUT  Y9 = 1,

P9 = _______, TT3 = _______, A9 = _______,

K9 = _______, ALT = _______, SL = _______,

U  = _______, E9  = _______, VO = _______, NFLT = _______,

$
```

Table 3-3. Input Format (Continued).

(FOR SINGLE-FLOW, MULTITUBE NOZZLES)

Column
2
↓
(60-Character Identification Card, Columns 1-60)

$ INPUT Y9 = 2,

N = ________, RP = ________, B9 = ________,

DT = ________, A7 = ________, Z5 = ________,

S1J = ________, TT3 = ________, P9 = ________,

K9 = ________, ALT = ________, SL = ________,

U = ________, E9 = ________, VO = ________,

A6 = ________, L9 = ________, NFLT = ________,

A = ________, ________, ________, ________,

Table 3-3. Input Format (Continued).

```
Column
2
↓
RR = _______, _______, _______, _______, _______, _______, _______,
     _______, _______, _______, _______, _______, _______, _______,
     _______, _______, _______, _______, _______, _______, _______,
     _______, _______, _______, _______, _______, _______, _______,
     _______, _______, _______, _______, _______, _______, _______,
     _______, _______, _______, _______, _______, _______, _______,
     _______, _______, _______, _______, _______, _______, _______,

RX = _______, _______, _______, _______, _______, _______, _______,
     _______, _______, _______, _______, _______, _______, _______,
     _______, _______, _______, _______, _______, _______, _______,
     _______, _______, _______, _______, _______, _______, _______,
     _______, _______, _______, _______, _______, _______, _______,
     _______, _______, _______, _______, _______, _______, _______,
     _______, _______, _______, _______, _______, _______, _______,

$
```

Table 3-3. Input Format (Continued).

(FOR SINGLE-FLOW, MULTICHUTE/SPOKE NOZZLES)

Column
2
⬇

(60-Character Identification Card, Columns 1-60)

$ INPUT Y9 = 3,

N = ________, RP = ________, B9 = ________,

R4 = ________, R6 = ________, SS = ________, A7 = ________,

TT3 = ________, P9 = ________, NFLT = ________,

K9 = ________, ALT = ________, SL = ________, U = ________,

E9 = ________, VO = ________, A6 = ________, L9 = ________,

A = ________, ________, ________, ________,

RR and RX as per the multitube nozzle case.

$

Table 3-3. Input Format (Continued).

(FOR DUAL-FLOW NOZZLES WITH MULTITUBE SUPPRESSORS ON THE OUTER STREAM)

```
Column
2
⬇
(60-Character Identification Card, Columns 1-60)

$ INPUT  Y9 = 5,

RP  = _______, DN  = _______, AA8 = _______, A9 = _______,

TT4 = _______, P4  = _______, TT5 = _______, P5 = _______,

N   = _______, DT  = _______, A7  = _______, B9 = _______,

Z5  = _______, S1J = _______, NFLT = _______,

K9  = _______, ALT = _______, SL  = _______, U  = _______,

E9  = _______, VO  = _______, A6  = _______, L9 = _______,

A   = _______, _______, _______, _______,

RR and RX as per multitube case.

$
```

Table 3-3. Input Format (Concluded).

(FOR DUAL-FLOW NOZZLES WITH MULTICHUTE/SPOKE SUPPRESSOR ON THE OUTER STREAM)

Column
2
↓
(60-Character Identification Card, Columns 1-60)

$ INPUT Y9 = 6,

RP = ________, DN = ________, AA8 = ________, A9 = ________,

TT4 = ________, P4 = ________, TT5 = ________, P5 = ________,

N = ________, B9 = ________, NFLT = ________,

R4 = ________, R6 = ________, SS = ________, A7 = ________,

K9 = ________, ALT = ________, SL = ________, U = ________,

E9 = ________, VO = ________, A6 = ________, L9 = ________,

A = ________, ________, ________, ________,

RR and RX as per multitube case.

$

Table 3-4. Input Variable Descriptions.

(FOR CONICAL NOZZLES)

Variable	Note	Description
P9		Nozzle Total to Ambient Pressure Ratio
TT3		Nozzle Exit Total Temperature, ° R
A9		Nozzle Exit Flow Area, ft^2
K9		Print Indicator: 0 = Total Nozzle Noise Only 1 = Nozzle Component and Total Noise
ALT	1	Altitude, Ground Sideline, or Arc Distance at which Prediction is to be made, ft
SL	1	Sideline Distance at Which Prediction is to be made, ft (Used for Flyover Cases Only)
U		Arc or Sideline Indicator 1 = Predictions to be made on an Arc 2 = Predictions to be made on a Sideline (or Flyover)
E9	2	EGA Indicator 0 = No EGA 1 = Full EGA 2 = 100-ft Layer of EGA
VO		Aircraft Flight Velocity
NFLT		Flight Effects Indicator 1 = "Free Jet" 2 = "True Flight"

Table 3-4. Input Variable Descriptions (Continued).

(FOR SINGLE-FLOW, MULTITUBE NOZZLES)

Variable	Note	Description
N		Number of Tubes
RP	3	Centerbody Plug Radius, ft
B9	4	Tube Centerline Cant Angle, degrees
DT	3	Tube Diameter, in.
A7		Nozzle Area Ratio
Z5		Number of Rows of Tubes Counting Center Tube (if Present) as zero
S1J		Tube Centerline Spacing to Tube Diameter Ratio
TT3, P9, K9, ALT, SL, U, E9, VO		Same as Conical Nozzle
A6		Ratio of Ejector Inlet Area to Nozzle Total (or Annulus) Area (Input Zero for no Ejector)
L9		Ratio of Ejector Length to Suppressor Nozzle Equivalent Diameter
A(1)	3,5	Ejector Treatment Faceplate Thickness, in.
A(2)	3,5	Ejector Treatment Hole Diameter, in.
A(3)	3,5	Ejector Treatment Cavity Depth, in.
A(4)	3,5	Ejector Treatment Open Area Ratio
RR	6	Ejector Treatment Specific Resistance, Rayls (49 Values Required)
RX	6	Ejector Treatment Specific Reactance, Rayls (49 Values Required)

Table 3-4. Input Variable Descriptions (Continued).

(FOR SINGLE-FLOW, MULTICHUTE/SPOKE NOZZLES)

Variable	Note	Description
N		Number of Elements
RP	3	Centerbody Plug Radius, ft
B9	4	Chute/Spoke Exit Cant Angle, degrees
R4		Outer Circumferential Flow Dimension, in.
R6		Inner Circumferential Flow Dimension, in.
SS		Outer Circumferential Element Dimension, in.
A7		Nozzle Area Ratio
TT3, P9, K9, ALT, SL, V, E9, VO,		Same as Conical Nozzle
A6, L9, A, RR, RX		Same as Multitube Nozzle

Table 3-4. Input Variable Descriptions (Continued).

(FOR DUAL-FLOW NOZZLES WITH A MULTITUBE SUPPRESSOR ON THE OUTER STREAM)

Variable	Note	Description
RP		Centerbody Plug Radius, ft
DN		Nozzle Outer Diameter, ft
AA8		Inner Nozzle Flow Area, ft^2
A9		Outer Nozzle Flow Area, ft^2
TT4		Inner Nozzle Exit Total Temperature, ° R
P4		Inner Nozzle Total to Ambient Pressure Ratio
TT5		Outer Nozzle Exit Total Temperature, ° R
P5		Outer Nozzle Total to Ambient Pressure Ratio
N, DT, A7, B9, Z5, S1J, A6, L9, A, RR, RX		Same as Multitube Nozzle
K9, ALT, SL, U, E9, VO		Same as Conical Nozzle

Table 3-4. Input Variable Descriptions (Concluded).

(FOR DUAL-FLOW NOZZLES WITH MULTICHUTE/SPOKE SUPPRESSORS ON THE OUTER STREAM)

Variable	Note	Description
RP, DN, AA8, A9, TT4, P4, TT5, P5		Same as Dual-Flow/Multitube
N, B9, R4, R6, SS, A7		Same as Multichute/Spoke
K9, ALT, SL, U, E9, VO		Same as Conical
A6, L9, A, RR, RX		Same as Multitube

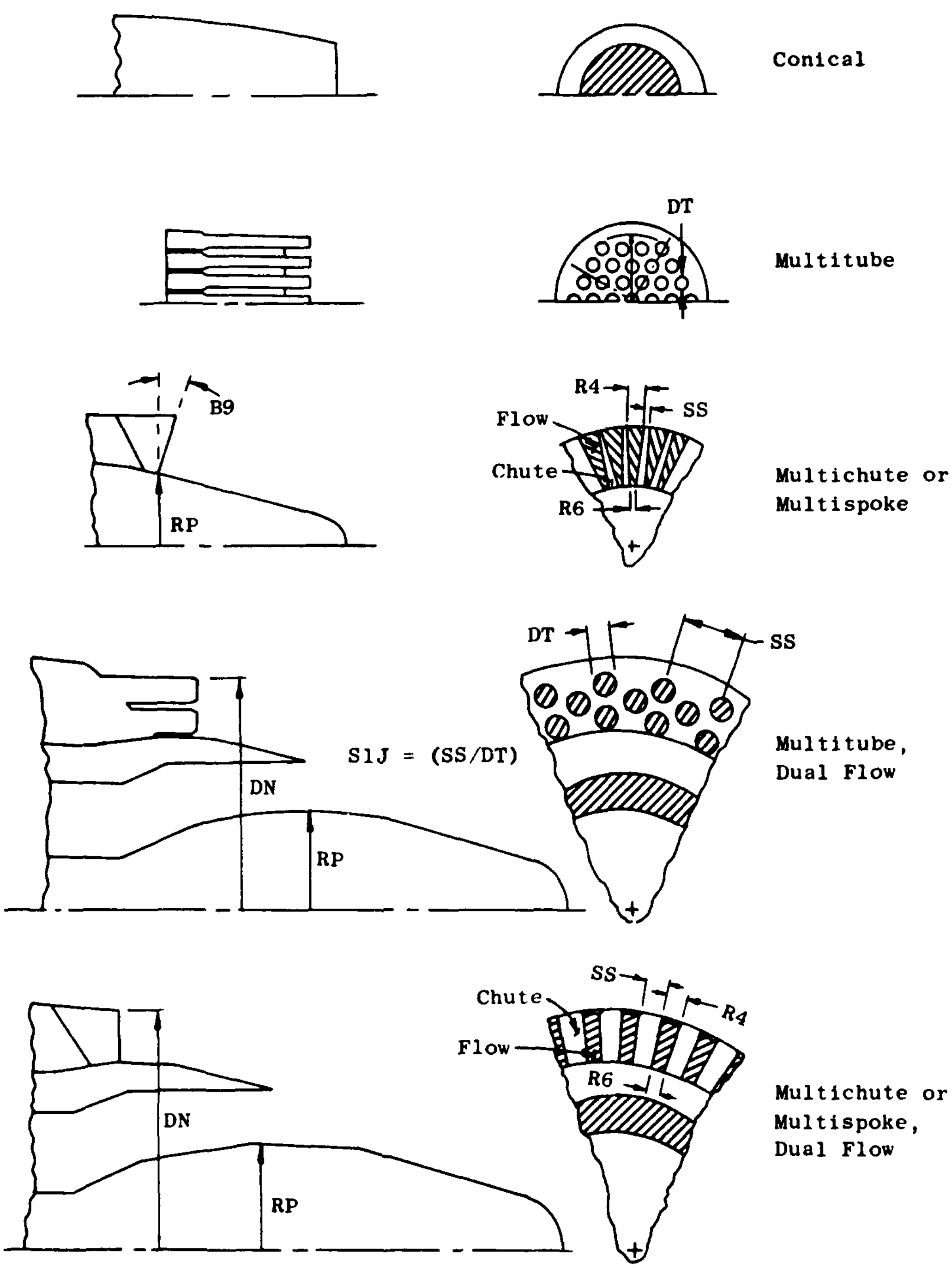
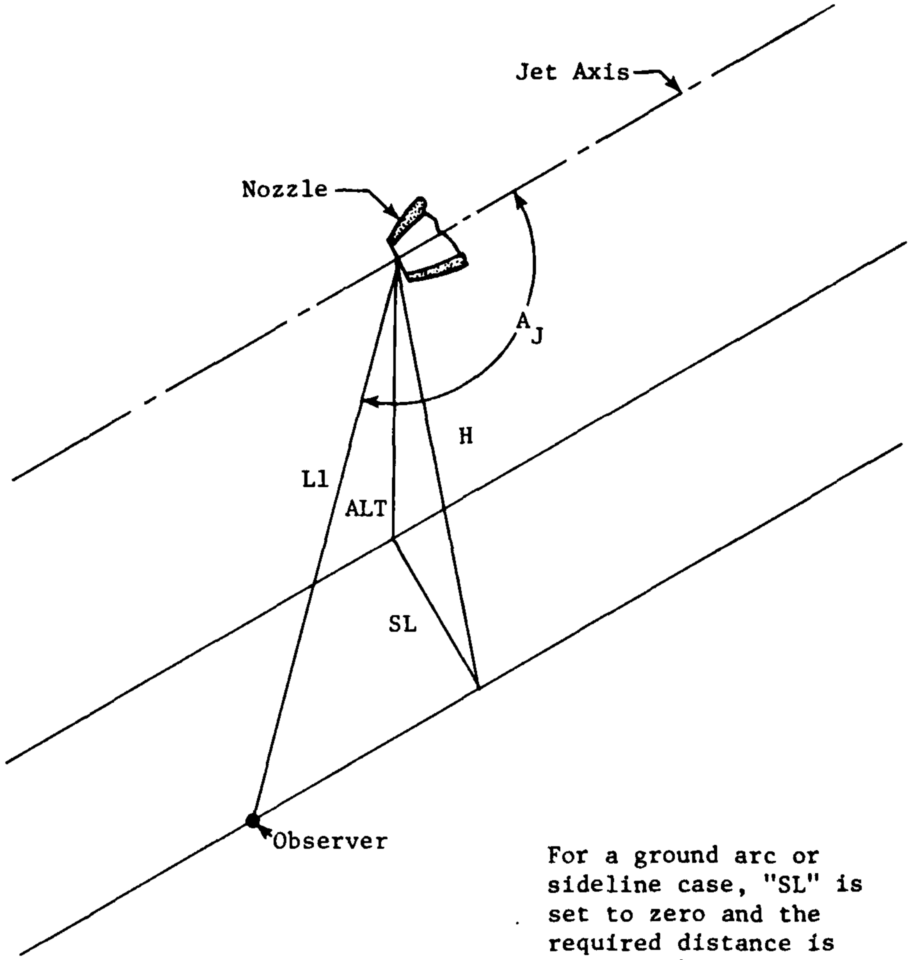


Figure 3-2. Nozzle Types Included in the Correlation.



For a ground arc or sideline case, "SL" is set to zero and the required distance is input as "ALT."

Figure 3-3. FORTRAN Symbol Convention for Acoustic Arena Variables.

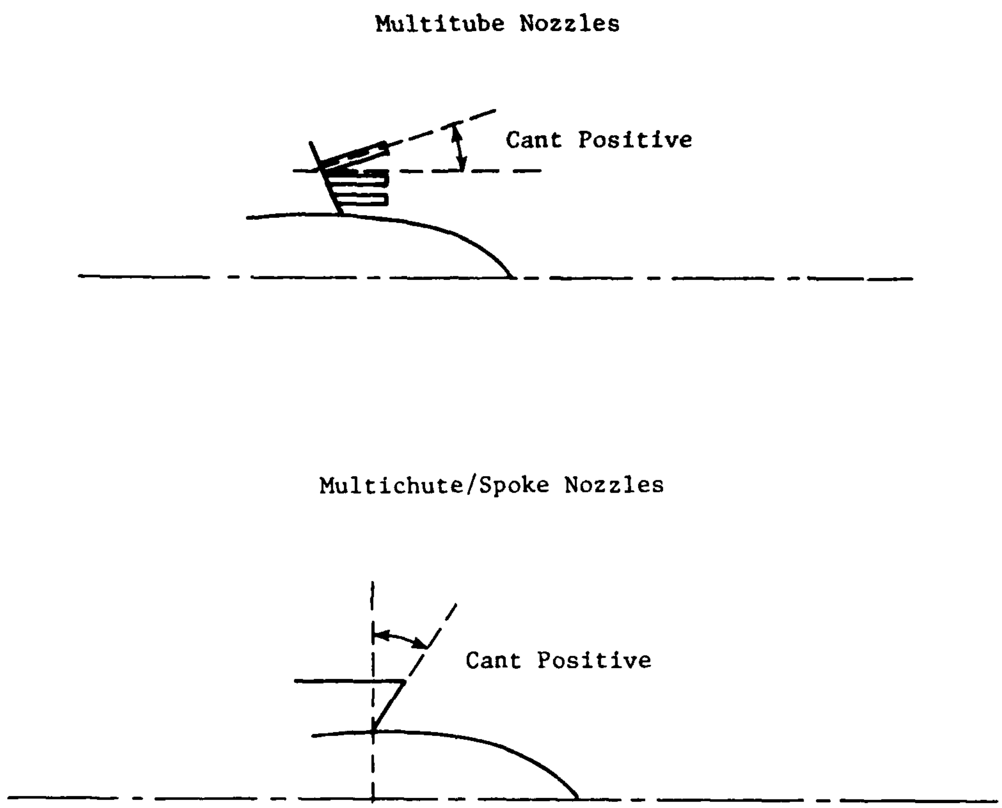


Figure 3-4. Definition of Cant Angles for Multielement Nozzles.

Table 3-5. Output Symbol Descriptions.

Symbol	Description
ARD	Suppressor Nozzle Area Ratio
AT	Area of an Individual Flow Element
A5	Merged Flow Area
A6	Mixed Flow Area
A8	Inner Nozzle Flow Area
A28	Outer Nozzle Flow Area
DUCT H	Outer Nozzle Duct Height
D5	Diameter of the Merged Flow Stream
PO	Ambient Pressure
PT8/PO	Inner Nozzle Pressure Ratio
PT28/PO	Outer Nozzle Pressure Ratio
RHO5	Density of the Merged Stream
RHO8	Density of the Inner Stream
RHO28	Density of the Outer Stream
TO	Ambient Temperature
TT5	Total Temperature of the Merged Stream
TT6	Total Temperature of the Mixed Stream
TT8	Total Temperature of the Inner Stream
TT28	Total Temperature of the Outer Stream
U5	Fully Expanded Merged Velocity
U6	Fully Expanded Mixed Velocity
U8	Fully Expanded Inner Stream Velocity
U28	Fully Expanded Outer Stream Velocity
W6	Mixed Stream Weight Flow
PWL	Sound Power Level, dB re: 10^{-13} watts
OASPL	Overall Sound Pressure Level re: 2 dynes/m^2
OAPWL	Overall PWL
PNL	Perceived Noise Level, PNdB
PNLT	Tone-Corrected PNL, PNdB
EPNL	Static Effective Perceived Noise Level, EPNdB

3.6 SAMPLE CASES

Example cases for a conical nozzle with and without EGA, a dual-flow nozzle with a multitube suppressor and a treated ejector, and a dual-flow nozzle with a multichute suppressor are given. The input data cards are listed in Table 3-6 as per the format given in Table 3-3.

Table 3-6. Input Data Card Listing Sample Case.

```
 AR SIECKMAN       TASK 3 HIGH VELOCITY JET NOISE PRCGRAM
 GENERAL ELECTRIC CO.  BLDG 300  BIN 79  M.D. H77  X2261
 MS -- ENGINEERING CORRELATION MODEL  --  CDC VERSICN
CASES
CONICAL NOZZLE CHECK CASE
$INPUT Y9#1,
P9#3.247, TT3#1380, A9#2.346, RP#0, K9#1,
ALT#2400, U#2, F9#0, V0#350, A6#0, L9#0, A#4*0,
$
$INPUT E9#2$
DUAL FLOW MULTI-TUBE CHECK CASE
$INPUT Y9#5,
RP#1.423, DN#6.687, AA8#7.649, A9#5.083, TT4#1010,
P4#1.567, TT5#1632, P5#3.278, K9#1, N#69,
 DT#3.672, A7#2.75, B9#0, Z5#3,
S1J#2.818, ALT#320, U#1, E9#0, V0#0.
A6#0, L9#0, A#4*0,
A6#1.303,L9#3.952,A#4*10,
RR#49*0.311,
RX#-87.135,-77.549,-69.239,-61.153,-54.949,-48.463,
-43.269,-38.767,-34.611,-31.008,-27.683,-24.219,-21.620,
-19.367,-17.287,-15.484,-13.819,-12.277,-10.954,-9.652,-8.608,
-7.702,-6.864,-6.088,-5.370,-4.762,-4.232,-3.771,-3.342,
-2.968,-2.619,-2.251,-1.970,-1.722,-1.487,-1.278,-1.077,-.882,
-.704,-.515,-.347,-.185,-.010,.185,.401,.703,1.1,1.794,4.097,
$
DUAL FLOW MULTI-CHUTE CHECK CASE
$INPUT Y9#6,
RP#.624, DN#2.671, AA8#.811, A9#1.555, TT4#1470,
P4#1.490, TT5#1750, P5#3.97, K9#0, N#20,
B9#0, R4#2.874, R6#2.060, SS#2.155,
A7#1.75, ALT#2400, U#2, E9#0, V0#350,
A6#0, L9#0, A#4*0,
$
```

NOTE: The symbol # indicates an equal sign (=).

```
XX      XX    XXXXXX
XXX    XXX    XXXXXX
XXXX  XXXX    XX
XX XXXX XX    XX
XX  XX  XX    XXXXXX
XX      XX    XXXXXX
XX      XX        XX
XX      XX        XX
XX      XX    XXXXXX
XX      XX    XXXXXX
```

```
 XXXXX X   X  XXXXX XXXXXX XXXXXX X   X
X       X X  X        X    X      XX XX
XXX      X   XXX      X    X      X XX X
  XXX    X     XXX    X    XXXX   X   X
     X   X        X   X    X      X   X
XXXXX    X   XXXXX    X    XXXXXX X   X
```

HIGH VELOCITY JET NOISE PROGRAM(CONTRACT DOT-OS.30034)
TASK3 -- ENGINEERING CORRELATION

AR DIECKMAN TASK 3 HIGH VELOCITY JET NOISE PROGRAM
GENERAL ELECTRIC CO. BLDG 306 BIN 79 M.D. H77 X2261
MS -- ENGINEERING CORRELATION MODEL -- CDC VERSION

HIGH VELOCITY JET NOISE PROGRAM - ENGINEERING CORRELATION

CONICAL NOZZLE CHECK CASE

*** INPUT ***

```
TA =  519.        PA    =  14.70
TT8= 13__ .       PT8/PA=   3.247
EJECTOR AREA RATIO PARAMETER=     0.000     VS=     352.0
PLUG DIA=      0.00     CANT=      0.000
```

***OUTPUT ***

```
DIA OF OUTER FLOW=       1.728      EQUIV AREA DIA=      1.728
```

NOZZLE EXIT CONDITIONS

```
JB=    2184.0     RHOB=      .0397      AT=     2.346      A8=     2.346
```

HIGH VELOCITY JET NOISE PROGRAM - ENGINEERING CORRELATION

C ITICAL NOZZLE CHECK CASE

* CONICAL MIXING NOISE
* 2400.0 FOOT ALTITUDE
* 0.0 FOOT SIDELINE
* NO EGA
* 519. DEGREE STANDARD DAY

ACOUSTIC ANGLE FROM INLET

FREQ	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	PWL
50.	54.1	56.9	58.5	59.5	60.4	61.0	64.9	65.8	64.1	66.0	73.7	80.3	84.2	86.2	83.1	158.4
63.	57.0	59.8	61.4	62.4	63.4	64.0	65.9	67.8	66.4	68.3	76.1	82.7	86.5	88.1	84.5	161.0
80.	58.7	61.6	63.3	64.4	65.4	66.0	68.9	69.8	68.7	70.6	78.2	84.6	88.2	89.3	85.0	163.0
100.	60.3	63.3	65.1	66.3	67.3	67.9	70.6	71.5	70.6	72.6	79.9	86.2	89.4	89.9	85.0	164.4
125.	61.6	64.8	66.7	67.8	68.9	69.5	72.1	73.0	72.5	74.5	81.6	87.6	90.3	90.0	84.3	165.2
160.	62.6	66.0	68.0	69.2	70.4	71.0	73.6	74.5	74.3	76.4	82.9	88.5	90.6	89.6	83.1	165.8
200.	63.6	67.1	69.3	70.6	71.8	72.5	74.8	75.7	75.8	77.8	83.9	89.1	90.5	88.7	81.5	166.0
250.	64.1	67.9	70.2	71.6	72.8	73.6	75.7	76.7	77.0	79.1	84.6	89.4	90.1	87.5	79.4	166.0
315.	64.3	68.4	70.8	72.4	73.7	74.5	76.5	77.5	78.1	80.2	85.1	89.3	89.4	85.8	76.8	165.8
400.	64.2	68.6	71.2	72.9	74.3	75.2	77.1	78.0	78.9	80.9	85.2	88.9	88.2	83.8	73.9	165.4
500.	63.7	68.5	71.4	73.2	74.7	75.6	77.3	78.3	79.4	81.4	85.6	88.3	86.8	81.5	70.6	165.0
630.	62.7	68.0	71.1	73.1	74.7	75.7	77.3	78.2	79.5	81.5	84.5	87.2	85.0	78.7	66.8	164.5
800.	61.0	67.0	70.4	72.6	74.4	75.5	76.9	77.9	79.3	81.2	83.6	85.8	82.8	75.6	62.6	163.9
1000.	58.4	65.5	69.4	71.4	73.7	74.9	76.2	77.2	78.8	80.5	82.3	84.1	80.3	72.2	58.1	163.2
1250.	55.8	63.5	67.8	70.5	72.6	73.9	75.1	76.1	77.8	79.3	80.5	81.8	77.2	68.1	52.6	162.4
1600.	51.3	60.3	65.4	68.5	70.6	72.3	73.3	74.3	76.1	77.5	78.1	78.9	73.5	63.3	46.1	161.5
2000.	45.7	56.3	62.2	65.8	68.4	70.1	71.0	72.1	74.0	75.1	75.2	75.4	69.2	57.9	38.7	160.5
2500.	38.9	50.9	57.9	62.1	65.2	67.0	68.0	69.1	71.0	71.8	71.3	70.9	63.8	51.0	29.4	159.4
3150.	27.9	43.1	51.7	56.9	60.4	62.7	63.6	64.8	66.6	67.1	65.9	64.8	56.5	41.9	16.8	158.2
4000.	16.3	31.4	42.4	49.6	53.4	56.1	57.2	58.5	60.2	60.2	58.3	56.3	46.5	29.3	-1.0	156.9
5000.	-.3	13.9	36.1	43.7	48.6	51.7	52.9	54.2	55.8	55.5	53.0	50.5	39.6	20.8	-12.6	155.5
6300.	-29.5	1.6	20.3	30.1	36.5	44.5	42.1	43.5	44.9	43.9	40.3	36.3	23.0	-.2	-42.6	154.1
8000.	-74.8	-47.8	-4.3	9.3	18.[illegible]	23.2	25.4	27.1	28.2	26.3	21.3	15.0	-2.2	-32.1	-88.5	152.5
10000.	-136.0	-70.1	-37.5	-18.8	-7.	.2	3.3	5.3	6.1	3.2	-5.3	-14.7	-37.0	-76.0	-151.3	151.0
OASPL	73.6	78.0	80.8	82.7	84.1	85.3	87.6	88.0	88.9	90.8	94.6	98.9	99.7	98.4	92.8	176.7
PNL	77.3	82.9	86.5	89.2	91.4	92.8	94.2	95.3	96.6	98.0	100.7	103.9	102.9	99.4	91.3	
PNLT	77.3	84.3	87.6	89.2	91.4	92.8	94.2	95.3	96.6	98.0	100.7	103.9	104.0	100.7	91.3	

EPNL = 103.5

HIGH VELOCITY JET NOISE PROGRAM - ENGINEERING CORRELATION

CONICAL NOZZLE CHECK CASE

* CONICAL SHOCK NOISE
* 2400.0 FOOT ALTITUDE
* 0.0 FOOT SIDELINE
* NO EGA
* 519.DEGREE STANDARD DAY

ACOUSTIC ANGLE FROM INLET

FREQ	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	PWL
50.	52.8	55.9	57.6	58.6	59.0	59.0	61.6	61.0	61.0	60.7	63.7	62.7	61.1	58.8	55.3	140.6
63.	55.7	58.8	60.6	61.5	61.9	61.9	65.0	64.4	64.5	64.3	67.5	66.5	64.9	62.6	59.0	143.9
80.	58.2	61.5	63.4	64.5	65.	65.1	68.2	67.9	68.1	68.0	71.0	70.0	68.4	66.0	62.4	147.2
100.	60.3	63.7	65.8	67.1	67.8	68.2	71.0	70.9	71.4	71.4	74.4	73.5	71.9	69.5	65.7	150.0
125.	61.5	65.1	67.4	69.0	70.	70.6	73.4	73.6	74.4	74.6	78.2	77.4	75.8	73.3	69.4	152.7
160.	62.0	65.8	68.3	70.2	71.6	72.6	75.4	76.2	77.5	78.1	81.3	80.6	79.0	76.4	72.3	155.8
200.	62.7	66.5	69.0	70.9	72.6	74.0	76.3	77.7	79.7	80.8	83.6	83.2	81.6	78.8	74.5	158.4
250.	65.2	68.5	70.3	71.6	[illegible]	74.5	76.2	78.1	80.8	82.6	85.5	85.4	83.8	80.8	76.1	160.9
315.	71.8	74.4	74.8	74.4	74.1	74.6	76.6	78.0	81.1	83.8	86.5	86.9	85.3	82.0	76.9	164.4
400.	78.6	81.9	82.7	81.7	79.4	76.9	79.8	77.8	80.4	83.9	86.0	86.9	85.3	81.7	75.9	167.7
500.	80.7	85.1	87.3	87.8	86.6	83.6	85.2	86.0	79.0	82.5	84.2	85.8	84.3	80.2	73.7	168.3
630.	77.9	83.1	86.3	88.2	88.9	88.0	87.7	84.2	79.3	79.8	81.5	84.0	82.5	77.8	70.4	167.5
800.	75.8	80.8	83.2	84.9	86.6	87.7	85.9	85.6	82.4	77.5	78.5	82.0	80.6	75.0	66.5	166.6
1000.	73.1	79.0	82.1	83.6	83.7	84.0	82.6	83.5	83.6	78.5	76.0	79.7	78.4	71.8	62.3	166.0
1250.	70.3	77.1	80.4	81.7	82.4	82.5	81.5	80.2	81.8	80.0	75.3	76.7	75.6	67.9	59.0	165.1
1600.	65.0	73.0	77.0	79.5	80.6	81.4	79.4	78.5	77.9	78.9	75.2	73.3	72.2	63.6	56.1	164.2
2000.	59.2	68.9	73.8	76.2	77.2	78.0	76.7	76.1	75.6	75.3	73.4	69.3	68.1	59.6	51.8	163.3
2500.	51.6	63.3	69.1	72.2	73.9	74.4	73.3	72.6	72.3	71.1	68.8	64.6	62.5	54.7	43.6	162.3
3150.	40.3	55.4	62.7	66.7	68.8	64.7	68.3	67.7	67.4	66.2	62.7	58.9	55.1	47.2	31.2	160.9
4000.	23.2	43.2	52.9	58.2	61.2	62.6	61.3	60.8	60.4	59.2	55.3	51.3	45.2	35.1	14.2	159.3
5000.	12.3	[illegible]	46.3	52.5	55.9	57.6	56.8	56.2	55.8	54.3	50.4	46.1	38.9	27.1	3.6	158.0
6300.	-16.9	14.8	30.2	38.7	43.6	46.1	45.8	45.4	44.8	42.9	37.9	32.1	22.7	6.6	-25.7	156.7
8000.	-62.2	-16.6	5.5	17.8	24.9	28.8	29.1	29.0	28.1	25.5	19.2	11.1	-2.0	-24.9	-71.1	155.3
10000.	-123.4	-58.9	-27.7	-10.3	-.1	5.7	7.6	7.2	6.0	2.3	-7.4	-18.6	-36.9	-68.8	-133.9	154.0
OASPL	85.4	90.1	92.5	93.7	94.	93.5	93.2	91.8	91.5	91.9	93.6	94.3	92.8	89.1	83.6	176.6
PNL	99.4	95.8	98.6	100.0	100.5	100.5	100.4	99.1	98.5	98.8	99.3	99.5	97.9	93.4	87.1	
PNLT	90.4	97.1	99.7	100.0	100.8	100.5	100.4	99.1	98.5	98.8	99.3	99.5	99.0	94.8	87.1	

EPNL = 102.9

HIGH VELOCITY JET NOISE PROGRAM - ENGINEERING CORRELATION

CONICAL NOZZLE CHECK CASE

* CONICAL TOTAL NOISE
* 2400. FOOT ALTITUDE
* 0.0 FOOT SIDELINE
* NO EGA
* 519.DEGREE STANDARD DAY

ACOUSTIC ANGLE FROM INLET

FREQ	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	PWL
50.	56.5	59.4	61.1	62.1	62.8	63.1	66.6	67.0	65.8	67.1	74.1	80.4	84.2	86.2	83.1	158.5
63.	59.4	62.3	64.0	65.2	65.7	66.1	69.1	69.4	68.6	69.8	76.7	82.8	86.6	88.1	84.5	161.1
80.	61.5	64.5	66.4	67.4	68.2	68.6	71.6	71.9	71.4	72.5	78.9	84.8	88.3	89.3	85.0	163.1
100.	63.3	66.5	68.5	69.7	70.6	71.1	73.8	74.2	74.0	75.0	81.0	86.5	89.5	89.9	85.0	164.5
125.	64.5	67.9	70.1	71.6	72.5	73.1	75.8	76.3	76.6	77.6	83.3	88.6	90.4	90.1	84.4	165.5
160.	65.3	68.9	71.2	72.7	74.[illegible]	74.9	77.6	78.5	79.2	80.3	85.2	89.1	90.9	89.8	83.4	166.2
200.	56.2	69.8	72.2	73.8	75.2	76.3	78.6	79.8	81.1	82.6	86.8	90.1	91.1	89.1	82.3	166.7
250.	67.7	71.2	73.2	74.6	75.9	77.1	79.0	80.5	82.3	84.2	88.1	90.8	91.0	88.3	81.0	167.1
315.	72.5	75.3	76.3	76.5	76.9	77.6	79.5	80.7	82.9	85.4	88.9	91.3	90.8	87.3	79.8	168.2
400.	78.8	72.1	83.0	82.2	80.0	79.2	81.6	80.9	82.7	85.7	88.6	91.0	90.0	85.9	78.0	169.7
500.	80.7	85.2	87.4	87.9	86.9	84.2	85.8	82.2	82.2	85.[illegible]	87.7	90.2	88.7	83.9	75.4	170.0
630.	78.0	83.3	86.4	88.3	89.1	88.2	88.1	85.2	82.4	83.7	86.3	88.9	86.9	81.3	71.9	169.3
800.	75.9	81.0	83.4	85.2	86.9	87.9	86.4	86.3	84.1	82.7	84.8	87.3	84.8	78.4	68.0	168.5
1000.	73.3	79.2	82.3	83.9	84.1	84.5	83.5	84.4	84.8	82.6	83.2	85.4	82.5	75.1	63.7	167.8
1250.	70.4	77.3	80.6	82.0	82.9	83.0	82.4	81.7	83.3	82.7	81.7	83.0	79.5	71.0	59.9	167.0
1600.	65.2	73.2	77.3	79.8	81.1	81.0	80.3	79.9	80.1	81.3	79.9	79.9	75.9	66.5	56.5	166.1
2000.	59.4	69.2	74.1	76.5	77.8	78.6	77.7	77.6	77.9	78.2	77.4	76.4	71.7	61.8	52.0	165.2
2500.	51.8	63.5	69.4	72.6	74.5	75.1	74.5	74.2	74.7	74.5	73.2	71.8	66.2	56.3	43.8	164.1
3150.	40.5	55.6	63.0	67.2	69.4	70.5	69.6	69.5	70.0	69.7	67.6	65.8	58.9	48.3	31.4	162.8
4000.	23.4	43.4	53.3	58.7	61.9	63.5	62.[illegible]	62.8	63.3	62.7	60.1	57.5	48.9	36.1	14.4	161.3
5000.	12.5	35.5	46.8	53.1	56.7	56.6	58.2	58.3	58.8	57.9	54.9	51.8	42.3	28.0	3.7	159.9
6300.	-16.7	15.1	30.6	39.3	44.4	47.2	47.3	47.6	47.9	46.6	42.3	37.7	25.9	7.4	-25.6	158.6
8000.	-62.0	-16.2	6.0	18.4	25.7	29.9	30.6	31.2	31.2	28.9	23.4	16.5	.9	-24.1	-71.0	157.1
10000.	-123.2	-58.6	-27.3	-9.7	.7	6.7	8.5	9.4	9.0	5.7	-3.3	-13.2	-33.9	-68.0	-133.8	155.7
OASPL	85.7	90.3	92.8	94.0	94.4	94.1	94.2	93.3	93.4	94.4	97.2	100.2	100.5	98.9	93.3	179.7
PNL	90.9	96.2	99.1	100.6	101.5	101.3	101.5	100.6	100.7	101.5	103.2	105.4	104.4	100.6	93.2	
PNLT	90.9	97.6	100.1	100.6	101.5	101.3	101.5	100.6	100.7	101.5	103.2	105.4	107.7	102.0	93.2	

EPNL = 106.5

```
HIGH VELOCITY JET NOISE PROGRAM - ENGINEERING CORRELATION

CONICAL NOZZLE CHECK CASE

                        *** INPUT ***

TT =  519.        P      =  14.7
TTR= 13 .       PTR/PA=    3.247
EJECTOR AREA RATIO PARAMETER=      0.000       VJ=       35 .
PLUG DIA=       0. 00      CANT=       0.000

                        ***OUTPUT ***

DIA OF OUTER ROW=       1.728      EQUIV AREA DIA=      1.728

NOZZLE EXIT CONDITIONS
JR=       2184.0      RHOR=       .0397      AT=       2.346      AR=       2.346
```

HIGH VELOCITY JET NOISE PROGRAM - ENGINEERING CORRELATION

CONICAL NOZZLE CHECK CASE

* CONICAL MIXING NOISE
* 2400.0 FOOT ALTITUDE
* 0.0 FOOT SIDELINE
* 100 FOOT LAYER EGA
* 519.DEGREE STANDARD DAY

ACOUSTIC ANGLE FROM INLET

FREQ	20	30	40	5	60	70	80	90	100	110	120	130	140	150	160	PWL
50.	53.6	-6.3	58.0	59.0	59.9	60.5	64.3	65.2	63.6	65.5	73.2	79.8	83.7	85.7	82.5	158.4
63.	56.4	59.2	60.9	61.9	62.8	63.4	66.3	67.2	65.8	67.7	75.6	82.2	86.0	87.5	83.8	161.0
80.	58.0	59.9	62.7	63.8	64.8	65.3	68.3	69.2	68.1	70.0	77.6	84.0	87.6	88.6	84.3	163.0
100.	59.5	62.6	64.4	65.6	66.0	67.2	69.9	70.8	70.0	72.0	79.3	85.6	88.7	89.1	84.1	164.4
125.	60.5	63.9	65.9	67.1	68.2	68.9	71.4	72.3	71.8	73.8	81.0	86.9	89.5	89.2	83.3	165.2
160.	61.6	65.1	67.2	68.5	69.6	70.3	72.9	73.8	73.6	75.6	82.2	87.7	89.8	88.7	82.0	165.8
200.	62.4	66.2	68.4	69.8	[illegible]	71.7	74.0	75.0	75.0	77.1	83.1	88.3	89.7	87.8	80.3	166.0
250.	62.8	66.9	69.3	70.8	72.9	72.8	75.0	75.9	76.2	78.3	83.8	88.5	89.2	86.4	78.1	166.0
315.	62.9	67.3	69.9	71.5	72.8	73.7	75.7	76.6	77.3	79.3	84.3	88.4	88.4	84.7	75.4	165.8
400.	62.7	67.4	70.2	72.0	73.4	74.3	76.2	77.2	78.0	80.1	84.3	88.0	87.2	82.6	72.4	165.4
500.	62.1	67.3	70.3	72.2	73.8	74.7	76.4	77.4	78.5	80.5	84.1	87.3	85.7	80.2	69.0	165.0
630.	60.9	66.7	70.0	72.1	73.7	74.8	76.3	77.3	78.6	80.5	83.5	86.2	83.8	77.4	65.1	164.5
800.	59.2	65.6	69.3	71.6	73.4	74.5	75.9	76.9	78.4	80.2	82.6	84.7	81.6	74.3	60.8	163.9
1000.	56.9	64.1	68.2	70.7	72.7	73.9	75.2	76.2	77.8	79.5	81.3	82.9	79.1	70.8	56.1	163.2
1250.	53.8	61.9	66.5	69.4	71.5	72.9	74.0	75.1	76.8	78.3	79.5	80.6	75.9	66.6	50.6	162.4
1600.	49.2	58.7	64.0	67.3	69.7	71.2	72.2	73.3	75.1	76.4	77.0	77.7	72.2	61.7	44.0	161.5
2000.	43.4	54.7	60.8	64.5	67.3	69.0	70.0	71.0	72.9	73.9	74.0	74.1	67.8	56.2	36.5	160.5
2500.	35.8	49.3	56.5	60.9	[illegible]	65.9	66.9	68.0	69.9	70.6	70.1	69.7	62.4	49.4	27.1	159.4
3150.	24.7	41.5	50.3	55.6	59.3	61.5	62.5	63.7	65.5	65.9	64.7	63.6	55.1	40.3	14.5	158.2
4000.	8.0	29.8	41.0	47.7	52.2	55.0	56.1	57.4	59.1	59.0	57.1	55.1	45.1	27.6	-3.3	156.9
5000.	-2.6	22.2	34.4	42.4	47.5	50.6	51.8	53.1	54.7	54.3	51.8	49.3	38.2	19.2	-14.9	155.5
6300.	-31.7	1.4	18.9	28.9	35.4	39.3	40.9	42.4	43.8	42.7	39.1	35.1	21.6	-1.9	-44.9	154.1
8000.	-77.0	-29.4	-5.7	8.0	16.8	22.1	24.3	26.0	27.1	25.2	20.1	13.8	-3.6	-33.8	-90.8	152.5
10000.	-138.2	-71.7	-38.9	-21.0	-8.2	-1.0	2.2	4.3	5.0	1.9	-6.5	-15.9	-38.4	-77.7	-153.6	151.0
OASPL	72.2	76.9	79.8	81.7	83.3	84.4	86.1	87.1	88.0	89.9	93.9	98.0	98.9	97.6	91.9	176.7
PNL	75.7	81.7	85.4	88.1	90.4	91.8	93.2	94.3	95.6	97.0	99.8	102.9	101.9	98.4	90.0	
PNLT	75.7	83.1	86.5	88.1	90.4	91.8	93.2	94.3	95.6	97.0	99.8	102.9	103.0	99.5	90.0	

EPNL = 102.5

HIGH VELOCITY JET NOISE PROGRAM - ENGINEERING CORRELATION

CRITICAL NOZZLE CHECK CASE

* CRITICAL SHOCK NOISE
* 2400.0 FOOT ALTITUDE
* 0.0 FOOT SIDELINE
* 100 FOOT LAYER EGA
* 519.DEGREE STANDARD DAY

ACOUSTIC ANGLE FROM INLET

FREQ	20	30	40	5	60	70	80	90	100	110	120	130	140	150	160	PWL
50.	52.3	55.4	57.1	58.1	58.5	58.4	61.1	60.4	60.5	60.1	63.2	62.1	60.6	58.3	54.7	140.6
63.	55.0	58.2	60.0	61.0	61.9	61.4	64.4	63.9	64.0	63.7	66.9	65.9	64.3	62.0	58.3	143.9
[illegible]	57.4	[illegible]	62.7	63.8	64.4	64.5	67.6	67.3	67.5	67.4	70.4	69.4	67.8	65.4	61.6	147.2
[illegible]	59.4	[illegible]	65.1	66.4	67.6	67.5	71.4	70.3	70.7	70.7	73.8	72.8	71.2	68.7	64.9	150.0
[illegible]	60.5	[illegible]	66.7	68.2	69.3	70.0	72.7	73.0	73.7	74.6	77.5	76.7	75.0	72.5	68.4	152.7
160.	60.9	64.9	67.5	69.4	70.8	71.9	74.7	75.5	76.8	77.4	80.5	79.8	78.2	75.5	71.2	155.8
200.	61.5	65.6	68.2	70.1	71.8	73.3	75.5	77.0	78.9	80.1	82.8	82.4	80.7	77.9	73.3	158.4
250.	63.9	67.5	69.4	72.8	72.2	73.7	75.5	77.3	80.0	81.9	84.7	84.5	82.9	79.8	74.8	160.9
315.	75.4	73.3	73.9	73.5	[illegible]	73.8	75.7	77.1	80.3	83.0	85.7	86.0	84.3	80.9	75.5	164.4
400.	77.1	[illegible]	81.7	83.7	79.5	76.1	[illegible]	76.9	79.6	83.0	85.1	85.9	84.3	80.5	74.4	167.7
[illegible]	[illegible]	[illegible]	86.2	86.8	85.7	82.7	94.3	79.1	79.1	81.6	83.3	84.8	83.2	79.0	72.1	168.3
630.	76.2	81.8	85.1	87.1	87.9	87.0	86.8	83.3	78.4	78.9	80.5	82.9	81.4	76.5	68.6	167.5
800.	[illegible]	79.4	82.0	83.8	85.6	86.7	85.0	84.6	81.4	76.6	77.5	80.9	79.4	73.7	64.6	166.6
1000.	71.2	77.6	80.9	82.5	82.7	83.0	81.6	82.5	82.6	77.5	74.9	78.5	77.2	70.4	64.4	166.0
[illegible]	68.2	[illegible]	79.1	[illegible]	[illegible]	81.4	83.5	79.2	80.8	79.0	74.2	75.6	74.3	66.4	57.0	165.1
[illegible]	62.9	71.4	75.7	78.3	79.5	79.3	78.3	77.4	76.8	77.9	74.0	72.0	70.8	62.0	53.9	164.2
2000.	[illegible]	[illegible]	72.4	[illegible]	76.	75.9	75.6	75.0	74.6	74.1	72.2	68.1	66.7	57.9	49.5	163.3
2500.	49.3	61.6	67.7	71.0	72.8	73.3	72.3	71.5	71.2	70.0	67.6	63.3	61.1	53.1	41.4	162.3
3150.	38.1	[illegible]	61.3	65.5	67.6	68.6	67.2	66.6	66.3	65.1	61.5	57.7	53.7	45.5	29.0	160.9
4000.	21.0	[illegible]	51.5	57.0	60.	61.5	63.3	59.7	59.3	58.1	54.1	50.0	43.8	33.4	12.0	159.3
5000.	[illegible]	[illegible]	44.9	51.3	54.7	56.5	55.7	55.2	54.7	53.1	49.2	44.8	37.5	25.4	1.3	158.0
6300.	-19.2	13.1	28.8	37.5	42.4	[illegible]	44.7	44.4	43.7	41.8	36.7	30.9	21.3	4.9	-28.0	156.7
8000.	-64.5	[illegible]	4.1	16.6	23.8	27.7	[illegible]	27.9	27.0	24.3	18.0	9.9	-3.4	-26.5	-73.3	155.3
10000.	-125.7	[illegible]	-29.1	-11.6	-1.3	4.6	5.9	6.1	4.9	1.2	-8.6	-19.8	-38.3	-70.4	-136.1	154.0
OASPL	83.8	88.8	91.4	92.6	[illegible]	92.6	92.3	[illegible]	90.6	91.6	92.7	93.4	91.8	88.0	82.3	176.6
PNL	88.7	94.5	97.5	99.0	99.8	99.6	99.5	98.2	97.6	97.8	98.3	98.6	96.8	92.2	85.6	
PNLT	88.7	[illegible]	98.5	[illegible]	99.8	99.6	99.5	98.2	97.6	97.8	98.3	98.6	97.9	93.6	85.6	

EPNL = 101.8

HIGH VELOCITY JET NOISE PROGRAM - ENGINEERING CORRELATION

CONICAL NOZZLE CHECK CASE

* CONICAL TOTAL NOISE
* 2400.0 FOOT ALTITUDE
* 0.0 FOOT SIDELINE
* 100 FOOT LAYER EPA
* 519.DEGREE STANDARD DAY

ACOUSTIC ANGLE FROM INLET

FREQ	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	PWL
50.	56.0	58.9	60.6	61.6	62.3	[illegible]	66.0	66.5	65.3	66.6	73.6	79.8	83.7	85.7	82.5	159.5
63.	59.5	61.7	63.5	64.5	65.2	65.5	68.5	68.9	68.0	69.2	76.1	82.3	86.0	87.5	83.8	161.1
80.	60.7	63.9	65.7	66.8	[illegible]	[illegible]	[illegible]	71.3	70.8	71.9	78.3	84.2	87.6	88.6	84.3	163.1
100.	62.4	65.6	67.8	69.5	69.9	70.4	73.2	73.6	73.4	74.6	80.4	85.8	88.8	89.2	84.2	164.5
125.	63.6	67.1	69.3	70.7	[illegible]	72.5	75.1	75.7	75.9	76.9	82.6	87.3	89.7	89.1	83.5	165.5
160.	64.2	68.0	70.4	72.0	73.3	74.2	76.9	77.8	78.5	79.6	84.4	88.4	90.1	88.9	82.3	166.2
200.	65.0	68.9	71.3	73.0	74.4	75.6	77.8	79.1	80.4	81.8	86.0	89.3	90.2	88.2	81.1	166.7
250.	66.4	70.2	72.3	73.8	75.1	76.3	78.2	79.7	81.5	83.4	87.3	90.0	90.1	87.3	79.7	167.1
315.	71.1	74.2	[illegible]	75.6	76.	76.7	78.7	79.9	82.1	84.5	88.0	90.4	89.8	86.2	78.4	168.2
400.	77.1	[illegible]	82.9	81.3	79.7	78.3	83.8	80.1	81.9	84.8	87.7	90.1	89.0	84.7	76.5	169.7
500.	79.1	[illegible]	86.3	86.9	85.9	83.3	84.9	81.4	81.3	84.1	86.7	89.2	87.7	82.7	73.8	170.0
630.	76.3	82.0	85.3	87.3	88.1	87.3	87.2	84.3	81.5	82.8	85.3	87.9	85.8	80.0	70.7	169.3
800.	74.1	79.6	82.2	84.1	85.8	87.0	85.5	85.3	83.2	81.8	83.8	86.2	83.7	77.0	66.1	168.5
1000.	71.3	77.8	81.1	82.7	83.1	83.5	82.5	83.4	83.9	81.6	82.2	84.3	81.2	72.6	61.9	167.8
1250.	68.4	75.8	79.3	[illegible]	81.8	[illegible]	81.4	81.6	82.3	81.7	80.6	81.8	78.2	69.5	57.9	167.0
1600.	63.0	71.6	76.0	78.6	79.9	79.9	79.3	78.8	79.0	80.2	78.8	78.7	74.6	64.9	54.4	166.1
2000.	57.2	[illegible]	72.7	75.3	76.6	77.5	76.6	76.5	76.8	77.1	76.2	75.1	70.3	60.2	49.7	165.2
2500.	49.5	61.9	68.0	71.4	73.1	74.0	73.4	73.1	73.6	73.4	72.9	70.6	64.8	54.6	41.5	164.1
3150.	38.3	53.9	61.6	65.9	68.2	69.4	68.5	68.4	68.9	68.6	66.4	64.6	57.5	46.6	29.1	162.8
4000.	21.2	41.8	51.9	57.5	60.7	62.4	61.7	61.7	62.2	61.5	58.9	56.3	47.5	34.4	12.1	161.3
5000.	10.2	[illegible]	45.4	51.8	[illegible]	57.5	57.1	57.3	57.7	56.8	53.7	50.6	40.9	26.3	1.4	159.9
6300.	-19.0	13.4	29.2	[illegible]	[illegible]	[illegible]	46.2	46.5	46.8	45.3	41.1	36.5	24.5	5.8	-27.9	158.6
8000.	-64.2	-17.9	4.6	17.1	24.6	28.8	29.5	30.1	30.1	27.8	22.2	15.3	-.5	-25.8	-73.2	157.1
10000.	-125.4	[illegible]	-28.7	-11.0	-.5	5.6	7.4	8.3	7.9	4.6	-4.4	-14.4	-35.3	-69.7	-136.0	155.7
OASPL	84.1	[illegible]	91.7	93.0	93.4	93.2	93.2	92.4	92.5	93.5	96.4	99.3	99.6	98.1	92.3	179.7
PNL	89.2	94.9	97.9	99.5	100.5	100.3	100.5	99.7	99.7	100.5	102.3	104.4	103.3	99.5	91.9	
PNLT	89.2	96.3	99.3	99.5	100.5	100.3	100.5	99.7	99.7	100.5	102.3	104.4	104.4	100.9	91.9	

EPNL = 105.4

```
HIGH VELOCITY JET NOISE PROGRAM - ENGINEERING CORRELATION

DUAL FLOW MULTI-TUBE CHECK CAS

                    *** INPUT ***

NO OF TUBES=  69
DIA OF TUBES=        .3 6       ARC=       2.75?
NOZZLE OUTER DIA=       6.687
A8=     7.649      A28=       5.?83
TT28= 1632.      PT28/P3=      3.2?8
T3=  519.      P3=  14.730
TT8= 101 .      PT8/P3=      1.567
EJECTOR AREA RATIO PARAMETER=      1.333      V =       ?.?
PLUG DIA=      2.?46      CANT=      ?.000

                    ***OUTPUT ***

OUTER NOZZLE EXIT CONDITIONS
U28=    2389.2     RHO28=      .?33    DUCT H=      .749

INNER NOZZLE EXIT CONDITIONS
U8=    1209.8     RHO8=     .0445

COANNULAR NOZZLE FLOW PARAMETERS

MERGED FLOW CONDITIONS
U5=    1024.5     RHO5=    .055?     D5=      6.178     A5=    29.978

MIXED FLOW CONDITIONS
U6=    1209.8     TT6= 1?1?.     W6=  2?27.7?     A6=    37.627
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HIGH VELOCITY JET NOISE PROGRAM - ENGINEERING CORRELATION

DUAL FLOW MULTI-TUBE CHECK CASE

- MERGED NOISE
- 320.0 FOOT ARC
- 0 EGA
- 519.DEGREE STANDARD DAY

ACOUSTIC ANGLE FROM INLET

FREQ	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	PWL
50.	82.7	83.2	83.6	84.1	84.8	85.5	86.5	87.8	88.9	90.8	93.7	97.0	100.2	102.5	102.9	155.1
63.	83.4	83.9	84.4	84.9	85.6	86.3	87.3	88.6	89.9	91.8	94.5	97.4	100.1	101.8	101.7	154.9
80.	84.0	84.5	84.9	85.5	86.2	86.9	87.9	89.2	90.7	92.6	95.1	97.6	99.8	100.8	100.2	154.6
100.	84.3	84.8	85.3	85.8	86.6	87.3	88.3	89.6	91.2	93.2	95.4	97.5	99.2	99.6	98.5	154.2
125.	84.5	85.0	85.5	86.0	86.7	87.5	88.5	89.7	91.6	93.5	95.5	97.3	98.5	98.3	96.6	153.8
160.	84.5	85.0	85.5	86.0	86.7	87.5	88.5	89.8	91.7	93.6	95.4	96.7	97.4	96.6	94.3	153.2
200.	84.2	84.8	85.3	85.8	86.5	87.3	88.3	89.6	91.6	93.5	95.1	96.1	96.3	94.9	92.2	152.5
250.	83.8	84.4	84.9	85.4	86.2	86.9	87.9	89.2	91.4	93.2	94.5	95.2	95.1	93.1	89.9	151.8
315.	83.2	83.8	84.3	84.9	85.6	86.4	87.4	88.7	90.9	92.7	93.8	94.2	93.7	91.1	87.5	150.9
400.	82.5	83.0	83.5	84.1	84.9	85.6	86.6	87.9	90.2	91.9	92.9	92.9	92.0	89.0	84.9	149.9
500.	81.6	82.1	82.7	83.2	84.	84.8	85.8	87.1	89.4	91.0	91.8	91.6	90.4	87.0	82.6	148.8
630.	80.5	81.1	81.6	82.2	83.	83.7	84.7	86.0	88.4	90.0	90.6	90.1	88.7	84.9	80.1	147.7
800.	79.3	79.8	80.4	81.0	81.7	82.5	83.5	84.8	87.3	88.7	89.1	88.5	86.8	82.6	77.6	146.3
1000.	78.0	78.6	79.1	79.7	80.5	81.3	82.3	83.6	86.0	87.3	87.7	86.9	85.0	80.5	75.2	145.0
1250.	76.6	77.2	77.8	78.3	79.1	79.9	80.9	82.2	84.7	85.8	86.1	85.1	83.1	78.4	73.0	143.6
1600.	75.0	75.6	76.2	76.7	77.5	78.3	79.3	80.6	83.1	84.[illegible]	84.3	83.2	81.0	76.1	70.5	142.0
2000.	73.5	74.1	74.6	75.2	76.[illegible]	76.8	77.8	79.1	81.6	82.3	82.6	81.3	79.1	74.0	68.3	140.6
2500.	71.9	72.5	73.0	73.6	74.4	75.2	76.2	77.5	80.0	80.5	80.8	79.4	77.0	71.9	66.1	139.2
3150.	70.1	70.7	71.2	71.8	72.6	73.4	74.4	75.7	78.3	78.5	78.8	77.3	74.8	69.6	63.9	137.7
4000.	68.1	68.7	69.2	69.8	70.6	71.4	72.4	73.7	76.3	76.3	76.6	75.0	72.4	67.1	61.5	136.3
5000.	66.6	67.2	67.7	68.3	69.1	69.8	70.8	72.1	74.7	74.5	74.9	73.2	70.5	65.1	59.5	135.1
6300.	64.4	64.9	65.4	66.0	66.8	67.5	68.5	69.8	72.5	71.9	72.4	71.6	67.7	62.2	56.9	133.9
8000.	61.5	62.1	62.6	63.2	63.9	64.7	65.7	67.0	69.6	68.8	69.3	67.3	64.3	58.7	53.5	132.9
10000.	58.3	58.8	59.3	59.9	60.6	61.4	62.4	63.7	66.4	65.2	65.9	63.7	60.3	54.6	49.7	132.2
OASPL	94.7	95.2	95.7	96.2	97.	97.7	98.7	100.0	102.0	103.7	105.4	106.9	108.2	108.7	108.0	163.9
PNL	100.6	101.2	101.7	102.3	103.1	103.8	104.8	106.1	108.4	109.8	110.7	110.9	110.5	108.7	106.2	
PNLT	100.6	101.2	101.7	102.3	103.1	103.8	104.8	106.1	108.4	109.8	110.7	110.9	110.5	108.7	106.2	

HIGH VELOCITY JET NOISE PROGRAM - ENGINEERING CORRELATION

DUAL FLOW MULTI-TUBE CHECK CASE

* PREMERGED NOISE
* 320.0 FOOT ARC
* NO EGA
* 519.DEGREE STANDARD DAY

ACOUSTIC ANGLE FROM INLET

FREQ	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	PWL
50.	66.1	65.2	64.7	64.5	65.[illegible]	65.4	68.0	73.1	73.9	77.4	75.6	73.6	72.8	72.2	71.7	132.6
63.	68.6	67.8	67.3	67.0	67.5	67.9	70.5	72.6	75.2	78.4	76.6	74.7	73.8	73.3	72.7	133.9
80.	71.2	70.4	69.9	69.6	70.1	70.5	73.1	75.2	76.9	79.9	78.1	76.1	75.3	74.7	74.2	135.7
100.	73.6	72.8	72.3	72.0	72.5	73.0	75.5	77.6	78.7	81.5	79.7	77.8	76.9	76.4	75.8	137.6
125.	75.9	75.1	74.7	74.4	74.9	75.4	78.0	80.0	80.6	83.4	81.6	79.6	78.8	78.2	77.7	139.6
160.	78.4	77.6	77.2	77.0	77.5	78.0	80.6	82.7	82.8	85.6	83.8	81.9	81.0	80.5	79.9	142.0
200.	80.5	79.8	79.4	79.3	79.8	80.2	82.9	84.9	84.9	87.7	85.9	84.0	83.1	82.6	82.0	144.2
250.	82.5	81.9	81.5	81.4	82.[illegible]	82.4	85.0	87.1	87.0	89.9	88.1	86.1	85.3	84.8	84.2	146.3
315.	84.4	83.9	83.6	83.5	84.1	84.6	87.2	89.3	89.1	92.1	90.3	88.4	87.6	87.0	86.5	148.6
400.	86.2	85.8	85.6	85.5	86.2	86.6	89.2	91.3	91.3	94.4	92.6	90.7	89.8	89.3	88.8	150.8
500.	87.7	7.4	87.2	87.2	87.9	88.3	91.0	93.1	93.2	96.4	94.7	92.7	91.9	91.3	90.8	152.7
630.	89.1	8.8	88.7	88.8	89.5	89.8	92.5	94.6	94.9	98.2	96.6	94.7	93.8	93.3	92.8	154.6
800.	90.2	90.0	90.0	90.2	90.9	91.1	93.8	96.0	96.5	99.9	98.5	96.5	95.7	95.1	94.6	156.3
1000.	91.0	90.9	91.0	91.2	92.	92.0	94.7	96.9	97.7	101.2	99.9	98.0	97.1	96.6	96.0	157.6
1250.	91.5	91.5	91.7	91.9	92.8	92.5	95.2	97.4	98.5	102.0	101.1	99.1	98.3	97.7	97.2	158.6
1600.	91.6	91.8	92.0	92.3	93.2	92.6	95.3	97.5	98.9	102.4	101.9	100.0	99.2	98.6	98.1	159.4
2000.	90.5	90.7	91.1	91.4	92.4	91.2	93.9	96.1	97.8	101.3	101.4	99.5	98.7	98.1	97.6	158.7
2500.	87.8	88.1	88.5	89.0	90.	88.1	90.9	93.1	95.1	98.6	99.3	97.4	96.5	96.0	95.4	156.6
3150.	84.7	85.1	85.6	86.1	87.2	84.7	87.5	89.7	91.9	95.3	96.8	94.8	94.0	93.4	92.9	154.2
4000.	81.2	81.7	82.3	82.9	84.	81.0	83.8	86.0	88.5	91.8	93.8	91.8	91.0	90.5	89.9	151.7
5000.	78.3	78.9	79.6	80.2	81.4	78.1	80.9	83.1	85.8	89.0	91.3	89.4	88.5	88.0	87.4	149.5
6300.	74.8	75.5	76.2	76.9	78.1	74.8	77.7	79.9	82.8	85.8	88.1	86.2	85.3	84.8	84.3	147.6
8000.	72.1	72.9	73.7	74.5	75.7	73.1	76.0	78.2	81.2	84.0	85.7	83.8	82.9	82.4	81.8	147.5
10000.	71.5	72.4	73.3	74.1	75.4	74.7	77.6	79.8	82.9	85.5	85.3	83.4	82.6	82.0	81.5	150.6
OASPL	100.0	100.0	100.1	100.3	101.2	100.7	103.4	105.6	106.6	110.1	109.5	107.6	106.7	106.2	105.7	167.2
PNL	110.9	111.1	111.3	111.6	112.6	111.5	114.2	116.4	117.9	121.3	121.3	119.3	118.5	118.0	117.4	
PNLT	110.9	111.1	111.3	111.6	112.6	111.5	114.2	116.4	117.9	121.3	121.3	119.3	118.5	118.0	117.4	

HIGH VELOCITY JET NOISE PROGRAM - ENGINEERING CORRELATION

DUAL FLOW MULTI-TUBE CHECK CASE

* SHOCK (M-F) NOISE
* 325.0 FOOT ARC
* NO EGA
* 519.DEGREE STANDARD DAY

ACOUSTIC ANGLE FROM INLET

FREQ	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	PWL
50.	42.5	42.5	42.5	42.5	42.6	42.9	44.1	44.6	44.6	44.6	42.8	44.9	40.0	39.5	38.9	103.5
63.	46.1	46.1	46.2	46.2	46.3	46.6	47.8	48.3	48.3	48.4	46.5	44.6	43.7	43.2	42.6	107.2
80.	49.9	49.9	50.0	50.0	50.1	50.4	51.7	52.2	52.2	52.2	50.4	48.4	47.6	47.0	46.5	111.1
100.	53.4	53.5	53.5	53.5	53.7	53.9	55.2	55.7	55.8	55.8	53.9	52.6	51.2	50.6	50.1	114.6
125.	56.9	56.9	57.0	57.0	57.2	57.5	58.8	59.3	59.3	59.4	57.5	55.6	54.7	54.2	53.7	118.2
160.	60.6	60.7	60.7	60.8	61.	61.3	62.7	63.2	63.3	63.3	61.5	59.5	58.7	58.2	57.6	122.1
200.	63.9	64.0	64.1	64.2	64.4	64.8	66.1	66.7	66.8	66.8	65.1	63.1	62.3	61.7	61.2	125.6
250.	66.9	67.1	67.2	67.4	67.7	68.1	69.6	70.2	70.3	70.4	68.6	66.7	65.8	65.3	64.7	129.0
315.	69.8	70.0	70.3	70.5	71.	71.4	73.0	73.7	73.9	74.0	72.3	70.4	69.5	68.9	68.4	132.5
400.	72.3	72.6	73.0	73.4	74.	74.7	76.3	77.2	77.5	77.7	76.	74.1	73.3	72.7	72.1	136.0
500.	74.1	74.5	75.0	75.7	[illegible]	77.3	79.2	80.3	80.7	81.	[illegible]	77.6	76.9	76.2	75.5	139.1
630.	75.2	75.7	76.5	77.4	78.6	79.6	81.9	83.2	83.9	84.6	83.1	81.	80.3	79.7	79.0	142.1
800.	75.8	76.4	77.2	78.4	79.9	81.2	84.0	85.8	86.9	87.6	86.6	84.8	83.9	83.2	82.5	145.0
1000.	76.9	77.2	77.9	78.9	80.5	82.	85.2	87.7	89.3	90.5	89.9	88.2	87.3	86.5	85.6	147.6
1250.	80.7	80.0	79.5	79.6	80.4	81.4	85.0	88.1	90.5	92.3	92.4	[illegible]	89.8	88.9	87.9	149.5
1600.	88.9	87.8	86.1	84.1	[illegible]	81.1	84.1	87.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	90.7	89.5	151.2
2000.	93.1	92.7	91.9	[illegible]	87.7	[illegible]	86.7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	152.2
2500.	90.6	91.0	91.3	91.2	[illegible]	[illegible]	82.7	81.2	84.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	150.8
3150.	85.3	85.6	86.3	87.3	88.2	85.0	84.1	80.0	78.6	83.	[illegible]	89.1	[illegible]	84.5	82.1	147.8
4000.	81.9	81.9	81.6	81.2	[illegible]	79.7	81.6	80.0	75.1	[illegible]	[illegible]	[illegible]	[illegible]	79.2	76.3	143.9
5000.	78.8	78.5	78.4	78.5	[illegible]	74.1	76.8	78.2	[illegible]	[illegible]	[illegible]	[illegible]	78.1	74.5	71.2	140.7
6300.	74.7	[illegible]	75.2	[illegible]	74.7	[illegible]	[illegible]	73.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	138.1
8000.	[illegible]	71.8	71.6	[illegible]	[illegible]	68.7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	137.2
10000.	[illegible]	[illegible]	71.1	71.2	71.1	[illegible]	71.3	71.4	71.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	67.5	140.0
OASPL	96.9	96.7	96.3	95.9	95.1	92.5	93.7	95.3	97.2	[illegible]	[illegible]	[illegible]	[illegible]	97.1	95.7	158.7
PNL	109.4	109.3	109.4	109.3	108.8	105.7	106.0	105.8	107.6	109.3	112.1	111.2	110.0	108.4	106.8	
PNLT	110.5	110.4	110.2	109.3	108.8	105.7	106.0	106.7	107.6	109.9	112.1	111.2	110.0	108.4	106.8	

HIGH VELOCITY JET NOISE PROGRAM - ENGINEERING CORRELATION

DUAL FLOW MULTI-TUBE CHECK CASE

- TOTAL NOISE
- 320.0 FOOT ARC
- [illegible]0 EGA
- 519.DEGREE STANDARD DAY

ACOUSTIC ANGLE FROM INLET

FREQ	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	PWL
50.	82.8	83.2	83.7	84.1	84.8	85.6	86.6	87.8	89.0	91.0	93.8	97.0	100.2	102.5	102.9	155.1
63.	83.6	84.0	84.4	84.9	85.6	86.4	87.4	88.7	90.0	92.0	94.6	97.4	100.1	101.8	101.7	155.0
80.	84.2	84.7	85.1	85.6	86.3	87.6	88.2	89.3	90.9	92.8	95.2	97.6	99.8	100.8	100.2	154.7
100.	84.7	85.1	85.5	86.0	86.7	87.4	88.5	89.8	91.5	93.4	95.5	97.6	99.2	99.7	98.5	154.3
125.	85.1	85.4	85.8	86.3	87.[illegible]	87.7	88.8	90.2	91.9	93.9	95.7	97.3	98.5	98.3	96.7	153.9
160.	85.4	85.7	86.1	86.5	87.2	87.9	89.1	90.5	92.2	94.3	95.7	96.9	97.5	96.7	94.5	153.5
200.	85.9	86.0	86.3	86.7	87.4	88.1	89.4	90.9	92.5	94.5	95.6	96.3	96.5	95.1	92.6	153.1
250.	86.3	86.4	86.6	86.9	87.6	88.1	89.8	91.3	92.7	94.9	95.4	95.7	95.5	93.7	91.0	152.9
315.	97.0	86.9	87.1	87.3	88.	88.6	90.4	92.1	93.2	95.5	95.4	95.2	94.6	92.6	90.0	152.9
400.	87.9	87.8	87.8	88.0	88.7	89.3	91.3	93.1	93.9	96.4	95.8	95.0	94.1	92.2	90.3	153.5
500.	88.8	88.7	88.7	88.9	89.6	90.1	92.3	94.2	94.9	97.6	96.6	95.3	94.3	92.8	91.5	154.3
630.	89.8	89.7	89.7	89.9	90.7	91.1	93.5	95.5	96.1	99.0	97.7	96.1	95.2	94.0	93.2	155.6
800.	90.7	90.6	90.7	90.9	91.7	92.1	94.6	96.7	97.4	100.5	99.2	97.4	96.5	95.6	94.9	157.0
1000.	91.4	91.3	91.5	91.7	92.6	92.8	95.4	97.5	98.5	101.7	100.5	98.7	97.8	97.1	96.4	158.2
1250.	92.0	92.0	92.1	92.3	93.2	93.1	95.8	98.0	99.3	102.5	101.7	99.9	99.0	98.3	97.7	159.2
1600.	93.6	93.3	93.1	93.0	93.7	93.0	95.7	98.0	99.6	103.0	102.7	100.9	109.0	99.3	98.6	160.0
2000.	95.0	94.9	94.5	93.9	93.7	91.9	94.4	96.5	98.4	101.9	102.3	100.5	99.6	98.9	98.2	159.7
2500.	92.5	92.8	93.2	93.3	93.2	90.1	91.7	93.5	95.5	99.0	100.1	98.4	97.5	96.7	96.0	157.7
3150.	88.1	88.4	89.0	89.8	90.8	88.0	89.3	90.3	92.3	95.7	97.4	95.7	94.8	94.0	93.2	155.2
4000.	84.7	84.9	85.1	85.2	86.2	83.7	86.0	87.1	88.9	92.0	94.2	92.5	91.6	90.8	90.1	152.5
5000.	81.7	81.9	82.2	82.6	83.3	80.0	82.6	84.6	86.5	89.2	91.6	89.9	89.0	88.2	87.5	150.2
6300.	77.9	78.4	78.9	79.3	80.	76.8	79.1	81.1	83.7	86.0	88.4	86.7	85.7	84.9	84.3	148.3
8000.	75.2	75.6	76.0	76.5	77.5	74.9	77.2	79.1	81.9	84.3	85.9	84.2	83.2	82.5	82.0	148.0
10000.	74.4	74.9	75.5	76.[illegible]	76.9	74.[illegible]	78.6	80.5	83.3	85.8	85.5	83.7	82.7	82.1	81.6	151.0
OASPL	102.5	102.5	102.6	102.7	103.3	102.9	105.0	106.9	108.3	111.3	111.3	110.6	110.8	110.8	110.1	169.3
PNL	114.7	114.7	115.0	115.1	115.5	113.8	115.9	117.8	119.5	122.6	123.2	121.9	121.3	120.6	119.7	
PNLT	114.7	114.7	115.0	115.1	115.5	113.8	115.9	117.8	119.5	122.6	123.2	121.9	121.3	120.6	119.7	

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HI [illegible] VELOCITY JET NOISE PROGRAM - ENGINEERING CORRELATION

[illegible] CHECK CASE

*** INPUT ***

[illegible]          ARO=      1.756
[illegible]    AREA [illegible]=         .31[illegible]
[illegible]      2.671
AR=      .311      A2R=      1.55[illegible]
TT2R= 175[illegible].      [illegible]T2R/P =      3.97[illegible]
T[illegible]=  519.      P =  14.7[illegible]
TT[illegible]= 14[illegible].      [illegible]=      1.4[illegible]
[illegible] AREA [illegible] PARAMETER=      [illegible]      V[illegible]=      35[illegible].
PLUG DIA=      1.[illegible]      CANT=      [illegible].000

***OUTPUT ***

OUTER NOZZLE EXIT CONDITIONS
V2R=    2639.[illegible]      RHO2R=      .[illegible]26      DUCT H=      .378

INNER NOZZLE EXIT CONDITIONS
V8=    1382.8      RHO8=      .329[illegible]

COANNULAR NOZZLE FLOW PARAMETERS

MERGED FLOW CONDITIONS
V5=    1475.7      RHO5=      .054[illegible]      D5=      2.673      A5=      5.612

MIXED FLOW CONDITIONS
V6=    1469.2      TT6=    948.      W6=    4[illegible]5.354      A6=      6.423
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HIGH VELOCITY JET NOISE PROGRAM - ENGINEERING CORRELATION

DUAL FLOW MULTI-CHUTE CHECK CASE

* TOTAL NOISE
* 2400.0 FOOT ALTITUDE
* 0.0 FOOT SIDELINE
* NO FGA
* 519.DEGREE STANDARD DAY

ACOUSTIC ANGLE FROM INLET

FREQ	20	30	40	5	60	70	80	90	100	110	120	130	140	150	160	PWL
50.	53.4	56.3	58.1	59.2	60.[illegible]	60.6	63.9	64.2	63.5	64.6	69.4	73.8	77.4	79.9	78.3	154.4
63.	56.3	59.3	61.0	62.1	62.9	63.5	65.5	65.8	65.2	66.3	71.0	75.2	78.4	80.4	78.3	155.4
[illegible].	57.8	[illegible]	62.6	63.7	64.[illegible]	65.1	67.[illegible]	67.4	66.9	67.9	72.3	76.2	79.0	80.5	77.8	156.0
1[illegible].	59.3	62.3	64.1	65.2	66.[illegible]	66.6	68.3	68.7	68.3	69.4	73.5	76.9	79.3	80.2	76.9	156.3
125.	60.6	[illegible].7	65.4	66.5	67.3	67.8	69.5	69.8	69.6	70.7	74.5	77.5	79.3	79.5	75.6	156.4
160.	61.8	64.9	66.6	67.7	68.5	69.0	70.7	71.0	70.9	71.9	75.2	77.7	79.0	78.5	74.0	156.4
200.	63.1	66.2	67.9	68.9	69.7	70.2	71.7	72.0	72.0	73.0	75.7	77.8	78.5	77.3	72.1	156.3
250.	64.2	67.3	69.1	70.0	70.8	71.2	72.8	73.0	72.9	74.0	76.3	77.7	77.8	75.8	70.0	156.3
315.	65.1	68.3	70.1	71.1	71.[illegible]	72.1	73.8	74.1	74.0	75.0	76.9	77.6	77.0	74.3	67.9	156.4
400.	65.8	69.3	71.1	72.1	72.8	73.1	75.0	75.3	75.1	76.1	77.6	77.6	76.3	73.0	66.4	156.9
500.	66.3	72.1	72.1	73.1	73.9	74.2	76.1	76.5	76.4	77.4	78.9	78.1	76.2	72.5	66.0	157.7
630.	66.4	70.6	72.7	73.8	74.7	75.0	77.1	77.7	77.8	78.9	80.3	79.0	76.7	72.6	66.2	159.0
800.	65.9	70.7	73.1	74.3	75.3	75.7	77.7	78.4	78.9	80.3	81.4	79.9	77.2	72.8	65.9	160.5
1000.	65.3	70.7	73.3	74.6	75.6	76.0	77.9	78.7	79.5	81.2	82.3	80.7	77.6	72.7	65.1	162.0
1250.	65.[illegible]	71.1	73.8	75.[illegible]	75.8	76.[illegible]	77.8	78.6	79.7	81.8	82.3	80.6	77.0	71.4	62.8	164.2
1600.	64.9	72.4	75.6	76.4	76.[illegible]	75.8	77.8	77.9	78.8	81.2	80.2	78.2	74.1	67.7	57.8	166.0
2000.	61.2	[illegible].9	75.8	74.0	78.[illegible]	76.9	77.4	76.2	76.5	78.9	75.6	74.3	69.6	62.4	51.1	165.4
2500.	52.2	64.3	70.5	74.1	76.3	76.4	75.1	73.6	73.2	75.1	72.3	69.5	64.0	56.0	42.8	163.7
3150.	40.5	55.4	62.6	66.6	69.0	71.2	69.9	69.8	69.0	70.1	66.6	63.2	56.8	47.5	31.6	162.1
4000.	23.0	43.0	52.8	58.2	61.1	62.7	61.9	62.8	62.9	63.0	58.7	54.5	46.7	35.5	15.1	160.4
5000.	11.6	34.8	46.1	52.1	55.7	57.5	57.1	57.4	58.5	58.3	53.1	48.3	39.9	27.7	4.2	158.7
6300.	-18.[illegible]	13.5	29.1	37.8	43.1	45.6	45.5	46.1	47.0	46.7	40.9	34.5	24.0	7.7	-25.2	156.8
8000.	-64.6	-18.6	3.7	14.1	23.5	27.7	29.1	29.9	30.6	29.6	22.9	14.2	.1	-23.2	-69.9	155.6
10000.	-125.9	-51.0	-29.5	-11.9	-1.2	4.6	7.7	8.9	9.5	7.2	-3.7	-15.5	-34.7	-67.1	-132.7	154.9
OASPL	76.0	[illegible]1.0	83.8	85.3	86.1	86.1	87.5	87.7	88.1	89.8	90.6	90.3	89.8	89.1	85.6	174.0
PNL	82.9	89.9	94.0	96.1	96.9	97.1	97.4	97.0	97.3	99.1	98.8	97.7	95.1	91.1	85.0	
PNLT	82.9	91.4	95.2	96.1	96.9	97.1	97.4	97.0	97.3	99.1	98.8	97.7	98.4	92.5	85.0	

EPNL = 100.2

3.7 PROGRAM SOURCE CODE LISTING

This section contains the FORTRAN IV source code listing for the engineering correlation computer program, suitable for running on the CDC 7600 computer. The listing of subroutines is as follows:

(1) Main Program (MS)

(2) SUB1 (Contains SUB1 through SUB6)

(3) EXTP

(4) SHKSUB

(5) PNLPT

(6) TPNLC

(7) PNTT8

(8) A block data listing

(9) EJECTS

```
      PROGRAM [illegible](INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT)
C     [illegible] -- ENGINEERING CORRELATION FOR TASK 2
      COMMON /[illegible]/ [illegible]
      [illegible](24),[illegible](24),F(24),F(24),S(15,24),[illegible](24,5),C(15,5),
     1 [illegible](15,24),Y1(24),Y(24),C1(15),EVE(20),
     1 S1(24),G(2,24),C2(15,2),[illegible](20),D(20),W(5),A(4),V(3),F1(15,24)
      COMMON /C02/ [illegible],Y9,T8,T5,R7,P1,Z9,DJ,AJ,[illegible],U,E9
     1 ,T6,V9,C9,[illegible],Q,L9,A6,A7,S6,P9,B9,ALI,SL,ANI,NFLT
      COMMON /[illegible]/ [illegible],IICASE(6),IDCASE(6),IDENT(6)
      REAL [illegible]
      REAL [illegible]
      NAMELIST/INPUT/ Y9,P9,TT3,A9,RP,K9,N,P9,P4,R6,S1J,SS,A7,
     1 N1,DT,Z5,[illegible],AA8,TT4,[illegible],TT5,ALT,SL,U,F9,V0,A6,L9,A,P5,RR,RX
     1 ,NFLT
C
C
      DATA F/5[illegible],[illegible],80.,100.,125.,160.,200.,250.,315.,400.,500.,630.,
     1800.,1000.,1250.,1600.,2000.,2500.,3150.,4000.,5000.,6300.,8000.,
     1 10000./
      DATA C/15*1./
      DATA IM/2[illegible]/
      DATA MM/2[illegible]/
      DATA [illegible]/1/
      DATA C2/0.7,1.0,1.35,1.8,2.35,2.7,3.4,4.2,5.0,
     1 5.5,5.[illegible],4.9,4.5,3.8,2.8,0.0,0.0,0.0,0.0,
     1 0.0,0.[illegible],0.0,0.1,0.4,[illegible],1.7,2.9,4.2,5.4,6.7/
      DATA S1/-.[illegible],-.[illegible],-.[illegible],-.398,-.301,-.201,-.097,[illegible],.097,.204,
     1 .3[illegible],.[illegible],.[illegible],.[illegible],.[illegible],.799,.9[illegible],1.,1.097,1.204,1.301,1.398,
     1 1.49[illegible],[illegible]/
      DATA ((G(I,J),I=1,2),J=1,24)/131.8,.72,135.4,.72,139.2,.72,
     1 142.4,.72,145.,.7,147.5,.68,148.6,.64,148.7,.6,148.,.55,
     1 147.2,.5,146.5,.45,145.7,.39,144.8,.33,143.9,.27,142.5,.2,
     1 141.,.[illegible],139.5,.[illegible],138.3,.[illegible],137.,[illegible],135.[illegible],134.1,0.,
     1 132.6,[illegible],131.3,[illegible],130.,[illegible]/
      WRITE(6,101)
  101 FORMAT(1H1////////////////
     1   50X,*XX         XX        XXXXXXX*/
     1   50X,*AXX       XXX        XXXXXXX*/
     1   50X,*AXXXX   XXXX         XX      */
     1   50X,*XX  XXXX  XX         XX      */
     1   50X,*XX    XX  XX         XXXXXXX*/
     1   50X,*XX         XX        XXXXXXX*/
     1   50X,*AX         XX             XX*/
     1   50X,*AX         XX             XX*/
     1   50X,*XX         XX        XXXXXXX*/
     1   50X,*XX         XX        XXXXXXX*//////
      X/40X,41H[illegible] XXXXX X     X   XXXXX  XXXXXX  XXXXXX  X     X
      X/40X,41HX          X   X   X            X     X          XX   XX
      X/40X,41HXXX          XX      XXX          X     X          X XX  X
      X/40X,41H     XXX      X          XXX      X     XXXX       X     X
      X/40X,41H        X      X             X    X     X          X     X
      X/40X,41H[illegible]XXXXX         X     XXXXX        X     XXXXXX  X     X)
      WRITE(6,103)
  103 FORMAT(///34X,48HHIGH VELOCITY JET NOISE PROGRAM(CONTRACT DOT-OS-
     16[illegible]3[illegible])/44X,3[illegible]HTASK 3 -- ENGINEERING CORRELATION //)
   12 READ(5,11)(IDENT(I),I=1,6)
   11 FORMAT(6A[illegible])
```

```
      IF(EOF(5)) 9999,14
   14 CONTINUE
      IF((IIC T(1).AND.7777 0000000000000B).EQ.IN) GO TO 16
      IF((IIC T(1).AND.7777 0000000000000B).EQ.MN) GO TO 244
      WRITE(6,13)(IICT(I),I=1,6)
   13 FORMAT(2X,6A10)
      GO TO 1
   16 BACKSPACE 5
  244 DO 23 I=1,6 $ IICASE(I)=10H
   23 CONTINUE
  24       GO TO 
      READ(5,11)(IOCASE(I),I=1,6)
      IF(EOF(5)) 9999,15
   15 CONTINUE
      IF((IOCASE(1).AND.7777 0000000000000B).EQ.IN) GO TO 17
      DO 22 I=1,6 $ IICASE(I)=IOCASE(I)
   22 CONTINUE
      GO TO 21
   17 BACKSPACE 5
C
   21  T0=519 $ P0=14.7 $ R1=.76475 $ PI=3.14159
       K1=1
       R7=0 $ K2=0 $ K7=0
       A9=49. 18*SQRT(T0)
  100  READ(5,INPUT)
      IF(EOF(5)) 9999,2500
 2500  T3=TT3 $ R9=RR $ R1=RT $ R2=RN $ A8=AA8
       T4=TT4 $ T5=TT5 $ AN1=
       PRINT 251
  251 FORMAT(1H1///,*     HIGH VELOCITY JET NOISE PROGRAM - ENGINEERING*,
     1 * CORRELATION*//)
      WRITE(6,19)(IICASE(I),I=1,6)
   19 FORMAT(1X,6A10//)
   2.  PRINT 2000
 2000  FORMAT(25X,13H*** INPUT ***/)
C
C
        GO TO(295,370,320,415,425,425),Y9
C        CONICAL NOISE ENTRY
  295      R1=SQRT(A9/P1) $ A7=0 $ R2=SQRT(A9/P1+R9**2) $ AN1=1 $ R9=0
       N=1
       GO TO 390
C           MULTI-CHUTE/SPOKE NOISE ENTRY
  320      R2=N*(R4+S5)/(2*P1)
       R1=SQRT(4*((R4+R6)/2)*(R2-R9*12)/P1)/24
       R2=R2/12
       S1=S5/R4+1
       PRINT 2002,N,2*R1,A7
 2002   FORMAT(* NO OF CHUTES/SPOKES=*,I4/* DIA OF CHUTE EQUIV AREA*,
     1 * TUBE=*,F10.3,5X,*ARD=*,F10.3)
       GO TO 390
C          MULTI-TUBE NOISE ENTRY
  370      R1=R1/24*R2=SQRT(...A7*R1**2+R9**2)
       PRINT 2004,N,2*R1,A7
  390      PRINT 2006,T5,P ,T3,R9
  395      PRINT 2016,A6,V
 2016  FORMAT(* ...RATIO PARAM...=*,F10.3,5X,*V =*,F10.1)
```

```
            PRINT 2208,R9*2,R9
      2206  FORMAT(* NO OF TUBES=*,I4,5X,
           1/* DIA OF TUBES=*,F10.3,5X,*ARD=*,F10.3)
      2  A  FORMAT(* TO =*,F6.0,5X,*        =*,F8.3/* TTR=*,F6.0,5X,*PTR/PS=*,
           1F8.3)
      2208  FORMAT(* PLUG DIA=*,F1 .3,5X,*CANT=*,F10.3///25X,
           1 13H*** OUTPUT ***)
            GO TO 525
C           COANNULAR PLUG ENTRY
      415   R1=SQRT(A9/P1)$A7=1
      425   IF(Y9-5) 485,435,460
C           MULTI-TUBE  COANNULAR ENTRY
      435   CONTINUE
            R1=R1/24
            PRINT 2210,R1*2,R1,A7
      2210  FORMAT(* NO OF TUBES=*,I4,5X,
           1 /* DIA OF TUBES=*,F11.3,5X,*ARD=*,F10.3)
            GO TO 485
C           MULTI-CHUTE/SPOKE COANNULAR ENTRY
      460   CONTINUE
            R1=SQRT(4*A9/(P1*R0))/2
            PRINT 2212,  ,A7,2*R1
      2212  FORMAT(* NO OF CHUTES/SPOKES=*,I4,5X,*ARD=*,F10.3/
           1 * DIA OF CHUTE EQUIV AREA TUBE=*,F10.3)
            S1J=SS/R4+1
      485   PRINT 2014,R2,A8,A9,T5,P5,T0,P0,T4,P4
      2014  FORMAT(* NOZZLE OUTER DIA=*,F10.3/* A8=*,F10.3,5X,*A28=*,
           1 F10.3/* TT28=*,F6.0,5X,*PT28/P0=*,F10.3/* T0=*,F6.0,5X,
           1 *P0=*,F8.3/* TTR=*,F6.  ,5X,*PTR/PC=*,F10.3)
            T3=T5$P9=P5
            R7=(R2-SQRT(R2**2-4*A9*A7/P1))/2
            GO TO 395
      525   CONTINUE
            H=SQRT(ALT**2+SL**2)
            A3=N*P1*R1**2
C           RADIUS RATIO CALCULATION
            R8=1-A/*A3/(P1*R2**2)$IF( R8.LT.0 ) GO TO  550$R8=SQRT(R8)
           GO TO 555
      550   R8=0
      555   TR=T3$G8=1.35
C           ITERATION FOR GAMMA
            DO 600 J=1,50
            T3=T8/(P9**((G8-1)/G8))
            G9=1.4
            IF( T3.LT.788.  2 ) GO TO  590
            G9=2.21798/T3**.070271
      590   IF( ABS(G8-G9).LT..001 ) GO TO  615
            G8=G9
      600   CONTINUE
            GO TO  15
C           CALCULATION OF FLOW PARAMETERS
      615   C3=G9*.    /(G9-1)
            U3=223.7  SQRT(R*C3*(1-1/((P9**((G9-1)/G9)))))
            R3=2.7*P3/T3
            D4=2*SQRT(A3/P1)
            IF( Y9.LT.4 ) GO TO  675
            IF( TR.EQ.T4 ) GO TO
```

```
C        [illegible] VARI[illegible]
      PRINT [illegible]
      PRINT [illegible]
 [illegible] FORMAT(/* [illegible] NOZZLE EXIT CONDITIONS*)
 [illegible] FORMAT([illegible] [illegible]*,F10.[illegible],5X,*[illegible]L H=*,F10.3)
      T3=T[illegible]$G2=G9$C4=C3
      GO TO [illegible]
 6[illegible]  PRINT 213
 21[illegible]  FORMAT(/* [illegible] NOZZLE EXIT CONDITIONS*)
      PRINT [illegible]
 [illegible] FORMAT([illegible],F10.1,5X,*[illegible]=*,F10.4)
      S[illegible]=R2/[illegible]
      GO TO 1[illegible]
 675  PRINT 2122,2*R2,D4
      PRINT [illegible]
      PRINT [illegible]
 2122 FORMAT(/* DIA OF [illegible] ROW=*,F10.3,5X,*EQUIV AREA DIA=*,F10.3/)
 2123   FORMAT(/* NOZZLE EXIT CONDITIONS*)
 2124   FORMAT(* U8=*,F10.1,5X,*RHO8=*,F10.4,5X,*AT=*,F10.3,5X,
     1* AR=*,F10.3)
      [illegible]
      IF(Y[illegible]-2) [illegible],7[illegible]
C        MULTI-ELEMENT POST-MERGED NOISE CALCULATIONS
 7[illegible]    R2=R2-R2*SIN(R9*PI/180)/COS(R9*PI/180)
 7[illegible]5   IF( PR.LT..6 ) GO TO  720
      R2=R2*(-1.947*ALOG10(PR/1.954))*(1-.2525*ALOG10(T8/1750))
      R2=R2*SQRT(R8/.71[illegible])
 72[illegible]   A5=(N*PI*(R2-R1)**2)/((SQRT(AN))-1)**2)
      A1=A5/[illegible]3
      PJ=((P7-1)*P0*4633.06)/(U3**2*R3)+1
      K0=((CJ*T3)+(U3**2/50062)-(T0*.24))/PJ
      K2=P0/(10.73*R3*P)**2)
      X3=K2*(C3-.24)*28.966*A1
      X2=(A1*K2*P[illegible]*.951P4+(U3**2/50082))/X3
      X1=(-1*K0)/X3
      X0=(-1*T0*.24)/X3
C        ITERATE FOR U MERGED/U8
      VJ=.5
      DO 815 I=1,50
      F2=X0+X1*VJ+X2*VJ**2+VJ**3
      F1=X1+ *X2*VJ+3*VJ**2
      V1=VJ-F2/F1
      IF( ABS(V1-VJ).LT..01*V1 ) GO TO  820
      VJ=V1
 815    CONTINUE
 81[illegible] PRINT 2123
 2123 FORMAT(* DID NOT CONVERGE*)
      GO TO  9999
 820    VJ=V1*U3
      D5=SQRT(1.27324*A5)
      R5=R3*[illegible]J/(VJ/U[illegible])**2*A1)
      PRINT 2125
 2125   FORMAT(/* MERGED FLOW CONDITIONS*)
      PRINT 2124,VJ,R5,D5,A5
 2124   FORMAT(* U5=*,F10.1,5X,*RHO5=*,F10.4,5X,*D5=*,F10.3,5X,
     1*A5=*,F10.3)
C        [illegible]
```

```
      X1=X1+1P(X2+V1)
      X2=X2+.1
      [illegible]
      IF( C1.LT.0 ) GO TO 910
      Y1=(-X2- [illegible] )/2
      Y2=(-X2+SQRT(C1))/2
      IF( Y1.LT.0 ) GO TO 89[illegible]
      IF( Y1.GT.1 ) GO TO 892
      PRINT 920,Y1
  920    FORMAT(* ROOT 2=*,F12.4)
  9[illegible]    IF( Y2.LT.0 ) GO TO 910
      IF( Y2.GT.1 ) GO TO 910
      PRINT 928,Y2
  928    FORMAT(* ROOT 3=*,F12.4)
C        SET INPUT VARIABLES TO CONICAL ROUTINE
  910    VR=V1$AR=A[illegible]
      T5=(R [illegible] /(PJ*R3*1.73)
      GR=1.4
      IF( T5.LT.788.3 ) GO TO 935
      GR=2.2375*/T5**.070271
  935    M=[illegible] (GR*T5*1716.49)
      T9=T8
      T8=T5*(1+((GR-1)/2)*M**2)
      IF( Y9.GT.4 ) GO TO 1515
C        CALCULATE MERGED NOISE
  963    K1=1$CALL SUB1
      IF( Y9.LT.4 ) GO TO 975$IF( U3.LT.VJ ) GO TO 975
      Z9=1[illegible]LOG10(A5/A3)+5.8
      Z9=Z9*[illegible](VJ/U3-.5)**2-Z9$CALL SUB2
  975    CALL SUB5$IF( K9.EQ.0 ) GO TO 990$CALL SUB3
     IIAS(1)=10HMERGED NOI
     IIAS(2)=10HSE
      CALL PLTT
  990    CALL SUB4
      IF( Y9.GT.3 ) GO TO 1595
C        MULTI-ELEMENT PRE-MERGED NOISE CALCULATIONS
C        SET INPUT TO CONICAL ROUTINE
      VR=U3$AR=A3/AN1$G2=G9$W8=R3*AR*VB$T8=T9
  1515    K1=2$CALL SUB1
C        CUTOFF/SHIELDING CALCULATION
      K7=[illegible]
      DJ=2*R[illegible] $ RA=A9*PI/180.0
      Z9=1[illegible]LOG10(AN1)
      IF( Y9.LT.3 ) GO TO 1560
      IF( Y9.[illegible] ) GO TO 1[illegible]
      Z8=1+A [illegible]
      GO TO 1575
  1560 IIP=75*[illegible] $ DO 1 70 J=1,IIP
      Z8=Z8+(2*(75-J+1)+1)*(1-1/S1J)**(J-1)
  1570     CONTINUE
  1575     Z[illegible]ALOG10(Z8)
C        CALCULATION OF CRITICAL ANGLE
      M=[illegible]V /SQRT(2360.7*(T3+T[illegible])/2)$DJ=(A /(V[illegible]))/(1+M)
      M=VR/SQRT(G2*T3*1716.49)
      D1=180-ATAN(SQRT(1-(1[illegible]**2))/DJ)*180/PI
      C1=[illegible](DJ/15)-1
C        [illegible] CALCULATION
```

```
      ZZ=DJ*(4+1.1E-04,.H5*X**2)
      AJ/=AIAN(1/(2*(2/DJ)))
C        POINT OF REFLECTION FOR CUTOFF
      ...(SEE-1)*...(C(L.7 H=A(R+RR)*(COS(AJ)/SI(2*+R=+R))
      Z...
      IF( Y9.EQ.3 ) GO TO  1145$IF( Y9.EQ.6 ) GO TO  1145$DJ=2*PI
 1145    IF( P.LT.1 ) GO TO  1170
      DJ=2*...
C        XP CALCULATION
      ZZ=DJ* *(SQRT(C**,-1))**.778151
C        CRITICAL FREQUENCY CALCULATION FOR ABSORPTION
 1170    F =A0/(2*DJ)
 1175    DO 1295 J=1,24
      SX=.8/((F(J)*DJ/V8)**.82)
C        ABSORPTION EFFECT
      ZZ=Z9
      IF( F(J).LT.FC ) GO TO  1220
      ZZ=Z8
      IF( F(J).GT.4*F0 ) GO TO  1220
      ZZ=((Z--Z8)/(-.60206))*ALOG10(F(J)/F0)+Z9
C        SOURCE LOCATION
 1220    Z=ZZ+DJ*SX
      SJ=X8/Z3
      TC=C$X(J)=0$IF( K7.EQ.2 ) GO TO  1265$X(J)=Z3
C        CUTOFF EFFECT
      IF( RR.GT..65 ) GO TO  1265$IF( SJ.GE.4 ) GO TO  1265
      TC=22.*62929-44.68829*SJ+43.858243*SJ**2-25.284491*SJ**3
      TC=TC+*.4145898*SJ**4-1.4693844*SJ**5+.1039457*SJ**6
      IF( RR.LT..6 ) GO TO  1265
      TC=TC-TC*(RR-.6)/.05
 1265    DO 1295 I=1,15
      IF( K7.EQ.2 ) GO TO  1290
      IF( ((I+1)*I0).LT.DJ ) GO TO  1291
      S(I,J)=S(6,J)+RVE(6J)-RVE(I)
      GO TO 1295
 1290    S(I,J)=S(I,J)-TC+ZZ
 1295    CONTINUE
C        EJECTOR EFFECTS DETERMINED
      IF( A6.EQ.0 ) GO TO  1310$IF(K7.EQ.2)GO TO 1300$CALL EJECTS
 1300    DO 1308 J=1,24$ DO 1308 I=1,15
      S(I,J)=S(I,J)+E1(I,J)
 1308    CONTINUE
 1310    IF( K7.EQ.2 ) GO TO  1365$CALL SUB5
      IF(K9.EQ.0) GO TO 1335
      CALL SUB3
      IIAS(1)=10HPREMERGED
      IIAS(2)=10HNOISE
      CALL PLTTB
 1335    IF( Y9.GT.3 ) GO TO  1630$CALL SUB6$CALL SUB4
C        CHECK FOR SHOCK CELL NOISE
      IF( P9.LT.1.9 ) GO TO  1395$V9=U3$C9=41.43*SQRT(C9*T3)$D8=2*PI
      IF( Y9.LT.3 ) GO TO  1355$D8=(P4+P6)/12
 1355    CALL SUB5$ZZ=Z$GO TO 1175
 1365    Z*=-2*P9
 1370    CALL SUB2
      CALL SUB5
      IF( K9.EQ.0 ) GO TO  1395
```

```
      IIAS(1)=10HSHOCK (M-F
      IIAS(2)=10H) NOISE
      CALL SUB3$CALL PNTTR
 1390     IF( P9.GT.4 ) GO TO  1685$CALL SUB6
 1395     IF( K9.EQ.0 ) GO TO  1400$K1=3
 1400     CALL SUB3
      IIAS(1)=10HTOTAL NOIS
      IIAS(2)=10HE
      CALL PNTTR
      GO TO  45
C         CONICAL NOZZLE NOISE
 1425     V8=U3$A8=A9$W8=R3*U3*A8
      IIAS(1)=10HCONICAL MI
      IIAS(2)=10HXING NOISE
      CALL SUB1$CALLSUB5$IF(K9.EQ.0)GO TO 1445$IF(P9.LT.1.9)GO TO 1475
      CALL SUB3$CALL PNTTR
C         CHECK FOR SHOCK CELL NOISE
 1445     IF( P9.LT.1.9 ) GO TO  1465$CALL SUB4$V9=V8
      C9=41.4*SQRT(G9*2.7*P0/F3)$D8=SQRT(4*A8/P1)$CALL SHKSUB$CALL SUB5
      IF( K9.EQ.0 ) GO TO  1461$CALL SUB3
      IIAS(1)=10HCONICAL SH
      IIAS(2)=10HOCK NOISE
      CALL PNTTR
 1461     CALL SUB6
 1465 CONTINUE
      IIAS(1)=10HCONICAL TO
      IIAS(2)=10HTAL NOISE
      IF( K9.EQ.0 ) GO TO  1475$K1=3
 1475     CALL SUB3$CALL PNTTR$GO TO 245
C         COANNULAR NOZZLE NOISE
 1485     PRINT 2135
 2135     FORMAT(//* COANNULAR NOZZLE FLOW PARAMETERS*)
      IF( Y9.EQ.4 ) GO TO  1545$A3=A9$V7=U3$T3=2.7*P0/R5$V6=R3$T8=T5
      R3=R5$C3=C4$P9=R5$A4=A8$U3=U5
      R2=SQRT(((P1*R2**2/4)-(A8+R9**2*P1/4))/P1)
      R2=R2-R2*SIN(R9*P1/180)/COS(R9*P1/180)
C         GO TO POST-MERGED VELOCITY CALCULATION
      GO TO 720
 1515     A8=A4+A5
      W4=V6*.4*V7$W5=W8
      W8=W4+.5$V8=(V7*W4+VJ*W5)/W8
      T5=T8$A9=A3$T8=(T4*W4+T5*W5)/W8
      T5=T9$U5=U3$U3=V7$R5=P3$R3=V6
      A3=A4$IF( U3.LT.VJ )GO TO 1580$V8=U3$T8=T4$W8=R3*V8*A8$GO TO 1580
 1545     W4=P3*A8*U3$W5=R5*A9*U5
      A3=A8$A8=A8+A9
      W8=W4+.5$VJ=U5$A5=A9
      IF( U3.LT.U5 ) GO TO  1570$V8=U3$T8=T4$W8=R3*V8*A8
      GO TO 1580
 1570     V8=(U3*W4+U5*W5)/W8
      T8=(T4*W4+T5*W5)/W8
 1580     PRINT 2131 $ PRINT 2130,V8,T8,W8,A8
C         DETERMINE POST-MERGED NOISE
 2131     FORMAT(/* MIXED FLOW CONDITIONS*)
 2130     FORMAT(* U6=*,F10.1,5X,*T16=*,F6.0,5X,*W6=*,F10.3,5X,
     1 *A6=*,F10.3)
      GO TO 46
```

```
 1595      V9=U5$T3=2.7*P0/R5$T8=T5
       W5=U5*.9*R5$K1=2
C          PRE-MERGED NOISE DETERMINATION
       IF( Y9.EQ.4 ) GO TO  1615$A8=A9/AN1$W8=W5/AN1$GO TO 1015
 1615      A8=.075*A9$W8=.7)*W5$CALL SUB1
       GO TO 1319
C          CHECK FOR OUTER STREAM SHOCK
 1630      IF( P5.LT.1.9 ) GO TO  1685$CALL SUB6$CALL SUB4
       P9=P5
       V9=U5$C9=41.43*SQRT(G2*2.7*P0/R5)$D8=2.5*R7
       IF(Y9-5) 1660,1655,1650
 1650      D8=(R4+R6)/12$GO TO 1355
 1655      D8=2*R1$GO TO 1355
 1660      CALL SHKSUB$Z9=10*ALOG10(SQRT(4*A9/P1)/D8)$CALL SUB2
       CALL SUB5
       IF( K9.EQ.0 ) GO TO  1685
       CALL SUB3
       IIAS(1)=10HOUTER SHOC
       IIAS(2)=10HK NOISE
       CALL PNTIB
C          CHECK FOR INNER STREAM SHOCK
 1685  IF( P4.LT.1.9 ) GO TO  1725$C9=41.43*SQRT(G9*2.7*P0/R3)$V9=U3
       CALL SUB6$CALL SUB4
       D8=SQRT(4*A3/P1)$IF(Y9.EQ.4)GO TO 1700
       D8=SQRT(D8**2+(2*R9)**2)-(2*R9)
 1700      CALL SHKSUB
       IF( R9.EQ.0 ) GO TO  1710$Z9=-3$CALL SUB2
 1710      CALL SUB5
       IF( K9.EQ.0 ) GO TO  1725$CALL SUB3
       IIAS(1)=10HINNER SHOC
       IIAS(2)=10HK NOISE
       CALL PNTIB
 1725      CALL SUB6$IF( K9.EQ.0 ) GO TO  1730$K1=3
 1730      CALL SUB3
       IIAS(1)=10HTOTAL NOIS
       IIAS(2)=10HE
       CALL PNTIB
       GO TO 245
 9999      STOP
       END
```

```
      CSUB1
            SUBROUTINE SUB1
            COMMON/CM1/L(9,24),X(24),F(24),E(24),S(15,24),KK(24,5),C(15,5),
          1 O(20),W(49),PX(49),F(20),F(15,24),Y1(24),Y(24),C1(15),PVE(20),
          1 S1(24),G(2,24),C2(15,2),I(20),D(2,2),W(5),A(4),V(3),E1(15,24)
            COMMON /CM2/ VR,A0,WR,K1,Y9,T8,T5,R7,P1,Z9,DJ,AJ,H,U,F9
          1 ,T2,V9,C9,DR,D1,V0,Q9,AP,Q,L9,A6,A7,S6,P9,F9,ALT,SL,AN3,NFLT
            COMMON /CM3/ IIAS(2),IICASE(6),IDCASE(6),IDENT(6)
            REAL I,KK,K1
      C         SAE ARP 876 (1975 REV) CONICAL NOZZLE NOISE
            XJ=ALOG10(VR/A0)
            WF=2
            IF( XJ.GT.0.22 ) GO TO  3010
            WE=W(1)+W(2)*XJ+W(3)*XJ**2+W(4)*XJ**3+W(5)*XJ**4
       3010     DEN=((WR/(AR*VR))/.076475)**WE
            O2=10*ALOG10(DEN*(AR/(1**2)))
            DO 3024 I=1,15
      C         OASPL AND FLIGHT EFFECTS
            O(I)=O2+C(I,1)+C(I,2)*XJ+C(I,3)*XJ**2+C(I,4)*XJ**3+C(I,5)*XJ**4+
          1 C1(I)
      C         CALCULATE MIXING NOISE FLIGHT EFFECTS
           IF (K1.EQ.0.1) GO TO 3022
           PVE(I)=-60*ALOG10(1/(1-(V0/A0)*COS(((I+1)*10)*P1/180)))
           GO TO 3024
       3022 DUM=(1-(V0/A0)*COS(((I+1)*10)*P1/180))
           PVE(I)=10*ALOG10((VR/(VR-V0))**C2(I,NFLT)*DUM)
       3024     CONTINUE
            IF( Y9.NE.4 )GO TO 3028$IF( T8.NE.T5 )GO TO 3028$AP=(R7/2)**2*P1
       3028     DO 3066 J=1,24
            T(1)=540$T(2)=1080$T(3)=1620
            DO 3066 I=1,15
            Z1=SIN((I+1)*P1/18)
            XJ=ALOG10(F(J)*2*SQRT(AP/P1)/(VR*Z1+A0*(1-Z1)))
            DO 3042 K=1,24
            E(K)=KK(K,1)+KK(K,2)*XJ+KK(K,3)*XJ**2+KK(K,4)*XJ**3+KK(K,5)*XJ**4
       3042     CONTINUE
            K6=I-7
            IF( K6.GT.0 ) GO TO  3050
            K6=1
       3050     IF( T8.GT.1080 ) GO TO  3058
            N1=3*K6-2
            RJ1=1
            GO TO 3062
       3058     N1=3*K6-1
            RJ1=2
       3062 S(I,J)=E(I)+(E(N1+1)-E(N1))*((T8-T(RJ1))/(T(RJ1+1)-T(RJ1)))+E(N1)
            S(I,J)=S(I,J)-PVE(I)
       3066     CONTINUE$RETURN
      CSUB3
            ENTRY SUB3
      C         EXTRAPOLATION AND OASPL AND PNL CALCULATION
            DO 311  K=1,15
            DO 13  J=1,24$X(J)=S(K,J)
         13 CONTINUE
            IF( K1.EQ.3 ) GO TO  3108
            AJ=(K+1)*10
            D1=1
```

```
      CALL EXTP
      DO 20 J=1,24$S(K,J)=X(J)
   20 CONTINUE
 3108     CALL PNLPIST(K)=V(2)$O(K)=V(1)$P(K)=V(3)
 3110     CONTINUE$RETURN
CSUB5
      ENTRY SUB5
C         PWL CALCULATION
      09=0$DO 3207 I=1,24$A2=1$DO 3204 J=1,15$AJ=(J+1)*10
      YJ=1.5*PI*(COS((AJ-5)*PI/180)-COS((AJ+5)*PI/180))
      A2=A2+(2.22752E-084E-8*YJ*10**(S(J,I)/10))
 3204     CONTINUE
      Y(I)=1 *ALOG10(A2)+130+1.24939
      09=09+10**(Y(I)/10)
 3207     CONTINUE
      09=10*ALOG10(09)
      RETURN
CSUB4
      ENTRY SUB4
C         RESET VARIABLES
      DO 3402 J=1,24$DO 3401 I=1,15$R(I,J)=S(I,J)
 3401     CONTINUE$Y1(J)=Y(J)
 3402 CONTINUE$RETURN
CSUB2
      ENTRY SUB2
C         DELTA SPL CORRECTION
      DO 3406 J=1,24$DO 3406 I=1,15$S(I,J)=S(I,J)+79
 3406     CONTINUE$RETURN
CSUB6
      ENTRY SUB6
C         SPL AND PWL ADDITION
      09=0
      DO 3506 J=1,24$DO 3503 I=1,15
      S(I,J)=10*ALOG10(10**(S(I,J)/10)+10**(R(I,J)/10))
 3503     CONTINUE
      Y(J)=10*ALOG10(10**(Y1(J)/10)+10**(Y(J)/10))
      09=09+10**(Y(J)/10)
 3506     CONTINUE
      09=10*ALOG10(09)
      RETURN$END
```

```
      SUBROUTINE EXTP
C       EXTP -- SPL EXTRAPOLATION SUBROUTINE
      COMMON /C1/ZL(24,24),X(24),F(24),F(24),S(15,24),R(24,5),C(15,5),
     1 Q(20),W(40),RA(40),F(20),E(15,24),Y1(24),Y(24),C1(15),RVF(20),
     1 S1(24),G(24,24),C2(15,2),T(20),U(20),Z(5),A(4),V(3),E1(15,24)
      COMMON /C2/ V8,A5,W8,F1,Y9,T8,T5,R7,P1,Z9,DJ,AJ,H,U,F9
     1 ,T0,V9,C9,D9,D1,V3,U9,AP,O,L9,A6,A7,S6,P9,R9,ALT,SL,ANI,NFLT
      COMMON /C3/ IIAS(2),IICASE(5),IDCASE(6),IDENT(6)
      REAL L,K,M
      REAL I
      G3=0
     DOP=1/(1-V3/A0*COS(AJ*PI/180))
      L1=H
      IF(U.EQ.2.)L1=H/SIN(AJ*PI/180)
      O=20*(ALOG10(L1/20))
      IF(F9.EQ. .) GO TO 470
      DIS=L1
      IF(F9.LT.2.0) GO TO 400
      IF(ALT/DIS.LT..035) GO TO 400
      IF(ALT.LT.100.0) GO TO 400
      DIS=L1*100.0/ALT
C        FAA CURVE FIT
  400    C1J=(.22411435E-  *DIS)-.66703095E-16
      C1J=(C1J*DIS)+.72854603E-12
      C1J=(C1J*DIS)-.32650913E-08
      C1J=(C1J*DIS)+.49614255E-05
      C1J=(C1J*DIS)+.44663172E-02
      G1=(C1J*DIS)+.59397772
      C1J=(.16573369E-24*DIS)-.46152934E-20
      C1J=(C1J*DIS)+.32361609E-16
      C1J=(C1J*DIS)+.39118972E-13
      C1J=(C1J*DIS)-.10464995E-08
      C1J=(C1J*DIS)+.29126338E-05
      C1J=(C1J*DIS)-.54379996E-03
      G2=(C1J*DIS)+.59506112
      IF(DIS.LE.4000.) GO TO 470
      G2=5.010264
      G1=15.94941+.0001*(DIS-4000)
  470    DO 670 J=1,24
      IF(F(J).GT.4000.) GO TO 510
      P3=F(J)
      GO TO 520
  510    P3=.89*F(J)
C        AIR ATTENUATION CURVE FIT
  520    R1=(-.19973809E-14*P3)+.36618630E-10
      R2=(R1*P3)+.32351924E-07
      R3=(R2*P3)+.13498887E-02
      PA=(R3*P3)+.17604677E-01
      IF(F9.EQ.0.) GO TO 660
      IF(P3.EQ.63) GO TO 610
      IF(P3.GE.2000.) GO TO 630
      ZIP=P3/2.5
      ZJ=.2*ALOG(ZIP)/ALOG(2.)
      GO TO 640
  610    ZJ=0
      GO TO 640
  630    ZJ=1.
```

```
  640    G3=(ZJ*(G1-G2))+G2
  660 COR=Q+G3+PA*((L1-01)/10.0)
C        DOPPLER SHIFT APPLIED
      IF (DOP.LT.0.89) GO TO 662
      IF (DOP.GT.1.12) GO TO 661
      E(J)=X(J)-COR $ GO TO 670
  661 IF(J.EQ.1) GO TO 663 $ E(J)=X(J-1)-COR $ GO TO 670
  662 IF (J.EQ.24) GO TO 663 $ E(J)=X(J+1)-COR $ GO TO 670
  663 E(J)=X(J)-3-COR
  670 CONTINUE
      DO 680 J=1,24
  680 X(J)=E(J)
      RETURN
      END
```

```
      SUBROUTINE SHSB
C        SHSB -- SAE SHOCK CELL NOISE PREDICTION SUBROUTINE
      COMMON/C1/F(24),F(24),E(24),S(15,24),X(24,5),C(15,5),
     1 D(20),R(20),E(40),F(  ),P(15,24),Y1(24),Z(24),CI(15),RVF(20),
     1 S1(24),G(2,24),G2(15,2),I(20),U(20),W(5),A(4),V(3),L1(15,24)
      COMMON /C2/ S,A0,RR,F1,Y9,T8,T5,P7,P1,Z9,DJ,AJ,H,U,F9
     1 ,T9,V9,C9,D8,D1,VC,09,X9,0,L9,A6,A7,S6,P9,R9,ALT,SL,ANI,NFLT
      COMMON /C3/ IIAS(2),IICASE(6),IUCASE(6),IDENT(6)
      REAL I,KR,K1
      A0=49.1*SQRT(T0)
      DEK=2.575*ALOG1 ((V0+10.)/100)
      D1=180*SQRT((V9/C9)**2-1)
      D0=10*ALOG10(((P**2)*D8/D1)**2)
      DO 399 K9=1,15
      AJR=(K +1)*PI*10/180
      DUM=1-(.C/A0)*COS(((K9+1)*10)*PI/180)
      DO 390 J=1,24
      SJ=ALOG10(F(J)*1.1*D8*9/A.)
      DO 250 K=2,24
      IF(SJ.GT.S1(K)) GO TO 240
  210    C1J=G(2,K-1)+(SJ-S1(K-1))*(G(2,K)-G(2,K-1))/(S1(K)-S1(K-1))
      G1=G(1,K-1)+(SJ-S1(K-1))*(G(1,K)-G(1,K-1))/(S1(K)-S1(K-1))
      GO TO 260
  240    IF(K.EQ.24) GO TO 210
  250    CONTINUE
  260    H1=0
      F1=(2*PI*F(J)*1.3)*D8/(.7*V9))*(1+(.7*V9/A0)*COS(AJR))
      DO 360 I=1,5
      F2=0
      KEND=8-(I+1)
      KSTART=0 $ DO 330 K=KSTART,KEND
      ZI=I $ ZK=K
      F3=F1*(ZI*(1.0-.06*((ZI+1.0)/2.0+ZK)))
      F2=F2+(COS(F3)*SIN(.115*F3)/(.115*F3))
  330    CONTINUE
      IF(C1J.LT..01) GO TO 360
      H1=H1+((C1J**(I**2))*F2)
  360    CONTINUE
C        SHOCK CELL NOISE FLIGHT EFFECTS
      S(K9,J)=D0+G1+10*ALOG10(1+.25*H1)+DEK
      IF (K9.LT.7) GO TO 380
      S(K9,J)=S(K9,J)+40*ALOG10(1/DUM)
  380    CONTINUE
  399    CONTINUE
      RETURN
      END
```

```
      SUBROUTINE PNLPT
C     PNLPT -- CALCULATES PNL, OASPL, AND PNLT
      COMMON/C1/L(9,24),X(24),F(24),E(24),S(15,24),KK(24,5),C(15,5),
     1 O(24),R(40),P(40),P(20),R(15,24),Y1(24),Y(24),T(15),RVF(20),
     1 S1(24),C(2,24),C2(15,2),I(20),D(24),W(5),A(4),V(3),E1(15,24)
      COMMON /C2/ V8,A0,W8,K1,Y9,T8,T5,R7,P1,Z9,DJ,AJ,H,U,F9
     1 ,T7,V9,C9,D8,D1,V0,O9,A8,Q,L9,A6,A7,S6,P9,R9,ALT,SL,AN1,NFLT
      COMMON /C3/ IIAS(2),IICASE(6),IOCASE(6),IDENT(6)
      REAL L,KK,K1
      TJ=0
      V(1)=0
      V(2)=0
      DO 370 J=1,24
      IF(X(J).GT.0.) GO TO 200
      X(J)=1
  200    IF(X(J).GE.L(7,J)) GO TO 320
      IF(X(J).GE.L(5,J)) GO TO 300
      IF(X(J).GE.L(3,J)) GO TO 280
      IF(X(J).GE.L(1,J)) GO TO 260
      AN=0
      GO TO 330
  260    AN=0.1*(10**(L(2,J)*(X(J)-L(1,J))))
      GO TO 330
  280    AN=10**(L(4,J)*(X(J)-L(5,J)))
      GO TO 330
  300    AN=10**(L(6,J)*(X(J)-L(5,J)))
      GO TO 330
  320    AN=10**(L(8,J)*(X(J)-L(9,J)))
  330    V(1)=V(1)+10**(X(J)/10)
      V(2)=V(2)+AN
      IF(TJ.GT.AN) GO TO 370
      TJ=AN
  370    CONTINUE
      V(2)=33.22*ALOG10(V(2)*.15+TJ*.85)+40
      V(1)=10.*ALOG10(V(1))
      CALL TPNLC(X,P2)
  980    V(3)=V(2)+P2
      RETURN
      END
```

```
      *TPNLC     THIS SECTION CALCULATES TONE CORRECTED PNL
       C         SPECTRAL IRREGULARITY CORRECTION
       C
       C         THIS PROCEDURE DETERMINES A SPECTRAL IRREGULARITY
       C         (I.E.,PURE TONE) CORRECTION FACTOR SEE VIA SECTION B36.3
       C         OF THE FAA NOISE CERTIFICATION DOCUMENT (NOV 17,1969) AS
       C         A FUNCTION OF THE UNCORRECTED 1/3 OCTAVE SPECTRUM,SPL.
       C
                 SUBROUTINE TPNLC(SPL,PTCOR)
                 DIMENSION SPL(24),ISPLF(24),SC(24),SPLP(24),SPLPP(24),SP(25),
               1 SBAR(24),F(24)
       C
       C    *INITIALIZE SPL FLAG*
                 DO 1 I=1,24
            1    ISPLF(I) = 0
       C
       C    *STEP 1*
                 DO 5 I=4,24
            5    SC(I)=SPL(I) - SPL(I-1)
       C
       C    *STEP 2 AND 3*
                 DO 10 I=5,24
                 IF(ABS(SC(I)-SC(I-1)).LE.5.0) GO TO 10
                 IF(SC(I).GT.0.0.AND.SC(I).GT.SC(I-1)) ISPLF(I)=1
                 IF(SC(I).LE.0.0.AND.SC(I-1).GT.0.0) ISPLF(I-1)=1
           10    CONTINUE
       C
       C    *STEP 4*
                 DO 25 I=1,24
                 IF(ISPLF(I).EQ.0) GO TO 20
                 IF(I.EQ.24) GO TO 15
       C         STEP 4B MODIFIED SUCH THAT PRECEDING AND FOLLOWING
       C         NON-FLAGGED SOUND PRESSURE LEVELS EMPLOYED IN AVERAGE.
                 II = I
                 DO 11 J=1,20
                 II = II-1
                 IF(ISPLF(II).EQ.0) GO TO 12
           11    CONTINUE
           12    SPLL = SPL(II)
                 IP1 = I+1
                 DO 13 J=IP1,24
                 IF(ISPLF(J).EQ.0) GO TO 14
           13    CONTINUE
                 J = 24
           14    SPLH = SPL(J)
                 SPLP(I) = (SPLL+SPLH)/2.
                 GO TO 25
           15    SPLP(24) = SPL(23)+SC(23)
                 GO TO 25
           20    SPLP(I) = SPL(I)
           25    CONTINUE
       C
       C    *STEP 5*
                 DO 30 I=4,24
           30    SP(I) = SPLP(I)-SPLP(I-1)
                 SP(3) = SP(4)
                 SP(25) = SP(24)
```

AD-A094 298 GENERAL ELECTRIC CO CINCINNATI OH AIRCRAFT ENGINE GROUP F/G 20/1
HIGH VELOCITY JET NOISE SOURCE LOCATION AND REDUCTION. TASK 6. --ETC(U)
MAR 79 P R GLIEBE, R E MOTSINGER, A SIECKMAN DOT-OS-30034
UNCLASSIFIED R79AEG290 FAA-RD-76-79-6A NL

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      C
      C     *STEP 6*
            DO 35 I=3,23
         35 SHAR(I) = (SP(I)+SP(I+1)+SP(I+2))/3.
      C
      C     *STEP 7*
            SPLPP(1) = SPL(1)
            SPLPP(2) = SPL(2)
            SPLPP(3) = SPL(3)
            DO 40 I=4,24
         40 SPLPP(I) = SPLPP(I-1)+SHAR(I-1)
      C
      C     *STEP 8*
            DO 45 I=1,24
         45 F(I) = SPL(I)-SPLPP(I)
      C
      C     *STEP 9 AND 10*
            CMAX = 0.0
            DO 65 I=1,24
            IF(I.GE.11.AND.I.LE.21) GO TO 50
      C      *FREQ 5.0HZ OR FREQ>500HZ*
            TC2 = F(I)/6.
            TC3 = 3.333
            GO TO 55
      C      *500 >FREQ >5.0HZ*
         50 TC2 = F(I)/3.
            TC3 = 6.666
         55 IF(F(I).LT.3.0) GO TO 65
            IF(F(I).GE.20.0) GO TO 60
            CMAX = AMAX1(CMAX,TC2)
            GO TO 65
         60 CMAX = AMAX1(CMAX,TC3)
         65 CONTINUE
            PICOP=CMAX
        500 RETURN
            END
```

```
      SUBROUTINE PNT18
C PNT18 -- PRINT AND EPNL CALC SUBROUTINE
C
      COMMON/CM1/L(9,24),X(24),F(24),E(24),S(15,24),KK(24,5),C(15,5),
     1 O(20),R(49),RK(49),P(20),R(15,24),Y1(24),Y(24),C1(15),RVE(20),
     1 S1(24),G(2,24),C2(15,2),T(20),D(20),W(5),A(4),V(3),E1(15,24)
      COMMON /CM2/ V8,A0,W8,K1,Y9,T8,T5,R7,P1,Z9,DJ,AJ,H,U,E9
     1 ,T0,V9,C9,D8,D1,V0,O9,A8,Q,L9,A6,A7,S6,P9,R9,ALT,SL,ANI,NELT
      COMMON /CM3/ IIAS(2),IICASE(6),IDCASE(6),IDENT(6)
      REAL L,KK,K1
      REAL MP,KT
C
 1000 FORMAT(/////50X,3H*  ,2A10)
 1001      FORMAT(50X,1H*,F7.1,* FOOT ALTITUDE*)
 1002      FORMAT(50X,1H*,F7.1,* FOOT SIDELINE*)
 1004      FORMAT(50X,1H*,F7.1,* FOOT ARC*)
 1006      FORMAT(50X,9H*  NO EGA )
 1008      FORMAT(50X,11H*  FULL EGA )
 1009      FORMAT(50X,21H*  100 FOOT LAYER EGA )
 1010 FORMAT(50X,1H*,F6.0,*DEGREE STANDARD DAY*//50X,*ACOUSTIC ANGLE*,
     1* FROM INLET*/*  FREQ     20     30     40     50     60     70*,
     1 *    60     90    100    110    120    130    140    150*,
     1 *   160    PWL*)
 1012      FORMAT(F7.0,16F7.1)
 1014      FORMAT(1X,A6,16F7.1)
 1016      FORMAT(* EPNL=*,F6.1)
 1017 FORMAT(1H1///,33X,*HIGH VELOCITY JET NOISE PROGRAM - *
     1 *ENGINEERING CORRELATION*//)
 1018 FORMAT(31X,6A10)
C
      PRINT 1017
      WRITE(6,1018)(IICASE(I),I=1,6)
  999 PRINT 1000,(IIAS(II),II=1,2)
      IF(U.EQ.1.) GO TO 160
      IF (SL.NE.0.0) GO TO 159 $ IF (V0.NE.0.0) GO TO 159
      PRINT 1002,H $ GO TO 170
  159      PRINT 1001,ALT
      PRINT 1002,SL
      GO TO 170
  160      PRINT 1004,H
  170 IF(E9-1) 171,172,173
  171      PRINT 1006 $ GO TO 200
  172      PRINT 1008 $ GO TO 200
  173      PRINT 1009
  200      PRINT 1010,T0
      DO 320 J=1,24
      PRINT 1012,F(J),(S(I,J),I=1,15),Y(J)
  320      CONTINUE
      IIAS(1)=5HOASPL
      PRINT 1 14,IIAS(1),(O(I),I=1,15),O9
      IIAS(1)=3HPNL
      PRINT 1 14,IIAS(1),(T(I),I=1,15)
      IIAS(1)=4HPNLT
      PRINT 1 14,IIAS(1),(P(I),I=1,15)
      PRINT 325
  325 FORMAT(1H0)
      DO 1015 I=1,15
```

```
      1015 P(1)=T(1)
           XXX=V0 $ IF (V0.GT.0.) GO TO 8825
           V0=30.
      8825 CONTINUE
            IF(V0.LE.0.) GO TO 1080
            IF(U.EQ.1.) GO TO 1080
C                EPNL CALCULATION
            I1=0.
            MP=0.0
            Z1=0.
            Z3=0.
            SJ=0.
C                FLYOVER TIME CALCULATION
            DO 500 J1=1,15
            AJ=(J1+1)*10
            T(J1)=(H/SIN(AJ*PI/180.))/A0
      7670       WJ=H/(SIN(AJ*PI/180.)/COS(AJ*PI/180.))
            ASK=(AJ-10)*PI/180.
            KT=(H/(SIN(ASK)/COS(ASK))-WJ)/V0
      7685       IF(J1.EQ.1) GO TO 490
            D(J1)=T(J1)+D(J1-1)+KT-T(J1-1)
            GO TO [illegible]00
       490      D(J1)=T(J1)+KT
       500      CONTINUE
            KT=D(8)
            DO 540 J=1,15
            T(J)=D(J)-KT
       540      CONTINUE
C                PNLT MAX SEARCH
            DO 610 J=1,15
            IF(P(J).GT.MP) GO TO 590
            GO TO 610
       590      MP=P(J)
            TJ=T(J)
       610      CONTINUE
            CJ=MP-10.
C                INITIAL AND FINAL TIME DETERMINATION
            DO 680 J=1,15
            IF(P(J).LT.CJ) GO TO 680
            IF((J-1).LT.1) GO TO 750
            D7=T(J)-(T(J)-T(J-1))*(P(J)-CJ)/(P(J)-P(J-1))
            GO TO 690
       680      CONTINUE
       690      DO 740 JJ=1,15
            J=16-JJ
            IF(P(J).LT.CJ) GO TO 740
            IF((J+1).GT.15) GO TO 780
            D9=T(J)+(T(J+1)-T(J))*(P(J)-CJ)/(P(J)-P(J+1))
            GO TO 820
       740      CONTINUE
       750      Z1=P(2)-P(1)
            D7=T(1)-((P(1)-CJ)/Z1)*(T(2)-T(1))
            GO TO [illegible]9[illegible]
       780      Z3=P(14)-P(15)
            D9=T(1[illegible])+((P(15)-CJ)/Z3)*(T(15)-T(14))
            T(16)=D9
            P(16)=[illegible]
```

```
C          INTEGRATION START
  820      IF(Z1.EQ.0.) GO TO 880
      TI=IFIX(2.*TJ-U7)
      I=1
      GO TO 900
  880      TI=IFIX(2.*(TJ-T(I)))
      I=1
  900      TJ=TJ-TI/2
  910      IF(TJ.GT.T(I+1)) GO TO 1020
      TT=T(I)
      IF(I.EQ.0) TT=U7
      IF(TT.EQ.T(I+1)) GO TO 950
      O1=(TJ-TT)/(T(I+1)-TT)
      GO TO 960
  950      O1=(TJ-T(I+1))/(T(I+2)-T(I+1))
  960      RJ=P(I)+O1*(P(I+1)-P(I))
      IF(RJ.LT.CJ) GO TO 990
      SJ=SJ+10.**(RJ/10.)
  990      TJ=TJ+.5
      GO TO 910
 1020      I=I+1
      IF(Z3.EQ.0.) GO TO 1050
      IF(I.GT.15) GO TO 1060
      GO TO 910
 1050      IF(I.LE.(16)) GO TO 910
 1060      E3=(10.*ALOG10(SJ))-13.
      PRINT 1015, .1*IFIX(10.*E3+.5)
 1080 V0=XXX
      RETURN
      END
```

```
      BLOCK DATA
      COMMON/CM1/L(9,24),X(24),F(24),E(24),S(15,24),KK(24,5),C(15,5),
     1 O(20),PR(49),PX(49),P(20),R(15,24),Y1(24),Y(24),C1(15),PVF(20),
     1 S1(24),G(2,24),C2(15,2),T(20),D(20),W(5),A(4),V(3),F1(15,24)
      COMMON /CM2/ VB,A0,WB,K1,Y2,IPZA, ICI                      N),IDC,IDENT                    REAL
AF JENG NORVE FIFICIE      IEW/
98460324.686,-11.5849            DA(I,N),,I=1,)               1 134.0671,78,13.5721,.8584482891,5827,78,14.71
     1 135.58 2175,18,-31,,-124,
     1070,78, 0,13,9902,1 13778,27,269730086,-45,
     1 137,99-1,79,33667,22,17358,-29,12441,-136,9456,
     1 139,23 6,50,85132,23,77030,-31,64966,-146,2695,
     1 142,77 5,83,32237,21,13044,-34,51163,-119,4629,
     1 142,74 6,86,50671,22,49117,-33,24900,-111,0132,
     1 144,8833,92,72220,28,02726,-47,22204,-120,3369,
     1 147,1420,101,6591,56,97311,-80,30287,-254,0784,
     1 149,5432,105,6668,40,77499,-108,0806,-262,8197,
     1 15 ,9 +2,107,0227,32,56691,-150,7574,-323,1343,
     1 151,0189,98,95452,-15,66443,-131,8180,-88,57726/
      DATA ((KK(I,N),N=1,5),I=1,12)/
     1 -10,54902,1,771008,-6,731992,,101391,,8636305,
     1 -10,47 72,-2,038344,-9,375026,1,117183,,9349618,
     1 -10,92 39,-2,967566,-8,846933,1,269824,,7043903,
     1 -10,61039,4,452847,-8,556268,-,4737891,,7829865,
     1 -10,04022,-1,11499,-10,29365,1,407677,,9611449,
     1 -10,20316,-1,654881,-10,75808,1,045175,1,144233,
     1 -10,57207,3,833069,-8,472411,,0446222,,7277405,
     1 -10,23 15,-1,286685,-11,13199,1,076169,1,066819,
     1 -10,64444,-3,383546,-11,9358,1,695872,1,549694,
     1 -10,52/71,2,105704,-8,993265,,4974295,,7882992,
     1 -11,03 52,-3,665336,-10,5132,1,784495,,7993335,
     1 -11,68293,-6,134871,-10,17043,1,993965,,5740519/
     DATA ((KK(I,N),N=1,5),I=13,24)/
     1 -11,20 20,-1,423282,-8,568622,1,369792,,5003525,
     1 -12,46 26,-7,189952,-9,689162,2,508981,,4032442,
     1 -13,19 08,-9,252206,-7,828305,3,004999,-,2370745,
     1 -11,88 13,-5,22407,-8,782326,1,981059,,3970906,
     1 -14,57344,-11,73308,-8,161604,3,560226,-,2413976,
     1 -16,53499,-15,38885,-5,695258,4,655082,-,9454673,
     1 -12,96 43,-10,26358,-8,530573,3,485636,,195912,
     1 -17,11 34,-17,86003,-6,628826,4,850326,-,8765574,
     1 -20,08749,-21,11827,-3,229256,5,837981,-1,727925,
     1 -14,20 73,-14,89855,-7,363175,4,301735,-,494157,
     1 -19,20 43,-22,94389,-5,903727,6,094622,-1,100933,
     1 -22,78446,-26,49346,-1,355867,6,749632,-2,499507/
C        PEL CALCULATION COEFFICIENTS
      DATA ((L(J,I),J=1,9),I=1,12)/
     1 49,,,079520,55,,,058098,64,,,043478,91,01,,030103,52,,
     1 44,,,058160,51,,,058098,60,,,040570,85,88,,030103,51,,
```

```
     1 39...038160,46...052286,56...036831,87,32..030103,49.,
     1 34...029640,42...047534,53...036831,79,85..030103,47.,
     1 30...033013,39...043573,51...035336,79,76..030103,46.,
     1 27...033013,36...043573,48...033333,75,96..030103,45.,
     1 24...033013,33...040221,46...033333,73,96..030103,43.,
     1 21...033013,30...037349,44...032651,74,91..030103,42.,
     1 18...033013,27...034859,42...030675,94,63..030103,41.,
     1 16...033013,25...034859,40...030103,100.0..030103,40.,
     1 16...033013,25...034859,40...030103,100.0..030103,40.,
     1 16...033013,25...034859,40...030103,100.0..030103,40./
      DATA ((L(J,I),J=1,9),I=13,24)/
     1 16...033013,25...034859,40...030103,100.0..030103,40.,
     1 16...033013,25...034859,40...030103,100.0..030103,40.,
     1 15...029640,23...034859,38...030103,100.0..030103,38.,
     1 12...033013,21...040221,34...029960,100.0..029960,34.,
     1 09...033013,18...037349,32...029960,100.0..029960,32.,
     1 05...027712,15...034859,30...029960,100.0..029960,30.,
     1 04...027712,14...034859,29...029960,100.0..029960,29.,
     1 05...033013,14...034859,29...029960,100.0..029960,29.,
     1 06...033013,15...034659,30...029960,100.0..029960,30.,
     1 10...038160,17...037349,31...029960,100.0..029960,31.,
     1 17...029520,23...037349,37...042285,44,29..029960,34.,
     1 21...029640,29...043573,41...042285,50,72..029960,37./
      END
```

```
      SUBROUTINE EJECTS
C     EJECTS -- EJECTOR EFFECT SUBROUTINE
      COMMON /CM/ H,U
      COMMON/CM1/L(9,24),X(24),F(24),E(24),S(15,24),KK(24,5),C(15,5),
     1 O(20), P(49),PA(49),P(20),R(15,24),Y1(24),Y(24),C1(15),EVE(20),
     1 S1(24),G(2,24),C2(15,2),T(20),D(20),W(5),A(4),V(3),E1(15,24)
      COMMON /CM2/ VM,AO,W8,A1,Y9,T8,T5,R7,P1,Z9,DJ,AJ,H,U,E9
     1 ,T2,V9,C9,DP,D1,VC,O9,A8,Q,L9,A6,A7,S6,P9,R9,ALT,SL,AN1,NFLT
      COMMON /CM3/ IIAS(2),IICASE(6),IDCASE(6),IDENT(6)
      REAL L,KK,K1
      REAL L9,L9,L2,K6,L3,M
C          HARDWALL EJECTOR EFFECTS
      DO 110 I=1,15
      DO 110 J=1,24
  110    E1(I,J)=0.0
      FP=.3*V8/SQRT(4*A8/P1)
      L8=5*ALOG10(L9/2)
      D3=SQRT(A6*A7*A8*AN1/P1+S6**2-A7*A8*AN1/P1)
      A5=A6 $ IF(Y9.GT.3) GO TO 133 $ IF(R9.EQ.0) GO TO 140
  133    A5=A6/(10**(12.78*(D3/S6-1)**2+.0461))
  140    D2=L8-23.59*A5-(11.*(ALOG10(P9/1.9))**2)+.005*(T8-T0)+30
      IF(D2.LT.3) GO TO 285
C          DIRECTIVITY EFFECTS
      DO 270 I=1,15 $ AJ=(I+1)*10
      IF(AJ.GT.OJ-60) GO TO 165 $ DE=.64*D2 $ GO TO 220
  165    IF(AJ.LT.OJ-30) GO TO 180
      IF(AJ.GT.OJ) GO TO 200 $ DE=.2*D2 $ GO TO 220
  180    DE=D2*(-4.8888-4*(AJ-OJ+60)**2+.64)
      IF(DE.GT.0) GO TO 220 $ DE=0 $ GO TO 270
  200 IF(AJ.GT.OJ+20) GO TO 210 $ DE=D2*SQRT((AJ-OJ)/20) $ GO TO 220
  210    DE=D2*(.00925*(AJ-OJ-20)+1)
C          SPECTRAL EFFECTS
  220    DO 260 J=1,24 $ IF(FP.GT.1.12*F(J)) GO TO 250
      IF(F(J)/FP.GT.8) GO TO 240
      E1(I,J)=.2*(F(J)/FP-1)**2-DE $ GO TO 260
  240    E1(I,J)=9.5-DE $ GO TO 260
  250    E1(I,J)=-DE
  260    CONTINUE
  270    CONTINUE
  280    IF(A(1).EQ.0) GO TO 820
C          EJECTOR TREATMENT EFFECTS
      XJ=M/5.0 $ IF(M.LT.1.13) GO TO 330 $ XJ=.226
  330    D4=SQRT(4*A8*AN1/P1) $ L3=L9*D4
      D3=D3*2.0
C          SHOE RESISTANCE AND REACTANCE
      YJ=.82.6-2.5694*XJ
      IF(XJ.LT..08929) GO TO 460
      YJ=.60394-3.48606*(XJ-.08929)
      IF(XJ.LT..22321) GO TO 460
      YJ=.13019-2.00751*(XJ-.22321)
      IF(XJ.LT..26786) GO TO 460
      YJ=.14055-.90634*(XJ-.26786)
      IF(XJ.LT..32143) GO TO 46
      YJ=0
  460    T1=(A(1)+.85*A(3)*YJ)/12
      RS=(.3*XJ)/A(2)
  5..    DO 815 J=1,24 $ A6=0
```

```
C          FREQUENCY DETERMINATION
      DO 755 KR=1,3 $ IF(KR-2) 520,530,540
520      P3=F(J)*6.28318*.89 $ GO TO 550
530      P3=F(J)*6.28318 $ GO TO 550
540      P3=F(J)*6.28318*1.12
550      X4=(P3*T1)/(A0*A(2))-1/TAN((P3*A(4)/12)/A0)
      IF(A(1).NE.10) GO TO 590
      IP=KR+2*J-2
      RS=RR(IP)
      X4=PX(IP)
590      A3=0 $ DO 730 I=9,15 $ K6=0 $ AJR=((I+1)*10-90)*PI/180
      A1=4*PS*COS(AJR)/((1+PS*COS(AJR))**2+(X4*COS(AJR))**2)
C          ABSORPTION PER REFLECTION
      A2=10*ALOG10(1-A1)
      DO 690 K=1,25 $ XJ=((2.5*X(J))/25)*K
C          SOURCE LOCATIONS
      ZJ=XJ/X(J)
      S2J=-11.19136+32.76997*ZJ-37.633732*ZJ**2+23.970385*ZJ**3
      S2J=S2J-10.115712*ZJ**4+2.4045214*ZJ**5-.23576959*ZJ**6
      S2J=S2J-11.6
C          EFFECT FOR ALL REFLECTIONS
      DO 675 JJ=1,11$IF(JJ.GT.1) GO TO 660$L2=(D3/2-S6)*TAN(AJR)+XJ
      GO TO 670
660      L2=L2+D3*TAN(AJR)
670      IF(L2.GT.L3) GO TO 680
675      CONTINUE
680      K6=K6+10**(((JJ-1)*A2+S2J)/10)
690      CONTINUE
C          POWER LEVEL REDUCTION
      AJ=(I+1)*10 $ K6=10*ALOG10(K6)
      YJ=1.5*PI*(COS((AJ-5)*PI/180)-COS((AJ+5)*PI/180))
      A3=A3+(2.227525E-6*4E-8*YJ*10**(K6/10))
730      CONTINUE
      A3=10*ALOG10(A3)+130-6.45175
      A4=A4+10**(A3/10)
755   CONTINUE $ A4=10*ALOG10(A4/3)
C          DIRECTIVITY EFFECTS
      DO 815 I=1,15 $ AJ=(I+1)*10 $ A5=A4
      IF(AJ.LT.OJ-50) GO TO 800 $ IF(AJ.LT.OJ) GO TO 810
800      A5=A4/2
810      E1(I,J)=E1(I,J)+(A5*1.2)
815      CONTINUE
820      RETURN $ END
```

3.0 REFERENCES

1. Clapper, W.S., Sieckman, A., Motsinger, R.E., et al., "High Velocity Jet Noise Source Location and Reduction: Task 3 - Experimental Investigation of Suppression Principles," General Electric Company, FAA-RD-76-79, 111-1, (to be published).

2. Stringas, E.J., Sieckman, A., Whittaker, R., Wolf, J., et al, "High Velocity Jet Noise Source Location and Reduction: Task 6 - Noise Abatement Nozzle Design Guide," General Electric Company, FAA-RD-76-79, V1, (to be published).

3. "Standard Values of Atmospheric Absorption as a Function of Temperature and Humidity for Use in Evaluating Aircraft Flyover Noise," SAE, ARP 866, August 1964.

4. "Method of Calculating the Attenuation of Aircraft Ground-to-Ground Noise Propagation During Takeoff and Landing," SAE, AIR 923, August 1965.

4.0 UNIFIED AEROACOUSTIC PREDICTION MODEL (M*G*B) COMPUTER PROGRAM

4.1 INTRODUCTION

This section describes the computational algorithims and associated computer program that provide the necessary link between the symbolic representation of the M*G*B model and the actual numerical results of the prediction method.

The computer program is written in FORTRAN IV language. It has been run on both the GE/Honeywell 6080 and CDC 7600 computers, and can easily be modified for running on other systems. The program subdivides the jet plume utilizing a built-in grid system which requires minimal input for specification. This grid system can be superseded by the user through more complex input if desired. The nozzle geometry is input through discrete point coordinates for each nozzle element boundary, and up to 109 elements can be input for a given case. A maximum of 24 axial stations along the jet plume is permitted, and up to 200 radial points per axial station can be accommodated. These limits can be changed if so desired by modifying the appropriate DIMENSION and COMMON statements in the program logic.

The limiting assumptions made in developing the method have been discussed in Reference 1, but it is appropriate to summarize them here to warn against indiscriminate violation of these limitations. They are as follows:

1. The exhaust nozzle elements should be coplanar; that is, each tube or chute of a multielement configuration should exhaust at the same axial plane. However, nozzle element exit planes can be staggered, provided that the mixing layer of a given element does not impinge on the wall of another element.

2. The jet exhaust gases must all be of the same constituent, for the calculation cannot accommodate gas mixtures or species concentrations.

3. Within any nozzle element, the flow is assumed to be uniform at the exit plane.

4. The time-averaged static pressure is assumed to be constant and uniform throughout the jet flow field and surrounding ambient field.

5. The exhaust nozzle elements must discharge axially, radial mean flow and swirl are neglected in the model.

6. The effects of shock formations on mixing and turbulence levels are neglected.

These assumptions and limitations are those which pertain to the types of problems which can be analyzed. There are, of course, additional assumptions that went into the formulation of the model itself which may restrict the accuracy of the model, but which do not restrict the type of problem which can be analyzed. The user is advised to consult Reference 2 for the details of the model formulation.

4.2 PROGRAM NOMENCLATURE AND SYMBOL CONVENTION

The jet plume and nozzle geometry coordinates are computed in the MAIN routine. The jet plume is divided into KX axial slices, specified by KA ($1 \leq KA \leq KX$). The FORTRAN symbol variables for the various coordinate parameters and indices are shown in Figure 4-1. Note that the radial subdivision, specified by index M ($1 \leq M \leq NR$), proceeds in increments DSIG(KA), from SIG = RMIN(KA) to the maximum value set by NR. The value of NR is determined during the calculation from the location where the axial momentum flux is within a certain tolerance of being equal to the ambient level, i.e.,

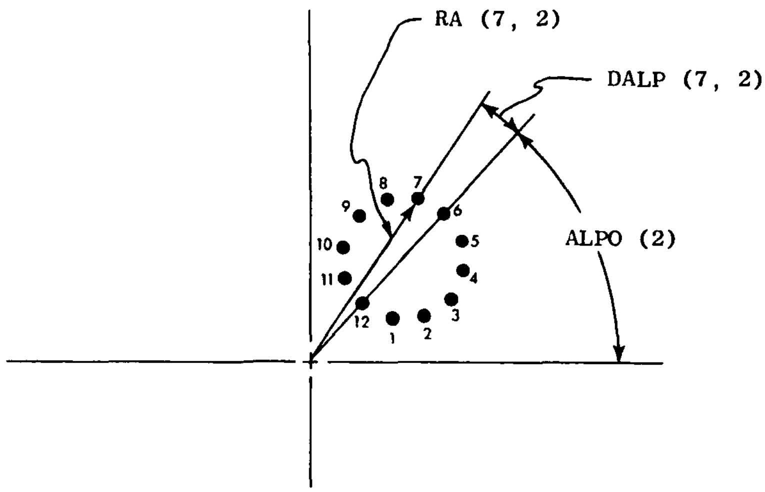
$$|RU2 - RU2E(1)| \leq RU2M$$

where RU2M is a specified input tolerance. The maximum allowable value of NR can be specified by the input variable IQUIT. The program dimension sizes limit KX and IQUIT to the following maximum values:

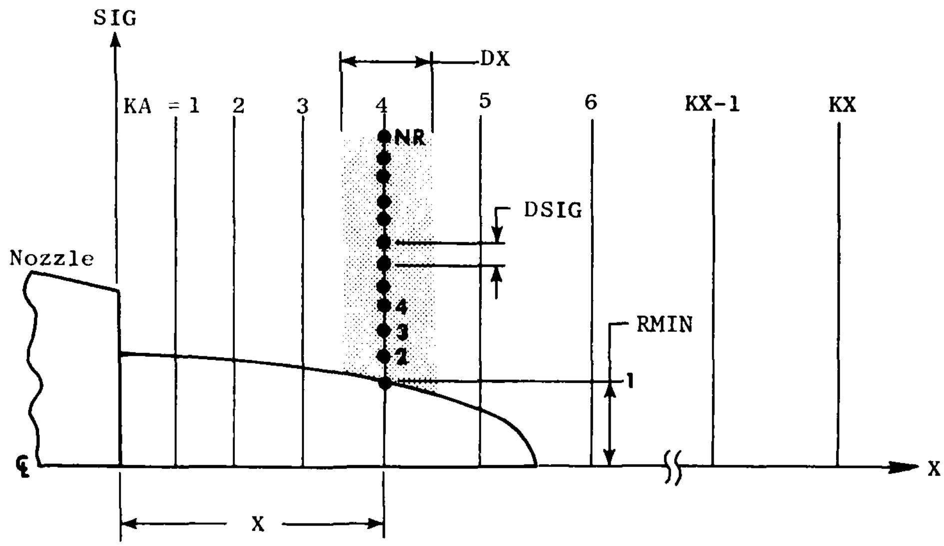
$$KX \leq 24 \qquad IQUIT \leq 200$$

The nozzle geometry itself is input as a number (NEST) of boundary elements. Each element is specified by coordinate pairs RA(I,J) and DALP(I,J), where RA(I,J) denotes the radius and DALP(I,J) denotes the angular increment, as shown in Figure 4-1. The index I denotes the boundary contour point number, and the index J denotes the boundary number. The reference angular location for each boundary is given by ALPO(J). For each boundary, the exit-plane values of total pressure PT(J) and total temperature TT(J) are also specified. Boundary Number One (J=1) is always considered to be the ambient field.

The farfield acoustic calculations are performed on either a constant-radius arc or a sideline parallel to the jet axis, according to whether the input variable NUMANG is set equal to 1 or 2, respectively. For NUMANG = 1, the input DIST is the arc radius; for NUMANG = 2, DIST is the sideline distance. The acoustic arena geometry specification in terms of FORTRAN variables is shown in Figure 4-2. Note that a distinction is made between the source-to-observer distance RSTAR and the nozzle-to-observer distance RADIUS. The observer angle relative to the jet axis THETA is always in units of radians, while the observer angle relative to the inlet axis THETD is in units of degrees. The farfield sound pressure level SPL(I,J) is computed at



(b) Nozzle Exit Plane Example Nozzle Element Coordinates



(a) Radial/Axial Plane

Figure 4-1. FORTRAN Symbol Convention for Coordinates and Geometric Variables.

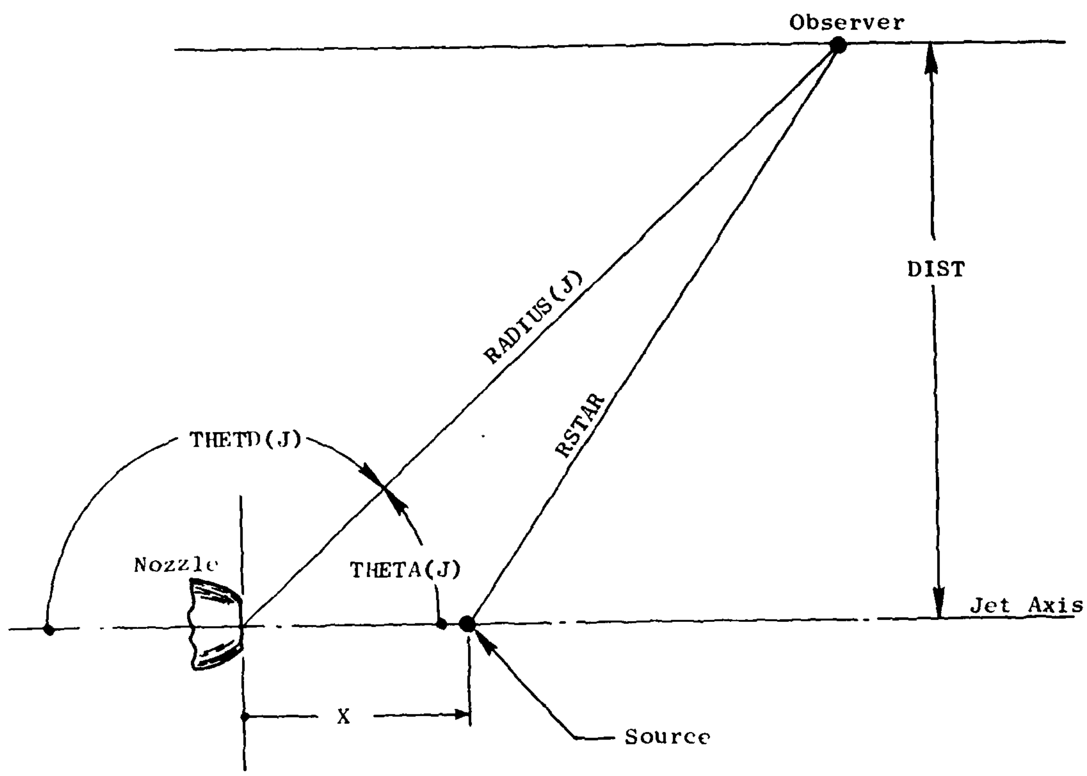


Figure 4-2. FORTRAN Symbol Convention for Acoustic Arena Variables.

every 1/3-octave frequency from FMIN to FMAX, at ten-degree increments from THETD = 20° to 160°.

A list of the important FORTRAN symbols used in the computer program is given in Table 4-1, along with their algebraic equivalents where possible. A complete description of all of the input variables and examples of input preparation are given in Section 4.5.

4.3 DESCRIPTION OF PROGRAM AND SUBROUTINES

A flow chart of the computer program logic is shown in Figure 4-3. It indicates the sequence of operations, the interconnections of various portions of the program, and their functions. A description of the main program and each of the subroutines is given in the following paragraphs.

4.3.1 MAIN

The main program initiates the computation and controls the sequence of operations. It reads the input data, computes the grid system for the aerodynamic flow field, and computes the various required nozzle exit plane flow parameters such as velocities, Mach numbers, momentum and enthalpy fluxes, etc. The main program prints out all input data, nozzle exit conditions, nozzle geometry, and coordinate system parameters.

The main program controls and executes the jet plume flow field computation. After each axial slice has been evaluated, the MAIN program calls subroutine SLICE to perform the requested acoustic calculations. Upon completing the calculations at all axial slices, MAIN then calls OUTPUT to perform some final calculations and print out the farfield noise levels. If additional cases are requested, the entire procedure is repeated, beginning with reading of input data; otherwise the execution is halted.

4.3.2 ARCCOS(X)

This is a function subroutine which computes the principal value of the arc cosine of the variable X. It is used in MAIN in evaluating certain angles relating boundary coordinate points and flow field location points.

4.3.3 ERF(X)

This function subroutine evaluates the error function of argument X using polynomial approximations as given in Reference 3. It is used in MAIN for evaluating flow field integrands.

Table 4-1. List of FORTRAN Symbols.

FORTRAN Symbol	Meaning	Related Subroutines
AA	Air attenuation factor	ATMOS
AAA	Intermediate variable	LSPFIT, MAIN
ABDTH	$\lvert\Delta\Phi\rvert$	MAIN
ABLE	Intermediate variable	MAIN
ABPA	$\lvert\phi-\alpha\rvert$	MAIN
ACH	Mach number M	MAIN
ACHM	Average mach number	MAIN
ACH2	M^2	MAIN
AK	Sound level constant	MAIN, OUTPUT
AL	Lighthill parameter	MAIN
ALFA	Frequency constant	MAIN
ALP	Angle	MAIN
ALPHT	Convection constant α_t	SLICE
ALPØ	Reference boundary angle	MAIN
AMUIN	Input turbulence constant μ_t	MAIN
AMULT	Intermediate value for μ_t	MAIN
AO	Speed of sound C_a	MAIN
ATOTAL	Total flow area	MAIN
B	Intermediate variable	LSPFIT
BETA	Shock strength parameter β	SHOCK
BETAIN	Input turbulence constant β_t	MAIN
BETAMC	Convection constant β_{Mc}	MAIN, SLICE
BK	Intermediate variable	SLICE
BKR	Intermediate variable	MAIN
BOT	Intermediate variable	LSPFIT
BUG	Intermediate variable	MAIN
C	Constant	LSPFIT
CH	Spreading parameter C_h/C_m	MAIN
CHX	Spreading parameter C_hx	MAIN
CJOCO	Ratio of C_j/C_a	SLICE
CM	Spreading parameter C_m	MAIN
CMAX	Intermediate variable	TPNLC
CMC	Intermediate variable	MAIN
CMMC	Spreading constant C_1	MAIN
CMVR	Spreading constant C_2	MAIN
CNST	Constant	SLICE
CO	Ambient speed of sound C_a	MAIN, SLICE, SHOCK
COEF	Conversion factor	OUTPUT
CONV	Convection factor	SHOCK
CONVF	Flight dynamic factor	SLICE
CONVO	Convection factor	SLICE
CONV2	Modified convection factor C	SLICE
CON1	Constant	SLICE

Table 4-1. List of FORTRAN Symbols (Continued).

FORTRAN Symbol	Meaning	Related Subroutines
CON2	Constant	SLICE
COST	Cos Φ	MAIN
COSTO	Cos Φ	MAIN
CP	Specific heat C_p	MAIN
CT	Cos θ	SLICE, CRD
CTSQ	$\mathrm{Cos}^2\ \theta$	SLICE
CTH	Cos θ	SHOCK
CVR	Intermediate variable	MAIN
DALP	Boundary coordinate $\Delta\alpha$	MAIN
DDTHE	Tolerance on $\Delta\theta$, radians	SLICE
DDTHED	Tolerance on $\Delta\theta$, degrees	SLICE
DELRA	Transformed boundary radius $\Delta\nu$	MAIN
DELSIG	Transformed radius Δr	MAIN
DELTA	Turbulence constant δ_t	MAIN
DELTIN	Input array of δ_t	MAIN
DEQ	Equivalent diameter D_{eq}	MAIN, SLICE, SHOCK
DIA	Reference D_{eq}	MAIN
DIRECT	Directivity factor	SLICE
DIST	Sideline or arc distance	MAIN, SLICE
DJET	Reference diameter	MAIN
DPHI	$\Delta\phi$	MAIN
DRMIN	Δr - minimum value	SLICE
DS	Source strength amplitude	SLICE
DSIG	Δr	MAIN, SLICE
DSPL	Mixing noise pressure	SLICE, OUTPUT
DSPL1	Intermediate variable	SHOCK
DSPL2	Intermediate variable	SHOCK
DTHED	$\Delta\theta$, degrees	SLICE
DTHM	Maximum increment of ϕ	MAIN
DU	Intermediate variable	MAIN
DUDR	$\partial U/\partial r$	MAIN, SLICE
DV	Eddy volume dV	SLICE
DX	Axial step size Δx	MAIN, SLICE
EF	Enthalpy flux	MAIN
EFE	Enthalpy flux	MAIN
EM	Mach number	SLICE
EMACH	Exit Mach number	MAIN, SLICE, OUTPUT
F	Intermediate variable	LSPFIT
FAC	Intermediate variable	PNLC
FC	Center frequency	SLICE
FIRSTU	Flight velocity U_a	MAIN, SLICE
FIS	Intermediate variable	MAIN
FM	Mass flow	MAIN

Table 4-1. List of FORTRAN Symbols (Continued).

FORTRAN Symbol	Meaning	Related Subroutines
FMAX	Maximum observed frequency	MAIN, OUTPUT
FMIN	Minimum observed frequency	MAIN, OUTPUT
FO	Observed frequency	SLICE, SHOCK, OUTPUT
FP	Peak frequency	SHOCK
FR	Frequency ratio	SLICE
FRSQ	Intermediate variable	SLICE
FS	Source frequency	SLICE
GAM	Specific heat ratio γ	MAIN, SHOCK
GAMA	Gas constant parameter	MAIN
GEXP	Gas constant parameter	SHOCK
GM	Shielding function	CRD
GOSQ	Shielding function	CRD
G2	Shielding function	SLICE, CRD
HF	Spectrum function	SLICE
HPSI	Intermediate variable	MAIN
HTR	Stagnation enthalpy	MAIN
I	Index	ALL
IC	Index	LSPFIT
IDENT	Title (80-characters)	MAIN
II	Index	TPNLC
IMH	Index	MAIN
IQUIT	Maximum number of points	MAIN
IS	Index	MAIN
ISSY	Index	MAIN
ISAVE	Index	LSPFIT
ISYM	Symmetry indicator	MAIN
IT	Symmetry indicator	MAIN
J	Index	ALL
JMAX	Maximum band number	OUTPUT, SHOCK, SLICE
JMIN	Minimum band number	OUTPUT, SHOCK, SLICE
J1	Index	CRD
J11	Index	CRD
J2	Index	CRD
J21	Index	CRD
J211	Index	CRD
K	Index, also wave number	MAIN, SLICE, PNLC
KN	Surrounding boundary index	MAIN
KNCAS	Case counter	MAIN
KNK	Surrounding boundary index	MAIN
KX	Number of axial slices	MAIN
L	Index	MAIN
LAVG	Shock spacing	SHOCK
LEAF	Number of boundary leaves	MAIN

Table 4-1. List of FORTRAN Symbols (Continued).

FORTRAN Symbol	Meaning	Related Subroutines
LEAV	Number of boundary leaves	MAIN
LINE	Printout counter	MAIN
LPHI	Number of flow field leaves	MAIN
LQ	Index	MAIN
M	Index	MAIN, SLICE
MACH	Mach number	SLICE
MAXNOY	Maximum noy value	PNLC
MC	Convection Mach number	SLICE, SHOCK, CRD
MCIN	Input array of M_c	SLICE
MIN	Input array of M_o	CRD
MJ	Jet exit Mach number	SHOCK
N	Index, also number of shocks	MAIN, SHOCK, LSPFIT
NBREF	Reference boundary number	MAIN
NCASE	Number of cases	MAIN
NCBDY	Number of centerbody points	MAIN
NCELL	Number of shock cells	MAIN, SHOCK
NCOUNT	Counter	LSPFIT
NN	Acoustic calculation selector	MAIN, SLICE
NODE	Intermediate variable	MAIN
NOV	Minimum number of points	MAIN
NOY	Noy value	PNLC
NPAGE	Page counter	MAIN
NPR	Printout counter	MAIN
NPRINT	Printout selector	MAIN, SLICE
NPTS	Number of points	LSPFIT
NR	Number of points	SLICE, CRD
NR1	Index	SLICE
NTP	Number of turning points	SLICE, CRD
NUM	Number of boundary points	MAIN
NUMANG	Arena selector	MAIN, SLICE
NUMK	Number of boundary points	MAIN
NXC	Index	LSPFIT
OAPWL	Overall power level	OUTPUT
OASPL	Overall sound pressure level	OUTPUT, PNLC
OBSTN	Observed Strouhal number	OUTPUT
OMEGR	Source radian frequency	SLICE
PAA	Ambient static pressure	MAIN
PC	Intermediate variable	PNLC
PGC	Gas constant parameter	MAIN
PHI	Angle ϕ	MAIN
PI	Constant π	MAIN, SLICE, OUTPUT
PIO2	$\pi/2$	CRD
PI2	2π	MAIN

Table 4-1. List of FORTRAN Symbols (Continued).

FORTRAN Symbol	Meaning	Related Subroutines
PNDB	PNdB	PNLC
PNL	PNL	OUTPUT, PNLC
PNLT	PNL_t, tone-corrected PNL	OUTPUT
POWER	Exponent	MAIN
PS	Ambient static pressure	MAIN, SHOCK
PSQ	Square of acoustic pressure	OUTPUT
PSQM	Mixing noise $\overline{p^2}$	SHOCK
PSQS	Shock noise $\overline{p^2}$	SHOCK
PSQT	Total noise $\overline{p^2}$	SHOCK
PT	Stagnation pressure	MAIN, SHOCK
PWL	Power level	OUTPUT
PWR	Sound power, watts	OUTPUT
Q	Intermediate variable	MAIN
RA	Boundary coordinate radius	MAIN
RAD	Flow integration variable R_o	MAIN
RADO	Flow integration variable R_o	MAIN
RADIUS	Nozzle-to-observer radius R	SLICE, OUTPUT, ATMOS
RADX	Argument $R_o/C_m x$	MAIN
RCBDY	Centerbody radial cooordinate	MAIN
PRCRIT	Critical pressure ratio	SHOCK
RCRC	Intermediate variable	MAIN
RFO	Intermediate variable	OUTPUT
RHO	Density ρ	MAIN
RHOE	Ambient density ρ_a	MAIN, SLICE
RHOESQ	ρ_a^2	SLICE
RHOR	Azimuthally-averaged ρ	MAIN, SLICE
RIN	Input radius	SLICE, CRD
RJET	Reference jet density ratio	MAIN
RMIN	Minimum value of r	MAIN
RMINEX	Exit plane value of RMIN	MAIN
RMINSQ	Square of RMIN	MAIN
RMNSQE	Square of RMINEX	MAIN
RMP	Dummy variable	MAIN
RND	Normalized radius r/D_{eq}	MAIN
ROOT	Root (zero) of g^2	SLICE
ROOT2	$\sqrt{2}$	SLICE
RO	Source radius r_o	CRD
RSIG	Turning point radius r_σ	SLICE, CRD
RSIG1	$r_{\sigma 1}$	CRD
RSIG2	$r_{\sigma 2}$	CRD
RSORSQ	Source location correction $(R^*/R)^2$	SLICE
RSTAR	Source-to-observer radius R*	SLICE

Table 4-1. List of FORTRAN Symbols (Continued).

FORTRAN Symbol	Meaning	Related Subroutines
RU	Mass flux ρU	MAIN
RU2	Momentum flux ρU^2	MAIN
RU2E	Exit plane value of ρU^2	MAIN
RU2M	Minimum value of ρU^2	MAIN
RU2REF	Reference value of ρU^2	MAIN
R1	Intermediate variable	CRD
R2	Intermediate variable	CRD
S	Intermediate variable	TPNLC
SA	Intermediate variable	MAIN
SAC	Intermediate value of τ_ϕ	MAIN
SACO	Intermediate value of τ_ϕ	MAIN
SAR	Intermediate value of τ_r	MAIN
SARO	Intermediate value of τ_r	MAIN
SAX	Intermediate value of τ_x	MAIN
SAXO	Intermediate value of τ_x	MAIN
SBAR	Intermediate variable	TPNLC
SDU	Intermediate value of $\partial U/\partial r$	MAIN
SEFE	Integral of enthalpy flux	MAIN
SGN	Sign	LSPFIT
SGN1	Sign	CRD
SGN2	Sign	CRD
SG1	Intermediate variable	CRD
SG2	Intermediate variable	CRD
SHIELD	Shielding integral	SLICE, CRD
SIC	Intermediate value of τ_ϕ	MAIN
SIG	Radius r	MAIN
SIGN	Sign	ERF
SIGSQ	r^2	MAIN
SIGR	Radius r	MAIN, SLICE
SINT	Sin θ	MAIN
SINTO	Sin θ_o	MAIN
SIR	Intermediate value of τ_r	MAIN
SIX	Intermediate value of τ_x	MAIN
SPL	SPL array	ALL
SPLL	Intermediate variable	TPNLC
SPLMAX	Maximum SPL	SHOCK
SPLP	Intermediate variable	TPNLC
SPLPP	Intermediate variable	TPNLC
SPLU	Intermediate variable	TPNLC
SRU	Mass flux integral	MAIN
SRUM	Mass flux integral	MAIN
SRU2	Momentum flux integral	MAIN
SRU2M	Momentum flux integral	MAIN

Table 4-1. List of FORTRAN Symbols (Continued).

FORTRAN Symbol	Meaning	Related Subroutines
SS	SPL array	PNLC
SSPL	Shock noise SPL array	SHOCK
STC	Azimuthal shear stress τ_ϕ	MAIN
STR	Radial shear stress τ_r	MAIN
STRFR	Radial coordinate stretching factor	MAIN
STRFX	Axial coordinate stretching factor	MAIN
STX	Axial shear stress τ_x	MAIN
SUE	Reference velocity	MAIN
SUM	Sum	OUTPUT
SUMNOY	Sum of noy value	PNLC
SUMSPL	Sum of SPL	PNLC
SUM1	Sum	CRD
SUM2	Sum	CRD
SU8	Integral of source strength	MAIN
SU8M	Integral of source strength	MAIN
SV2	Square of velocity	MAIN
S1	Intermediate variable	LSPFIT
T	Temperature	ERF, MAIN
TA	Intermediate variable	MAIN
TAA	Ambient static temperature	MAIN
TAO	Intermediate variable	MAIN
TAU	Total shear stress τ	MAIN
TAUR	Azimuthal average of τ	MAIN, SLICE
TC2	Intermediate variable	TPNLC
TC3	Intermediate variable	TPNLC
TE	Exit static temperature	MAIN
TEMP	Normalized temperature T/Ta	SLICE
TERM	Directivity factor	SLICE
TH	Angle ϕ	MAIN
THCR	Critical angle θ_{cr}	SHOCK
TERM	Directivity factor	SLICE
THE	Angle θ	SLICE, CRD
THETA	Observer angle θ, radians	SLICE, OUTPUT
THETD	Observer angle θ_I, degrees	SLICE, OUTPUT, SHOCK
THO	ϕ_0	MAIN
THT	Observer angle θ_I, radians	SHOCK
T1	Intermediate value of enthalpy flux	MAIN
TOP	Intermediate variable	LSPFIT
TSR	Static temperature	MAIN
TSTD	Circumferential asymmetry test parameter	MAIN
TSTH	Circumferential asymmetry test parameter	MAIN
TSTHL	Circumferential asymmetry test parameter	MAIN
TSTL	Circumferential asymmetry test parameter	MAIN

Table 4-1. List of FORTRAN Symbols (Concluded).

FORTRAN Symbol	Meaning	Related Subroutines
TT	Stagnation temperature	MAIN
TTR	Stagnation temperature	MAIN
TURBIN	Turbulence intensity, u'	MAIN
U	Mean velocity	MAIN
UAP	Intermediate variable	MAIN
UAVG	Mass-average of U at x	MAIN
UC	Convection velocity U_c	SHOCK
UE	Exit plane velocity U_j	MAIN, SHOCK
UGLY	Intermediate variable	MAIN
UJET	Reference exit velocity	MAIN
UMAX	Maximum local value of U at x	MAIN
UND	Normalized value of U, U/UREF	MAIN
UNITS	Constant for units conversion	MAIN, OUTPUT
UR	Azimuthal average of U	MAIN, SLICE
UREF	Reference exit velocity	MAIN
U8	Intermediate value of source strength	MAIN
U8I	Integral of source strength	MAIN
VA	Intermediate value of momentum	MAIN
VAO	Intermediate value of momentum	MAIN
VI	Intermediate value of momentum	MAIN
VMAX	Maximum of velocities inside and outside	MAIN
VMIN	Minimum of velocities inside and outside	MAIN
VO	Flight velocity U_a	SHOCK
VR	Velocity ratio VMIN/VMAX	MAIN
WITHIN	Dummy variable	LSPFIT
X	Axial distance x	MAIN, SLICE
XCBDY	Centerbody axial coordinate	MAIN
XD	Intermediate variable	LSPFIT
XE	Exit plane axial coordinate	MAIN
XND	Normalized axial coordinate X/D_{eq}	MAIN
XOR	Variable x/R	SLICE
X1	Intermediate variable for curve fitting	LSPFIT
X13	Intermediate variable for curve fitting	LSPFIT
X4	Intermediate variable for curve fitting	LSPFIT
X43	Intermediate variable for curve fitting	LSPFIT
Y	Intermediate variable for curve fitting	LSPFIT
YC	Intermediate variable for curve fitting	LSPFIT
YI	Intermediate variable for curve fitting	LSPFIT
Y3	Intermediate variable for curve fitting	LSPFIT

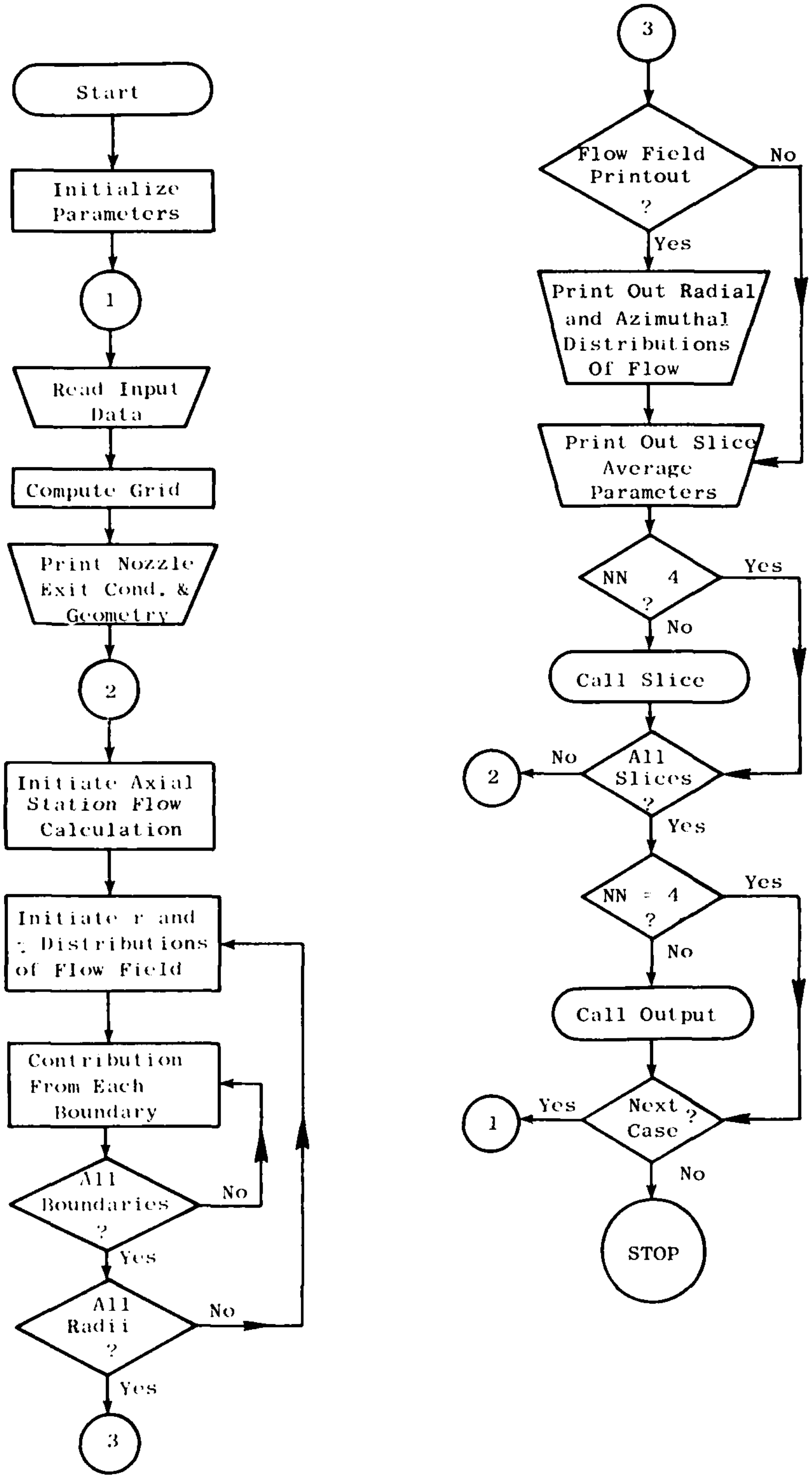
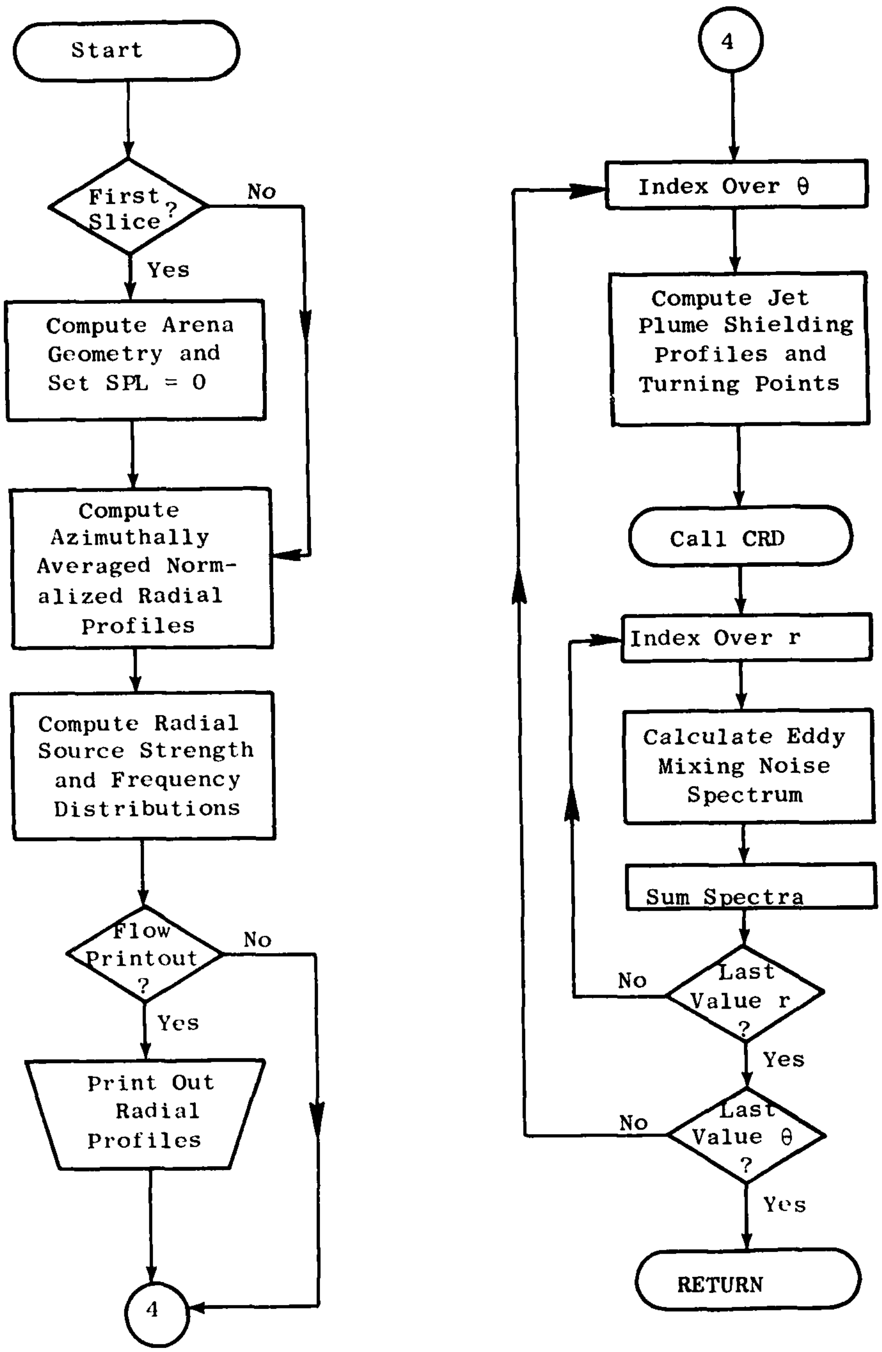
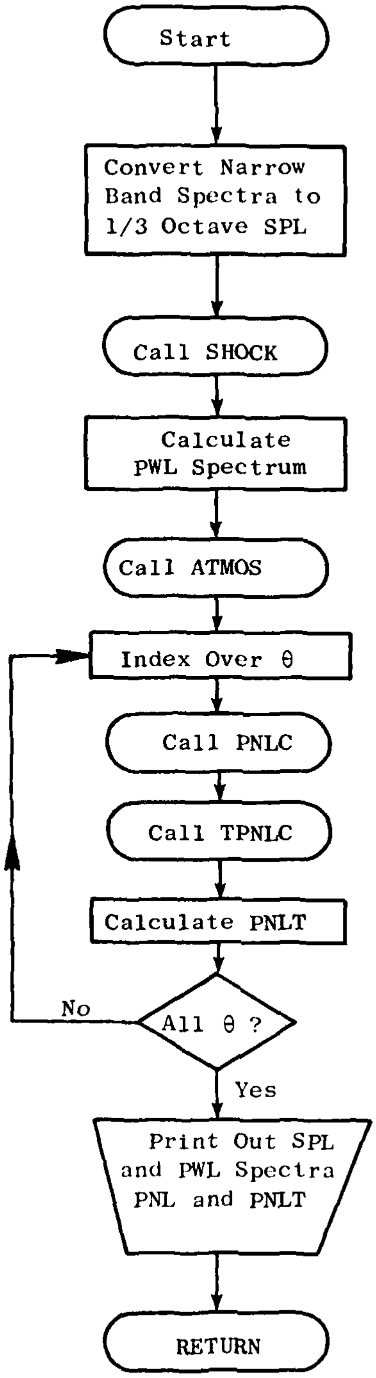


Figure 4-3. Computer Program Flow Chart.



(b) Subroutine SLICE

Figure 4-3. Computer Program Flow Chart (Continued).



(c) Subroutine OUTPUT

Figure 4-3. Computer Program Flow Chart (Concluded).

4.3.4 LSPFIT

Subroutine LSPFIT is a curve-fitting routine which utilizes least-squares polynomial fits of second order to perform interpolation, differentiation and integration of input discrete-point data. The calling statement is:

```
CALL LSPFIT(X, Y, N, XC, YC, NC, NF, A)
```

where (X, Y) are the input data coordinates (N values of each), XC are the values of X where output is requested, YC are the output functions, NC is the number of output data points, and NF indicates the type of output desired. The coding for NF is as follows:

NF = 0, YC are interpolated values of Y

NF = 1, YC are derivatives of Y

NF = -1, YC is the integral of Y from XC(1) to XC(J), $1 \leq J \leq NC$.

The parameter A is the second derivative of Y. Subroutine LSPFIT is used in MAIN to interpolate input plug/centerbody geometry coordinates at various axial stations in the flow field, and to obtain radial gradients of density from the computed density profiles.

4.3.5 SLICE

Subroutine SLICE directs the mixing noise calculation for each axial slice. The calling sequence is as follows:

```
CALL SLICE (X(KA), DSIG(KA), DX, M)
```

where X(KA) is the axial location, DSIG(KA) is the radial step size, DX is the axial slice thickness, and M is the number of radial points in the slice. The flow parameters (which are circumferentially mass-averaged values) are transferred through labeled COMMON statements. Subroutine SLICE computes the acoustic arena geometry parameters THETA, THETD, RADIUS and initializes SPL (I,J) to zero during the first call, skipping this calculation on succeeding calls. The normalized radial profiles of velocity (MACH) and temperature (TEMP) are evaluated, followed by a calculation of source strength amplitude DS and characteristic frequency FS for each radial volume element.

Subroutine SLICE computes the acoustic shielding function profiles G2(J), the number of turning points NTP, and their locations RSIG. Subroutine CRD is then called to calculate the acoustic shielding exponentials and quadrupole directivity functions. Subroutine SLICE then sums up the mixing noise contributions from each radial volume element, factoring in their individual source strengths, characteristic frequencies, spectrum shapes, directivities, and shielding factors. The resulting noise spectrum from each slice is stored as the variable DSPL(I,J), where I denotes the observer angle index and J is the 1/3-octave frequency band index. Upon completing the calculation for a given slice, SLICE returns control to MAIN.

4.3.6 CRD

Subroutine CRD computes the shielding function integrals and quadrupole directivity factors for a given axial slice as a function of radial source location. The radial distributions of normalized velocity (MACH) and temperatures (TEMP) and shielding function (G2) are transferred to CRD through labeled COMMON statements. The calling statement is:

```
CALL CRD
```

At each source radius, subroutine CRD interrogates the data to determine which of the six shielding conditions in Figure 4-4 applies, and computes the appropriate shielding integral (β_{01}, β_{02}, or β_{12}) and the appropriate directivity factors. After all radial source volumes have been evaluated, CRD returns control to SLICE.

4.3.7 OUTPUT

Subroutine OUTPUT performs the final acoustic calculations and prints out the far field SPL spectra, OASPL, PNL and PNLT directivities. The calling sequence is as follows:

```
CALL OUTPUT (EMACH, DJET, RJET, UJET, UNITS)
```

where EMACH, DJET, RJET, and UJET are the characteristic (usually reference) jet Mach number, diameter, density ratio and velocity, respectively. The parameter UNITS is a conversion factor for converting from lb_f/ft^2 to $dynes/cm^2$ relative to 0.0002 $dynes/cm^2$. Subroutine OUTPUT converts the narrowband spectra from SLICE into 1/3-octave levels. Subroutine SLICE then calls SHOCK to compute SSPL spectra (shock noise) and adds these to the turbulent mixing noise spectra to obtain the total-noise spectra. The corresponding power spectrum (PWL) is then computed, and subroutine ATMOS is then called to correct all SPL spectra for atmospheric attenuation. Subroutines PNLC and TPNLC are then called to calculate perceived noise level

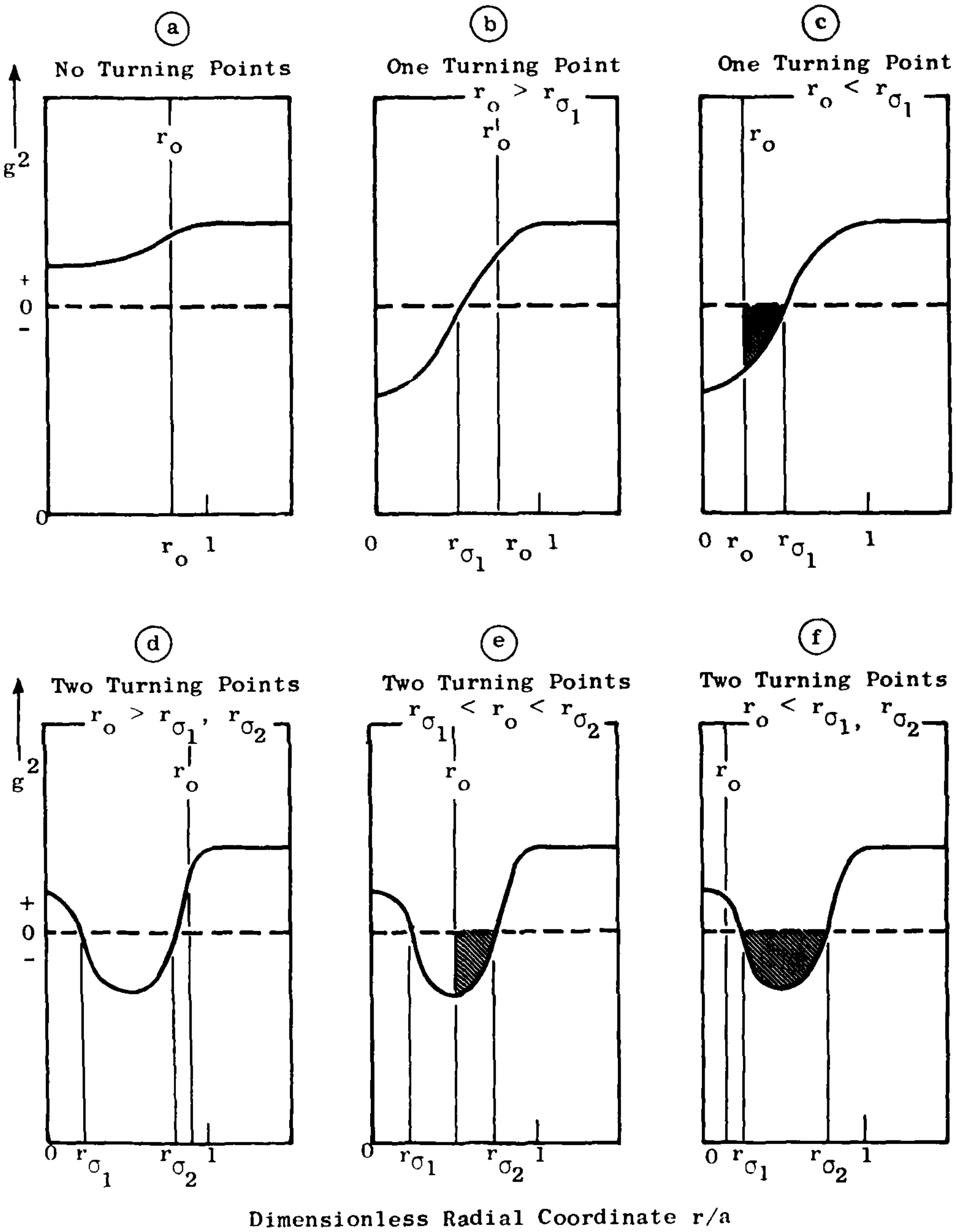


Figure 4-4. Possible Solution Types for a Maximum of Two Turning Points. (Shaded Areas Denote Shielding of Source.)

PNL and tone-corrected noise level PNLT. Finally, overall sound pressure level OASPL is computed, and all of these acoustic parameters are then printed out. Subroutine OUTPUT then returns control to MAIN.

4.3.8 SHOCK

Subroutine SHOCK computes the broadband shock-associated noise spectra at each observer angle. The calling statement is as follows:

CALL SHOCK

All parameters are transferred into and out of this subroutine through labeled COMMON statements. Subroutine SHOCK computes the 1/3-octave SPL spectra for each nozzle boundary element which has a non-zero shock cell number input, NCELL > 0. The individual boundary contributions are summed on a mean-square pressure basis and added to the mixing noise spectra.

4.3.9 ATMOS

Subroutine ATMOS corrects the input SPL spectra for atmospheric attenuation effects using standard-day atmospheric absorption factors for 70% relative humidity and 59° F ambient conditions. The calling sequence is as follows:

CALL ATMOS (SPL, RADIUS)

where SPL(I,J) is the sound pressure spectrum array, I denotes the index for observer angle, J denotes the index on frequency, and RADIUS(I) is the nozzle-to-observer distance array. The atmospheric absorption in dB per 1000 ft, from Reference 4, is corrected to the proper distance RADIUS(J), and the result is subtracted from SPL(I,J). The array of SPL(I,J) returned to OUTPUT is the corrected array.

4.3.10 PNLC

Subroutine PNLC computes the perceived noise level in PNdB at each observer angle from the input 1/3-octave spectra. The calling sequence is as follows:

CALL PNLC (SS, FAC, PNDB, OASPL)

where SS is the input array of either 1/3-octave or octave SPL values, FAC is a constant equal to 0.15 for 1/3-octave and 0.3 for octave levels, PNDB is the output PNL, and OASPL is the conventional overall level. The method used to calculate PNL is taken from Reference 5. The OASPL output from subroutine PNLC is discarded because it only computes the summation for the first 24 values of SS. This is sometimes insufficient for scale model condition, where the frequency range of interest can cover as many as thirty-three 1/3-octave frequency bands.

4.3.11 TPNLC

Subroutine TPNLC determines a pure-tone correction factor to the PNL value as a function of the 1/3-octave SPL spectrum. The calling sequence is as follows:

CALL TPNLC (SPL, PTCOR)

where SPL is the input 1/3-octave spectrum and PTCOR is the correction to be applied to PNL to account for the presence of tones in the spectrum. Subroutine TPNLC reads in SPL and returns PTCOR. The tone correction and detection procedure is based on the method proposed in Reference 7.

4.4 PROGRAM USAGE AND LOGIC

A complete description of the program input variables and input format is given in Section 4.5. A list of notes and suggestions on running the program is also included. A description of program output format, including warning flags and diagnostics, is given in Section 4.6. A sample case listing (including input data card images) is given in Section 4.7 for a 7-tube suppressor nozzle, one of the data-theory comparison cases presented in Reference 2. A complete FORTRAN source listing of the program logic is given in Section 4.8.

Program users should be completely familiar with Appendix A, since there are many pitfalls which can be avoided by giving attention to the recommendations presented therein. The program flexibility permits analysis of nozzle planforms of any imaginable shape, so long as certain input rules and guidelines are followed. When non-axisymmetric nozzles are run, a completely three-dimensional, turbulent, compressible flow field analysis is performed, and input mistakes can be costly in terms of computer processor time. The user should make initial checkout runs for complex nozzles, running just one or two axial slices at first, to ensure that all input is as desired, before running a complete jet plume.

The program is designed to serve as a diagnostic tool, in addition to functioning in the standard jet noise prediction mode. Individual slice calculations can be made by suitable input selection, running each slice (or axial station) as a separate case. This mode permits evaluation of the relative contributions of each slice at each frequency and observer angle. Various components of the acoustic model can be bypassed to assess, for example, the separate effects of convection, acoustic shielding, etc. The program can also be used to predict only the jet flow field, if desired.

4.5 DESCRIPTION OF INPUT

The input data is supplied through NAMELIST input format, with the exception of the alphanumeric title data card, which precedes the input NAMELIST data. Any number of successive cases can be run consecutively, limited only by the user's execution time available. Each successive case requires a title card (80 - character label in columns 1 - 80), followed by the INPUT NAMELIST. The data from preceding cases remain in storage, so only those variables which are to be changed from the preceding case input value need be included in the INPUT file of succeeding cases.

A suggested input preparation format is given in Table 4-2. Those variables marked by an asterisk (*) have preset values built into the program, and need not be input unless the user desires to override the preset values with a different one. The definitions of each of the input variables given in Table 4-2 are listed in Table 4-3. Again, preset variables are marked by an asterisk (*). The values of those variables which are preset are given in Table 4-4. The format of Table 4-3 is such that a note number (where appropriate) is given for each variable which corresponds to the note number in Section 4.5.1 ("Notes on Input"). These notes give further elaboration on how to specify and prepare the input data.

Table 4-2. Suggested Input Format.

Column
2

(80 - CHARACTER TITLE CARD, COLUMNS 1-80)

$INPUT

KX* = __________, NEST = __________, LPHI* = __________, ISYM = __________,

IQUIT* = __________, NN* = __________, NCASE* = __________, NBREF* = __________,

NPRINT* = __________, NCBDY = __________,

NØV = __________, __________, __________, __________, __________, __________,
X = __________, __________, __________, __________, __________, __________,
DSIG = __________, __________, __________, __________, __________, __________,
BETAIN* = __________, __________, __________, __________, __________, __________,
DELTIN* = __________, __________, __________, __________, __________, __________,
AMUIN* = __________, __________, __________, __________, __________, __________,
RMIN = __________, __________, __________, __________, __________, __________,

XE = 0, __________, __________, __________, __________, __________,
ALPØ = 0, __________, __________, __________, __________, __________,
LEAV = 1, __________, __________, __________, __________, __________,
NUM = 1, __________, __________, __________, __________, __________,
KN = 1, __________, __________, __________, __________, __________,
DEQ = __________, __________, __________, __________, __________, __________,
DS = __________, __________, __________, __________, __________, __________,
NCELL = __________, __________, __________, __________, __________, __________,

PT = __________, __________, __________, __________, __________, __________,
TT = __________, __________, __________, __________, __________, __________,

Table 4-2. Suggested Input Format (Concluded).

Column
2

DALP(1,2) = _________, _________, _________, _________, _________,

DALP(1,3) = _________, _________, _________, _________, _________,

(etc., for boundary 4, 5, 6, ...NEST)

RA(1, 2) = _________, _________, _________, _________, _________,

RA(1, 3) = _________, _________, _________, _________, _________,

(etc., for boundary 4, 5, 6, ...Nest)

CM* = _________, CH* = _________, CMVR* = _________, CMMC* = _________,

GAM = _________, CP = _________, PS = _________, ALFA* = _________,

DTHM* = _________, RU2M* = _________, AK* = _________, BK* = _________,

STRFR* = _________, STRFX* = _________, ATØTAL = _________,

ALPHMC* = _________, BETAMC* = _________,

NUMANG = _________, DIST = _________, FMIN* = _________, FMAX* = _________,

ALPHT* = _________, _________, _________, _________, _________, _________,

XCBDY = _________, _________, _________, _________, _________, _________,

RCBDY = _________, _________, _________, _________, _________, _________,

$

(NEXT CASE, IF ANY)

Table 4-3. Input Variable Definitions.

Variable	Note	Description
KX*		Number of axial stations to be analyzed; a maximum of 24 stations is permitted.
NEST	1	Number of closed boundary contours defining the nozzle exit geometry; a maximum of 110 is permitted.
LPHI	7	Number of symmetric leaves (repeating segments in the nozzle exit planform.
ISYM		Nozzle symmetry indicator; ISYM = 1 for axsymmetric nozzles or completely asymmetric nozzles, = 0 otherwise.
IQUIT		Maximum number of radii at which flow field is calculated ($\leq$200).
NN*	12	Acoustic Calculation option indicator.
NCASE*		Number of cases to be run consecutively.
NBREF*		Reference condition boundary number.
NPRINT*	13	Aerodynamic station printout indicator.
NCBDY	9	Number of centerbody input coordinate points. A maximum of 40 is permitted.
NØV		Minimum number of radii at which flow field is to be calculated, for each axial station (KX values required).
X	11	Axial location of each axial station, ft. (KX values required).
DSIG	11	Radial step size to be taken for flow field calculation at each axial station, ft. (KX values required).
BETAIN*	15	Axial shear stress turbulence constant (KX values required).
DELTIN*		Azimuthal shear stress turbulence constant (KX values required).

Table 4-3. Input Variable Definitions. (Continued)

Variable	Note	Description
AMUIN*		Azimuthal velocity gradient turbulence frequency constant (KX values required).
RMIN	9	Minimum radius for flow field calculation at each axial station (KC values required).
XE	8	Axial location of exit plane of each boundary, ft. (NEST values required).
ALPØ	2	Reference angle α_o from which the coordinates of each boundary point are specified, radians (NEST values required).
LEAV	1,4	Number of symmetric leaves (repeating segments) of each boundary (NEST values required).
NUM	1,5	Number of input points (coordinate pairs) to be supplied for each boundary (NEST values required).
KN	1	The number of the boundary which encloses a given boundary (NEST values required).
DEQ	16	Equivalent flow area diameter of each boundary, ft. (NEST values required).
DS	16	Shock-cell spacing characteristic dimension, usually hydraulic diameter, of each boundary, ft. (NEST values required).
NCELL	16	Number of shock cells for each boundary element (NEST values required).
PT	6	Stagnation pressure inside each boundary, lb_f/ft^2 (NEST values required).
TT	6	Stagnation temperature inside each boundary ° R (NEST values required).
DALP(I,J)	2,3,5	Angular increment $\Delta\alpha$ from preceding boundary point which locates the given boundary point I on boundary J, radians (omit boundary number 1, ambient field).

Table 4-3. Input Variable Definitions (Continued).

Variable	Note	Description
RA (I,J)	2,3,5	Radial coordinates of boundary point I on boundary J, ft. (omit boundary number 1, ambient field).
CM*	10	Empirical jet momentum diffusion rate spreading parameter C_m.
CH*	10	Ratio of enthalpy-to-momentum spreading parameters C_h/C_m.
CMVR*	10	Momentum spreading parameter velocity ratio influence coefficient.
CMMC*	10	Momentum spreading parameter Mach number influence coefficient.
GAM		Specific heat ratio $\gamma = C_p/C_v$.
CP		Specific heat at constant pressure C_p, in $(ft\text{-}lb_f)/(slug - {}^\circ R)$
PS		Ambient static pressure, lb_f/ft^2.
ALFA*		Turbulence characteristic frequency constant.
DTHM*	7	Maximum allowable increment in angular coordinate, $(d\phi)_{max}$, for flow field calculation.
RU2M*		Minimum value of jet momentum flux, $(\rho U^2)_{min}$, below which the flow is not calculated.
AK*		Sound pressure level proportionality constant for mixing noise calculation.
BK*		Sound pressure level proportionality con- for dipole density-gradient noise calculation.
STRFR*	11	Radial coordinate stretching factor for use of automatic mesh calculation.
STRFX*	11	Axial coordinate stretching factor for use of automatic mesh calculation.

Table 4-3. Input Variable Definitions (Concluded).

Variable	Note	Description
ATØTAL		Nozzle Total exit flow area, ft^2.
ALPHMC*	14	Convection Mach number weighting factor.
BETAMC*	14	Convection Mach number weighting factor.
NUMANG		Arena selection indicator; NUMANG = 1 indicates constant radius arc, NUMANG = 2 indicates sideline parallel to the jet axis.
DIST		Arc or sideline distance, ft.
FMIN*		Minimum frequency for which acoustic calculations are required, Hz ($\geq$50); an integer variable.
FMAX*		Maximum frequency for which acoustic calculations are required, Hz ($\leq$100,000); an integer variable.
ALPHT*		Convective amplification factor turbulence constant α_t; 15 values required, one for each observer angle θ_I from θ_I = 20° to 160° in 10° increments.
XCBDY	9	Centerbody input point axial coordinate, NCBDY values required.
RCBDY	9	Centerbody input point radial coordinate, NCBDT values required.

Table 4-4. Preset Input Values.

Variable	Value
AK	0.08
ALFA	1.0
ALPHT	15* 0.5
ALPHMC	0.5
AMUIN	24* 0.2
BETAIN	24* 4.0
BETAMC	0.325
BK	0.0
CH	1.15
CM	0.075
CMMC	0.08
CMVR	0.25
DELTIN	24* 4.0
DTHM	0.1
FMAX	100000
FMIN	50
IQUIT	50
KX	15
LPHI	9999
NBREF	2
NCASE	1
NN	0
NPRINT	1
RU2M	3.0
STRFR	0.01
STRFX	1.259921

4.5.1 Notes on Input

1. The jet nozzle geometry is specified by input of the number of component boundaries, NEST, along with pairs of coordinates, RA and DALP, for each boundary element. The ambient field is always treated as the first boundary in the input arrays for UE, PT, TT, LEAV, NUM, KN, XE, and ALPO. This is why some numbers have already been filled in on Table 4-2 in the first column for these arrays. A nozzle with N elements has NEST = N + 1 boundaries.

2. The steps to specifying nozzle geometry input are as follows, referring to Figure 4-1:

   a. Obtain sketch or drawing of nozzle exit cross section and select a coordinate origin which is optimum from the standpoint of symmetry and boundary point specification.

   b. Number each boundary, reserving boundary Number 1 for the ambient field.

   c. With respect to the coordinate origin, select a reference angular location for each boundary, ALPØ.

   d. For each boundary, select points represented by pairs of coordinates. The coordinates used as input are radius, RA(I,J), *and angular increment from the preceding point*, DALP(I,J). For the first point, DALP(I,J) is the angular increment from the reference angle ALPØ. The index I is the boundary point number, and the index J is the boundary number. Both ALPØ and DALP are to be input in radians, and RA is input in feet.

3. The last point on a given boundary should be located at ALPØ if the boundary has only one leaf. The sum of all DALP(I,J) should equal zero if the boundary has only one leaf.

4. If the boundary is a circle about the origin, only one point on the boundary need be supplied, and the value of LEAV for that boundary is set equal to the number of boundary points desired on the circle.

5. The program uses linear interpolation between input boundary points. If a boundary is made up of or contains straight line segments, only the end-points of the straight line segments need be input.

6. The variables PT and TT refer to stagnation pressure and temperature at the exit plane <u>inside</u> the boundary of interest. Setting the first value of PT equal to PS gives a static ambient field. The first value of PT greater than PS simulates non-zero flight velocity.

7. The variable LPHI determines what angular extent of the flow field needs to be calculated. If the nozzle geometry is axisymmetric, setting LPHI equal to a large number (such that 2π/LPHI is less than DPHM) forces the program to calculate the flow field at only one angular location. The flow field for a nozzle containing two adjacent circular jets, for example, has LPHI = 4, since the flow is the same each quadrant. Several examples of how boundary parameters are specified are shown in Figure 4-5.

8. The program can currently only handle coplanar nozzles; that is, every nozzle element must terminate at the same axial location. Therefore XE must be the same for all input boundaries.

9. The centerbody, if any, is input through coordinates pairs XCBDY(J), RCBDY(J), where $1 \leq J \leq$ NCBDY. A maximum of 40 points can be input. The LSPFIT subroutine uses this input to interpolate for finding the values of RMIN at each axial location X. The LSPFIT routine can treat line segments, both straight and curved. Typical examples of centerbody coordinate input are shown in Figure 4-6. If there is no centerbody, the user can avoid automatic computation of the potential core of axisymmetric nozzles (which has no impact on mixing noise) by specifying RMIN as input, but with NCBDY = 0. This option causes the computation to begin at r = RMIN(KA), where KA is the axial station number.

10. The input value of CM is modified for velocity ratio and Mach number effects by the relation

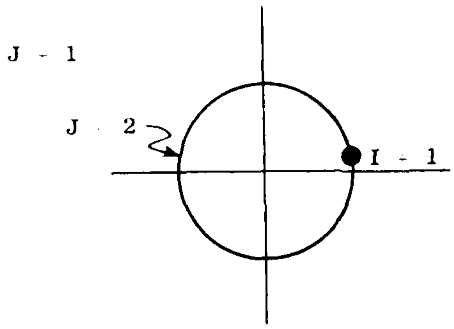
$$\text{DBDX} = \frac{\text{CM}}{(1 + \text{CMVR*VR})(1 + \text{CMMC*ACH})}$$

where DBDX is the modified value of C_m, and VR and ACH are the velocity ratio and Mach number, respectively, of a given boundary. The heat transport spreading parameter is then calculated from the relation

$$C_h = \text{CH} * \text{DBDX}$$

The values of CM, CMMC, CMVR and CH recommended and preset in the program are given in Table 4-4. These values can be changed by the user to reflect experimental evidence if so desired.

11. The axial locations of the axial stations can be input by the array X(KA), where $1 \leq$ KA $\leq$ KX. The radial mesh step size can also be input by the array DSIG(KA). An automatic grid selection procedure has been devised to obviate the need for supplying all values of X(KA) and DSIG(KA). The only input required is the first axial station X(1), and the grid stretching factors STRFR and STRFX. The grid is then calculated from the following relations:



NEST = 2

LPHI = 999

ISYM 1

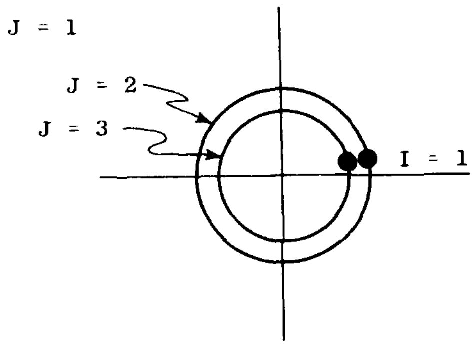
LEAV = 1,36

NUM 1,1,

ALP_ϕ = 0,0,

KN = 1,1,

(a) Circular Jet



NEST = 3

LPHI = 999

ISYM = 1

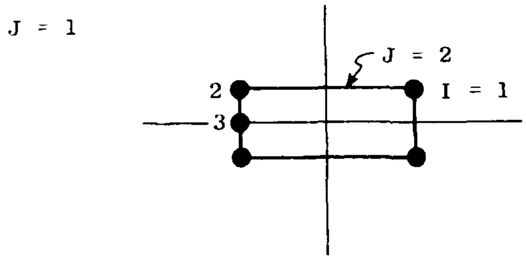
LEAV = 1,36,36,

NUM = 1,1,1,

ALP_ϕ = 0,0,0,

KN = 1,1,2,

(b) Coannular Jet



NEST = 2

LPHI = 4

ISYM 0

LEAV = 1,2,

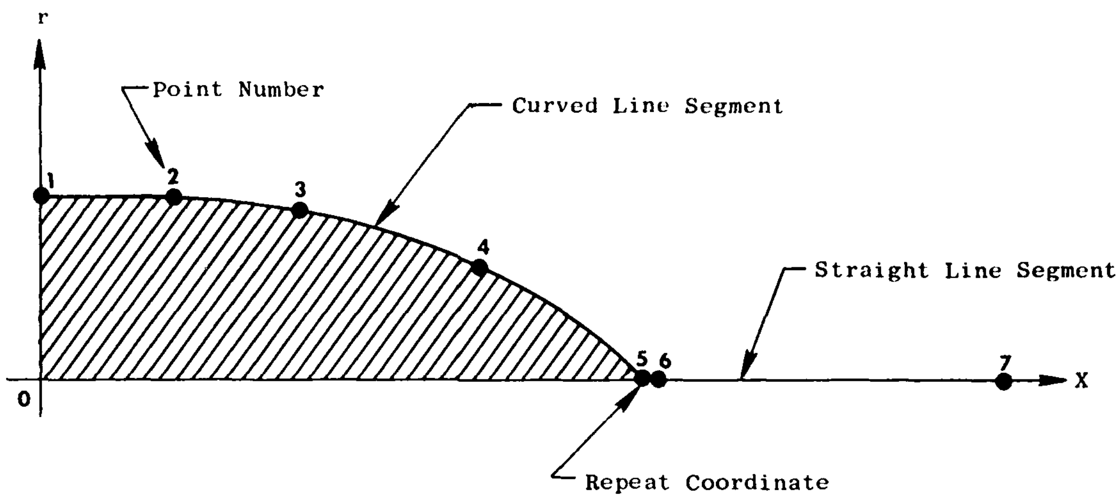
NUM = 1,3,

ALP_ϕ = 0,0,

KN = 1,1,

(c) Rectangular Jet

Figure 4-5. Examples of How Boundary Parameters are Specified.

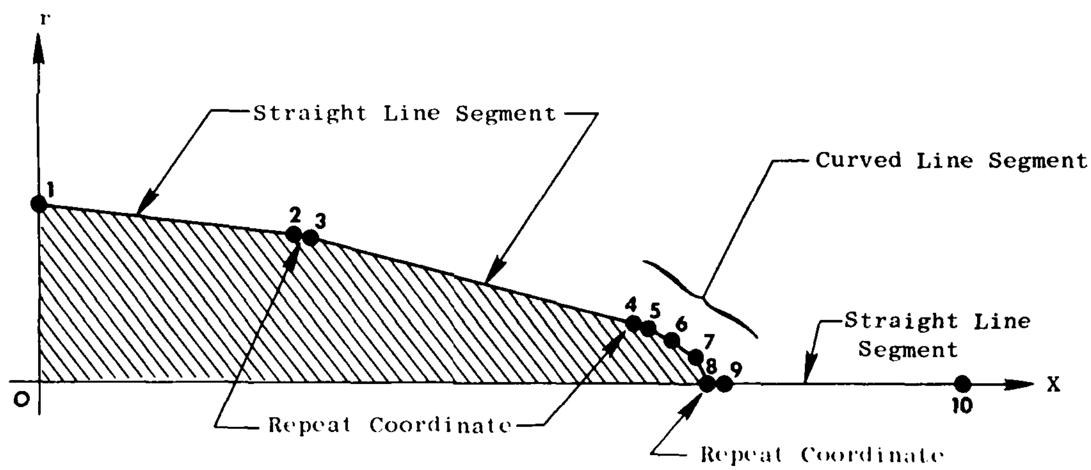


NCBDY = 7,

XCBDY = $X_1, X_2, X_3, X_4, X_5, X_6 (=X_5), X_7$,

RCBDY = R_1, R_2, R_3, R_4, 0, 0, 0,

(a) Example 1 - Curved Centerbody



NCBDY = 10,

XCBDY = $X_1, X_2, X_3\ (=X_2), X_4, X_5 (=X_4), X_6, X_7, X_8, X_9 (=X_8), X_{10}$,

RCBDY = $R_1, R_2, R_3 (=R_2), R_4, R_5 (=R_4), R_6, R_7, R_8, R_9 (=R_8), R_{10}$,

(b) Example 2 - Segmented-Cone Centerbody with Curved Tip

Figure 4-6. Centerbody Input Coordinate Examples.

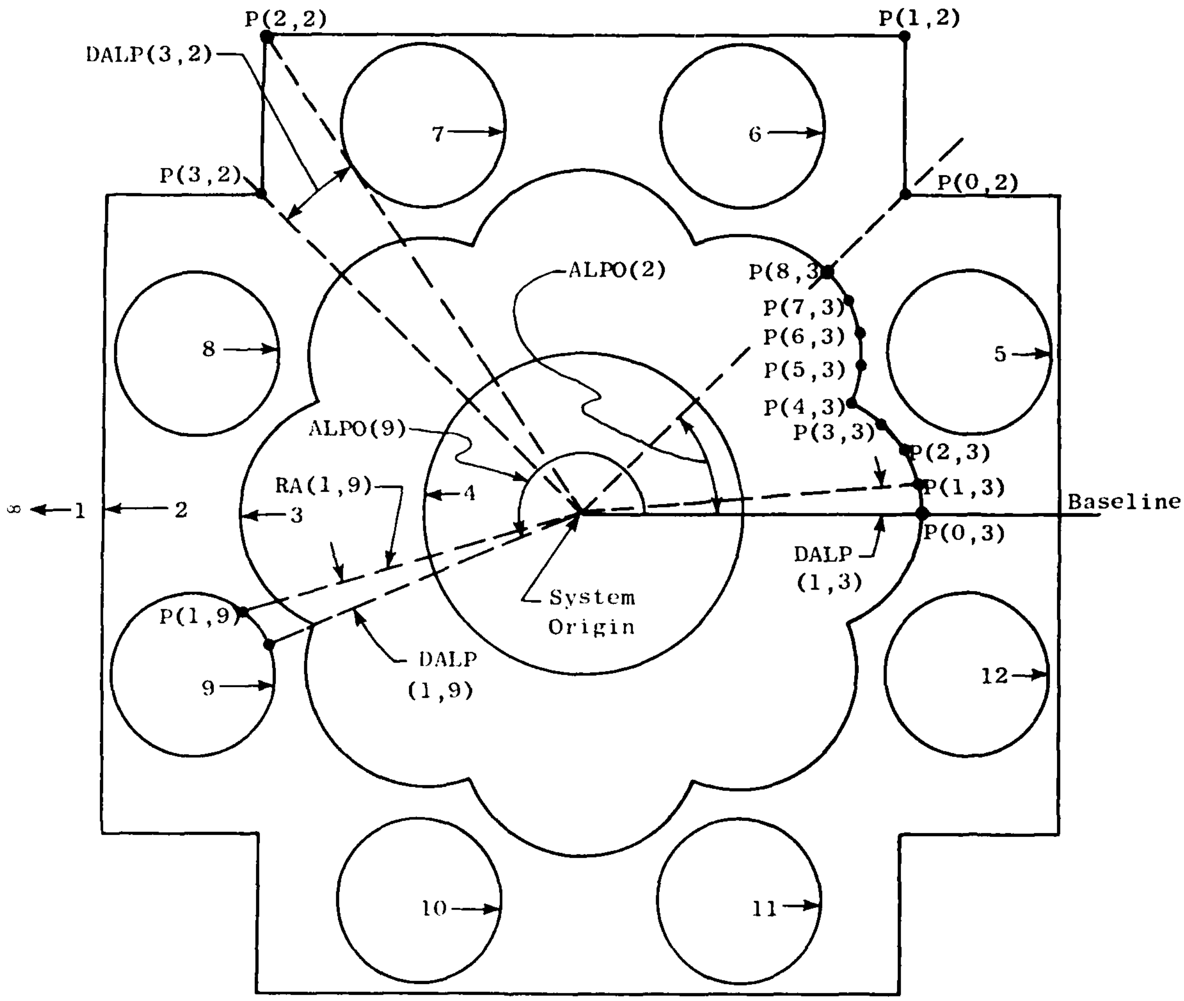


Figure 4-7. Example Demonstration of Nozzle Geometry Specification with a Generalized Nozzle Exit Configuration.

$$X(KA) = STRFX * X(KA-1)$$

$$DSIG(KA) = STRFR * X(KA)$$

This provides a grid which exhibits larger and larger step sizes as the plume is developed downstream. Recommended value of STRFR and STRFX are preset and listed in Table 4-4.

12. The variable NN determines the type of acoustic calculation desired. Normal (preset) operation is with NN = 0, which give the complete acoustic calculation. The user may desire to perform diagnostic computations to assess the relative importance of convection, shielding, etc. By selecting the appropriate value of NN, the various components of the acoustic calculation can be switched on and off in various combinations. Setting NN = 4 gives only the aerodynamic calculation, and the acoustic calculations are bypassed. The various options for NN are listed below:

    NN = 0 - complete acoustic calculation.

    NN = 1 - convective amplification, no shielding.

    NN = 2 - no convective amplification, no shielding.

    NN = 3 - no convective amplification, with shielding.

    NN = 4 - no acoustic calculation, aerodynamics only.

13. The printout of aerodynamic flow field data is controlled by NPRINT. When NPRINT = 0, no aerodyanmic printout is provided. If NPRINT = 1, aerodynamic printout is provided at every axial station. If NPRINT = 2, aerodynamic printout is provided at every second axial station (i.e., KA = 1, 3, 5, 7, etc). For PRINT = 3, printout is provided at every third station, etc.

14. For dual flow nozzles, if the inner stream has a higher velocity than the outer stream, use ALPHMC = 0.5 and BETAMC = 0.325 (preset values). These variables are weighting factors in the convection Mach number calculation, which is computed from the relation

$$MC = ALPHMC * MACH + BETAMC * EMACH$$

where MACH is the local acoustic Mach number U/C_a and EMACH is the exit plane reference Mach number U_j/C_a. If the outer stream has a higher velocity than the inner stream, use ALPHMC = 0.5 and BETAMC = 0.325/VR, where VR = $(U_{outer}/U_{inner})_j$. For multielement suppressor nozzles, VR = U_j/U_m, where U_m is the postmerged potential core velocity. If U_m is not known, BETAMC = 0.2 to 0.25 is usually a good approximation.

15. For dual flow nozzles, input BETAIN = 4.0 (preset) for all values of X, provided the inner stream velocity is higher than the outer stream velocity at the exit plane. If the outer stream velocity is higher than the inner stream velocity at the exit plane, input BETAIN = 0 for all axial stations where X $\leq$ 10*DEQ(NBREF), and BETAIN = 4.0 thereafter, where NBREF is the outer stream boundary number. For multielement nozzles, input BETAIN = 0 for axial distances less than 10*DEQ(1), where DEQ(1) is the equivalent diameter based on total flow area at the exit plane.

16. For each boundary element DEQ, DS and NCELL are input. The first value of DEQ is the total flow area equivalent diameter. The first value of NCELL determines whether or not the shock cell noise is computed. If NCELL(1) is input zero, no shock noise is computed; for NCELL(1)>0, the shock cell noise routine is called. The shock noise of each boundary element is computed separately and added to the total noise. If any boundary has a value of NCELL = 0, that boundary element is bypassed in the shock noise calculation. It is recommended that NCELL = 8 be used for each element unless the actual number is known.

4.5.2 Example Case Input Selection

To illustrate how geometric input parameters are selected for a complex nozzle geometry, an example is presented, taken from Reference 6. The example nozzle exit geometry is shown in Figure 4-7. Consideration of this figure indicates that information over a 45° sector of the flow field will be sufficient to describe the complete flow field. This is one-eighth of a circle, thus LPHI = 8. Neither axial total similarity or dissimilarity exists so ISYM is 0. Counting the number of closed contours indicates a value of NEST of 12, where one is included for the ambient or external field. Values of PT and TT must be provided for the exit state existing just within each of these contours. Values of XE, ALPO, LEAV, NUM, KN, DEQ, DS, and NCELL must be provided for all the contours except the first which is the boundary at infinity. Values of these parameters for the contours shown in Figure A-3 are now considered in the following discussion.

Boundary 2: Description of this boundary starting at 45° to the system baseline is convenient. Thus ALPO = $\pi/4$ radians. Since each 90° sector of the contour is identical with the proceeding one, LEAV = 4. Since the program assumes straight lines to exist between successive boundary points, description of this boundary is possible with only three points for each quadrant. These are P(1,2), P(2,2), and P(3,2). Each point is described by (1) its distance from the system origin and (2) the angle between (a) the line joining it with the origin and (b) the line joining the preceding point with the origin. Note that no value of RA is given for the point P(0,2) since it will be identical to RA(3,2). The value of NUM for boundary 2 will therefore be 3.

Boundary 3: This contour has eight symmetric leaves; thus LEAV = 8. ALPO of 0.0 is as convenient as any other value. The eight points indicated, P(1,3) through P(8,3), probably are sufficient to describe the boundary. Thus NUM = 8.

Boundary 4: Since this is a circle about the origin, it can be divided into a convenient number of leaves and only one point need be given for each (NUM = 1). If a hundred boundary points are desired, set LEAV = 100, DALP(1,4)= $\pi/50$ and RA(1,4) equal to the circle radius.

Boundary 5 through 12: Each of these contours must be described individually unless certain artifical changes are made in the arrangement. A partial representation of Boundary 9 is shown in Figure 4-7. Note that successive points on the boundary are obtained by progressing around the boundary in a counter-clockwise fashion. In order to reduce the labor of representing each circle separately, a straight line can be drawn connecting each circle. Two contours can then be visualized, one consisting of the outer halves of the circles and the lines, the other consisting of the inner halves of the circles and the lines. Each contour has eight leaves and only one need be represented by the programmer. Since this technique requires the computer to integrate along each straight line twice in the course of computation, it will definitely increase the computational time over the method in which each contour is represented separately.

4.6 OUTPUT DESCRIPTION

The output format is generally self-explanatory. The input data are first printed out, using the same nomenclature previously defined in Table 4-1. Nozzle exit plane flow conditions (static temperature, velocity, Mach number, momentum flux, and enthalpy flux) are then printed out for each boundary contour.

At each axial location specified, the radial and tangential distributions of flow field properties are printed out. After the flow field information, the noise characteristics of that particular axial station are then listed.

Following all of the axial station flow field data, a summary table of the noise characteristics (SPL spectra, PNL, PWL, OASPL) is given.

Section 4.7 contains an input deck card listing and output printout for a sample case run. This particular case is for a 7-tube nozzle presented in Reference 2. For brevity, only a portion of the total output is shown; but the formats of the various output data are all included.

Two warning flags are built into the program. The first is a case termination flag, which occurs whenever an input total pressure (P_T) is less than the input static pressure (P_S). The flag message is as follows:

****ERROR - MACH NO. SQUARE IS NOT GREATER THAN ZERO - CASE WILL TERMINATE****

The second flag is a warning detected in subroutine SLICE, which occurs whenever the number of turning points (NTP) is found to be greater than 2. The flag message is as follows:

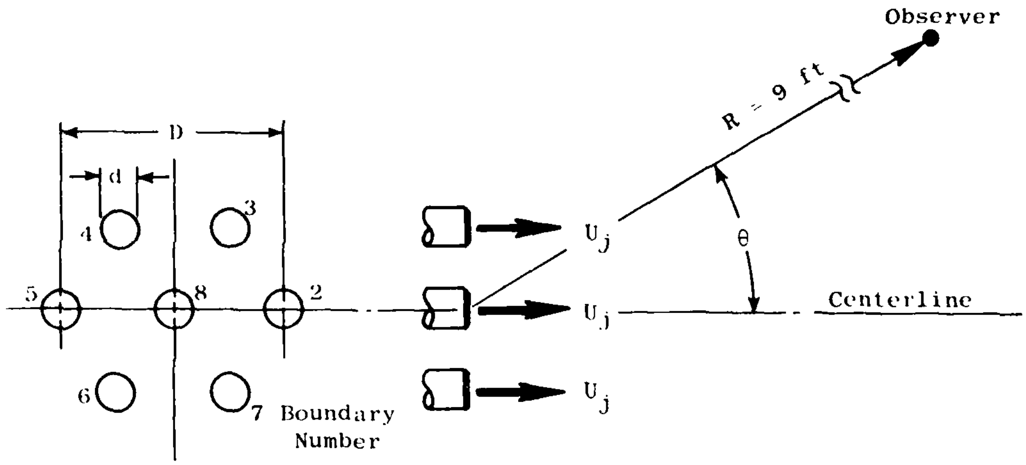
WARNING - NO. OF TURNING POINTS IS GREATER THAN 2 AT

KA = ______, X = ______, ITH = ______, THETA = ______, NTP = ______

where KA is the axial station number, X is the axial location, ITH is the observer angle index, THETA is the observer angle in degrees (θ_I), and NTP is the number of turning points found. The two outermost turning points are used and those inboard of these two are discarded in such cases, since the acoustic shielding model can only accommodate up to 2 turning points. The noise output at those values of θ_I where this warning appears should be treated as suspect, since the acoustic shielding effects are not properly modeled. This is most likely to occur in the initial mixing regions of multitube nozzles, where multiple peaks in the azimuthally averaged velocity profiles are likely to occur.

4.7 SAMPLE OUTPUT LISTING

An example case of a 7-tube multielement nozzle is described here, selected from one of the data/theory comparison cases presented in Reference 2. The nozzle consists of a hexagonal array of 0.875-inch-diameter tubes, with a spacing/diameter ratio of 3. The acoustic arena is a 9-ft-radius arc. The geometry is illustrated in the sketch below.



d 0.875 in.

D 3.0 in.

The input data cards for this case are listed in Table 4-5. Note that all geometry input lengths are in feet, and all input geometry angles are in radians. The output listing for this case follows Table 4-5.

Table 4-5. Input Data Card Listing Sample Case.

```
5R329 01   10-06-77   16.471   *** INPUT DATA CARD LISTING -- M*G*B ***
         CRD 7-TUBE AR#2.3 NOZZLE  -  VJ#2200 FPS - TTJ#1600 DEG-R
 $INPUT
 NEST=8, LPHI=12, ISYM=0, IQUIT=100,
 RU2M=3, DTHM=0.1, PS=2116,
 ATOTAL=0.029231, DEQ=8*0.0729167, DS=8*0.0729167, NCELL=8*8,
 KN=8*1, XE=8*0,
 GAM=1.35, CP=6619,

 ALPO=0.0,5.96144,0.725447,1.77264,2.8198,3.8670,4.9142,0.0,
 LEAV=0,6*1,24,   NUM=1,6*24,1, KN=8*1, XE=8*0,
 DALP(1,2)=
 .033596,.045590,.054084,.059862,.063450,.065168,
 .065168,.063450,.059862,.054084,.045590,.033596,
 .017039,-.005317,-.034336,-.068984,-.103591,-.126562,
 -.126562,-.103591,-.068984,-.034336,-.005317,.017039,
 DALP(1,3)=
 .033596,.045590,.054084,.059862,.063450,.065168,
 .065168,.063450,.059862,.054084,.045590,.033596,
 .017039,-.005317,-.034336,-.068984,-.103591,-.126562,
 -.126562,-.103591,-.068984,-.034336,-.005317,.017039,
 DALP(1,4)=
 .033596,.045590,.054084,.059862,.063450,.065168,
 .065168,.063450,.059862,.054084,.045590,.033596,
 .017039,-.005317,-.034336,-.068984,-.103591,-.126562,
 -.126562,-.103591,-.068984,-.034336,-.005317,.017039,
 DALP(1,5)=
 .033596,.045590,.054084,.059862,.063450,.065168,
 .065168,.063450,.059862,.054084,.045590,.033596,
 .017039,-.005317,-.034336,-.068984,-.103591,-.126562,
 -.126562,-.103591,-.068984,-.034336,-.005317,.017039,
 DALP(1,6)=
 .033596,.045590,.054084,.059862,.063450,.065168,
 .065168,.063450,.059862,.054084,.045590,.033596,
 .017039,-.005317,-.034336,-.068984,-.103591,-.126562,
 -.126562,-.103591,-.068984,-.034336,-.005317,.017039,
 DALP(1,7)=
 .033596,.045590,.054084,.059862,.063450,.065168,
 .065168,.063450,.059862,.054084,.045590,.033596,
 .017039,-.005317,-.034336,-.068984,-.103591,-.126562,
 -.126562,-.103591,-.068984,-.034336,-.005317,.017039,
 RA(1,2)=
 .12392,.13145,.13759,.14212,.14489,.14583,
 .14489,.14212,.13759,.13145,.12392,.11529,
 .10596,.09646,.08748,.07991,.07476,.07292,
 .07476,.07991,.08748,.09646,.10596,.11529,
 RA(1,3)=
 .12392,.13145,.13759,.14212,.14489,.14583,
 .14489,.14212,.13759,.13145,.12392,.11529,
 .10596,.09646,.08748,.07991,.07476,.07292,
 .07476,.07991,.08748,.09646,.10596,.11529,
 RA(1,4)=
 .12392,.13145,.13759,.14212,.14489,.14583,
 .14489,.14212,.13759,.13145,.12392,.11529,
 .10596,.09646,.08748,.07991,.07476,.07292,
```

Table 4-5. Input Data Card Listing Sample Case (Concluded).

```
5R329 01   10-06-77    16.471     *** INPUT DATA CARD LISTING -- M*G*B ***

 .07476,.07991,.08748,.09646,.10596,.11529,
 RA(1,5)=
 .12392,.13145,.13759,.14212,.14489,.14583,
 .14489,.14212,.13759,.13145,.12392,.11529,
 .10596,.09646,.08748,.07991,.07476,.07292,
 .07476,.07991,.08748,.09646,.10596,.11529,
 RA(1,6)=
 .12392,.13145,.13759,.14212,.14489,.14583,
 .14489,.14212,.13759,.13145,.12392,.11529,
 .10596,.09646,.08748,.07991,.07476,.07292,
 .07476,.07991,.08748,.09646,.10596,.11529,
 RA(1,7)=
 .12392,.13145,.13759,.14212,.14489,.14583,
 .14489,.14212,.13759,.13145,.12392,.11529,
 .10596,.09646,.08748,.07991,.07476,.07292,
 .07476,.07991,.08748,.09646,.10596,.11529,
 DALP(1,8)=0.2618, RA(1,8)=0.036458,

 ALPHMC=0.5, BETAMC=0.25,
 FMIN=100, FMAX=80000, NUMANG=1, DIST=9.0,
 KX=24, X=0.0729167, STRFR=0.01,
 DSIG=10*0.00729167, 14*0,  NOV=10*20,14*0,
 BETAIN=15*0.0,
 NPRINT=
 NCASE=1,

 PT=2116,7*5732, TT=540,7*1605,
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COMPUTATION OF AERO-ACOUSTIC PROPERTIES OF SUPPRESSOR NOZZLES

CASE NO. 1　　　CRD 7-TUBE AR=2.3 NOZZLE - VJ=2200 FPS - TTJ=1600 DEG-R

INPUT DATA

KX= 24　　NEST= 8　　LPHI= 12　　ISYM= 0　　NPRINT= 6　　CM= .075

CH= 1.150　　GAM= 1.350　　CP= 6619.0　　DTHM= .1000　　RU2M= 3.0000　　PS= 2116.0

COMPUTATION MESH CONTROL PARAMETERS......................../ TURBULENCE CONSTANTS

SLICE NO.	X	DSIG	RMIN	NOV	BETA	DELTA	MU
1	.07292	.00729	0.00000	20	0.00	4.00	.20
2	.09187	.00729	0.00000	20	0.00	4.00	.20
3	.11575	.00729	0.00000	20	0.00	4.00	.20
4	.14583	.00729	0.00000	20	0.00	4.00	.20
5	.18374	.00729	0.00000	20	0.00	4.00	.20
6	.23150	.00729	0.00000	20	0.00	4.00	.20
7	.29167	.00729	0.00000	20	0.00	4.00	.20
8	.36748	.00729	0.00000	20	0.00	4.00	.20
9	.46293	.00729	0.00000	20	0.00	4.00	.20
10	.58333	.00729	0.00000	20	0.00	4.00	.20
11	.73495	.00735	0.00000	0	0.00	4.00	.20
12	.92594	.00926	0.00000	0	0.00	4.00	.20
13	1.16667	.01167	0.00000	0	0.00	4.00	.20
14	1.46991	.01470	0.00000	0	0.00	4.00	.20
15	1.[illegible]	[illegible]	0.00000	0	0.00	4.00	.20
16	2.33333	.02333	0.00000	0	4.00	4.00	.20
17	2.93982	.02940	0.00000	0	4.00	4.00	.20
18	3.70393	.03704	0.00000	0	4.00	4.00	.20
19	4.66667	.04667	0.00000	0	4.00	4.00	.20
20	5.87963	.05880	0.00000	0	4.00	4.00	.20
21	7.40787	.07408	0.00000	0	4.00	4.00	.20
22	9.33333	.09333	0.00000	0	4.00	4.00	.20
23	11.75926	.11759	0.00000	0	4.00	4.00	.20
24	14.81574	.14816	0.00000	0	4.00	4.00	.20

XE(2)= 0.00　ALPO(2)= 5.9614　LEAV(2)= 1　NUM(2)= 24　KN(2)= 1

DALP(1, 2)= .0336　RA(1, 2)= .1239　DALP(2, 2)= .0456　RA(2, 2)= .1315

DALP(3, 2)= .0541　RA(3, 2)= .1376　DALP(4, 2)= .0599　RA(4, 2)= .1421

DALP(5, 2)= .0635　RA(5, 2)= .1449　DALP(6, 2)= .0652　RA(6, 2)= .1458

DALP(7, 2)= .0652　RA(7, 2)= .1449　DALP(8, 2)= .0635　RA(8, 2)= .1421

DALP(9, 2)= .0599　RA(9, 2)= .1376　DALP(10, 2)= .0541　RA(10, 2)= .1315

DALP(11, 2)= .0456　RA(11, 2)= .1239　DALP(12, 2)= .0336　RA(12, 2)= .1153

DALP(13, 2)= .0170　RA(13, 2)= .1060　DALP(14, 2)= -.0053　RA(14, 2)= .0965

DALP(15, 2)= -.0343　RA(15, 2)= .0875　DALP(16, 2)= -.0690　RA(16, 2)= .0799

DALP(17, 2)= -.1036　RA(17, 2)= .0748　DALP(18, 2)= -.1266　RA(18, 2)= .0729

DALP(19, 2)= -.1266　RA(19, 2)= .0748　DALP(20, 2)= -.1036　RA(20, 2)= .0799

DALP(21, 2)= -.0690　RA(21, 2)= .0875　DALP(22, 2)= -.0343　RA(22, 2)= .0965

DALP(23, 2)= -.0053　RA(23, 2)= .1060　DALP(24, 2)= .0170　RA(24, 2)= .1153

COMPUTATION OF AERO-ACOUSTIC PROPERTIES OF SUPPRESSOR NOZZLES

CASE NO. 1   CRD 7-TUBE AR=2.3 NOZZLE - VJ=2200 FPS - TTJ=1600 DEG-R

XE(3)= 0.00 ALPO(3)= .7254 LEAV(3)= 1 NUM(3)= 24 KN(3)= 1

DALP(1, 3)=	.0336	RA(1, 3)=	.1239	DALP(2, 3)=	.0456	RA(2, 3)=	.1315
DALP(3, 3)=	.0541	RA(3, 3)=	.1376	DALP(4, 3)=	.0599	RA(4, 3)=	.1421
DALP(5, 3)=	.0635	RA(5, 3)=	.1449	DALP(6, 3)=	.0652	RA(6, 3)=	.1458
DALP(7, 3)=	.0652	RA(7, 3)=	.1449	DALP(8, 3)=	.0635	RA(8, 3)=	.1421
DALP(9, 3)=	.0599	RA(9, 3)=	.1376	DALP(10, 3)=	.0541	RA(10, 3)=	.1315
DALP(11, 3)=	.0456	RA(11, 3)=	.1239	DALP(12, 3)=	.0336	RA(12, 3)=	.1153
DALP(13, 3)=	.0170	RA(13, 3)=	.1060	DALP(14, 3)=	-.0053	RA(14, 3)=	.0965
DALP(15, 3)=	-.0343	RA(15, 3)=	.0875	DALP(16, 3)=	-.0690	RA(16, 3)=	.0799
DALP(17, 3)=	-.1036	RA(17, 3)=	.0748	DALP(18, 3)=	-.1266	RA(18, 3)=	.0729
DALP(19, 3)=	-.1266	RA(19, 3)=	.0748	DALP(20, 3)=	-.1036	RA(20, 3)=	.0799
DALP(21, 3)=	-.0690	RA(21, 3)=	.0875	DALP(22, 3)=	-.0343	RA(22, 3)=	.0965
DALP(23, 3)=	-.0053	RA(23, 3)=	.1060	DALP(24, 3)=	.0170	RA(24, 3)=	.1153

XE(4)= 0.00 ALPO(4)= 1.7726 LEAV(4)= 1 NUM(4)= 24 KN(4)= 1

DALP(1, 4)=	.0336	RA(1, 4)=	.1239	DALP(2, 4)=	.0456	RA(2, 4)=	.1315
DALP(3, 4)=	.0541	RA(3, 4)=	.1376	DALP(4, 4)=	.0599	RA(4, 4)=	.1421
DALP(5, 4)=	.0635	RA(5, 4)=	.1449	DALP(6, 4)=	.0652	RA(6, 4)=	.1458
DALP(7, 4)=	.0652	RA(7, 4)=	.1449	DALP(8, 4)=	.0635	RA(8, 4)=	.1421
DALP(9, 4)=	.0599	RA(9, 4)=	.1376	DALP(10, 4)=	.0541	RA(10, 4)=	.1315
DALP(11, 4)=	.0456	RA(11, 4)=	.1239	DALP(12, 4)=	.0336	RA(12, 4)=	.1153
DALP(13, 4)=	.0170	RA(13, 4)=	.1060	DALP(14, 4)=	-.0053	RA(14, 4)=	.0965
DALP(15, 4)=	-.0343	RA(15, 4)=	.0875	DALP(16, 4)=	-.0690	RA(16, 4)=	.0799
DALP(17, 4)=	-.1036	RA(17, 4)=	.0748	DALP(18, 4)=	-.1266	RA(18, 4)=	.0729
DALP(19, 4)=	-.1266	RA(19, 4)=	.0748	DALP(20, 4)=	-.1036	RA(20, 4)=	.0799
DALP(21, 4)=	-.0690	RA(21, 4)=	.0875	DALP(22, 4)=	-.0343	RA(22, 4)=	.0965
DALP(23, 4)=	-.0053	RA(23, 4)=	.1060	DALP(24, 4)=	.0170	RA(24, 4)=	.1153

COMPUTATION OF AERO-ACOUSTIC PROPERTIES OF SUPPRESSOR NOZZLES

CASE NO. 1   CRD 7-TUBE AR=2.3 NOZZLE - VJ=2200 FPS - TTJ=1600 DEG-R

XE(5)= 0.00 ALPO(5)= 2.8198 LEAV(5)= 1 NUM(5)= 24 KN(5)= 1

DALP(1, 5)=	.0336	RA(1, 5)=	.1239	DALP(2, 5)=	.0456	RA(2, 5)=	.1315
DALP(3, 5)=	.0541	RA(3, 5)=	.1376	DALP(4, 5)=	.0599	RA(4, 5)=	.1421
DALP(5, 5)=	.0635	RA(5, 5)=	.1449	DALP(6, 5)=	.0652	RA(6, 5)=	.1458
DALP(7, 5)=	.0652	RA(7, 5)=	.1449	DALP(8, 5)=	.0635	RA(8, 5)=	.1421
DALP(9, 5)=	.0599	RA(9, 5)=	.1376	DALP(10, 5)=	.0541	RA(10, 5)=	.1315
DALP(11, 5)=	.0456	RA(11, 5)=	.1239	DALP(12, 5)=	.0336	RA(12, 5)=	.1153
DALP(13, 5)=	.0170	RA(13, 5)=	.1060	DALP(14, 5)=	-.0053	RA(14, 5)=	.0965
DALP(15, 5)=	-.0343	RA(15, 5)=	.0875	DALP(16, 5)=	-.0690	RA(16, 5)=	.0799
DALP(17, 5)=	-.1036	RA(17, 5)=	.0748	DALP(18, 5)=	-.1266	RA(18, 5)=	.0729
DALP(19, 5)=	-.1266	RA(19, 5)=	.0748	DALP(20, 5)=	-.1036	RA(20, 5)=	.0799
DALP(21, 5)=	-.0690	RA(21, 5)=	.0875	DALP(22, 5)=	-.0343	RA(22, 5)=	.0965
DALP(23, 5)=	-.0053	RA(23, 5)=	.1060	DALP(24, 5)=	.0170	RA(24, 5)=	.1153

XE(6)= 0.00 ALPO(6)= 3.8670 LEAV(6)= 1 NUM(6)= 24 KN(6)= 1

DALP(1, 6)=	.0336	RA(1, 6)=	.1239	DALP(2, 6)=	.0456	RA(2, 6)=	.1315
DALP(3, 6)=	.0541	RA(3, 6)=	.1376	DALP(4, 6)=	.0599	RA(4, 6)=	.1421
DALP(5, 6)=	.0635	RA(5, 6)=	.1449	DALP(6, 6)=	.0652	RA(6, 6)=	.1458
DALP(7, 6)=	.0652	RA(7, 6)=	.1449	DALP(8, 6)=	.0635	RA(8, 6)=	.1421
DALP(9, 6)=	.0599	RA(9, 6)=	.1376	DALP(10, 6)=	.0541	RA(10, 6)=	.1315
DALP(11, 6)=	.0456	RA(11, 6)=	.1239	DALP(12, 6)=	.0336	RA(12, 6)=	.1153
DALP(13, 6)=	.0170	RA(13, 6)=	.1060	DALP(14, 6)=	-.0053	RA(14, 6)=	.0965
DALP(15, 6)=	-.0343	RA(15, 6)=	.0875	DALP(16, 6)=	-.0690	RA(16, 6)=	.0799
DALP(17, 6)=	-.1036	RA(17, 6)=	.0748	DALP(18, 6)=	-.1266	RA(18, 6)=	.0729
DALP(19, 6)=	-.1266	RA(19, 6)=	.0748	DALP(20, 6)=	-.1036	RA(20, 6)=	.0799
DALP(21, 6)=	-.0690	RA(21, 6)=	.0875	DALP(22, 6)=	-.0343	RA(22, 6)=	.0965
DALP(23, 6)=	-.0053	RA(23, 6)=	.1060	DALP(24, 6)=	.0170	RA(24, 6)=	.1153

COMPUTATION OF AERO-ACOUSTIC PROPERTIES OF SUPPRESSOR NOZZLES

CASE NO. 1 CPD 7-TUBE AR=2.3 NOZZLE - VJ=2200 FPS - TTJ=1600 DEG-R

```
XE( 7)=    0.00  ALPO( 7)= 4.9142  LEAV( 7)=  1   NUM( 7)= 24    KN( 7)=  1
          DALP( 1, 7)=  .0336    RA( 1, 7)=  .1239  DALP( 2, 7)=  .0456    RA( 2, 7)=  .1315
          DALP( 3, 7)=  .0541    RA( 3, 7)=  .1376  DALP( 4, 7)=  .0599    RA( 4, 7)=  .1421
          DALP( 5, 7)=  .0635    RA( 5, 7)=  .1449  DALP( 6, 7)=  .0652    RA( 6, 7)=  .1458
          DALP( 7, 7)=  .0652    RA( 7, 7)=  .1449  DALP( 8, 7)=  .0635    RA( 8, 7)=  .1421
          DALP( 9, 7)=  .0599    RA( 9, 7)=  .1376  DALP(10, 7)=  .0541    RA(10, 7)=  .1315
          DALP(11, 7)=  .0456    RA(11, 7)=  .1239  DALP(12, 7)=  .0336    RA(12, 7)=  .1153
          DALP(13, 7)=  .0170    RA(13, 7)=  .1060  DALP(14, 7)= -.0053    RA(14, 7)=  .0965
          DALP(15, 7)= -.0343    RA(15, 7)=  .0875  DALP(16, 7)= -.0690    RA(16, 7)=  .0799
          DALP(17, 7)= -.1036    RA(17, 7)=  .0748  DALP(18, 7)= -.1266    RA(18, 7)=  .0729
          DALP(19, 7)= -.1266    RA(19, 7)=  .0748  DALP(20, 7)= -.1036    RA(20, 7)=  .0799
          DALP(21, 7)= -.0690    RA(21, 7)=  .0875  DALP(22, 7)= -.0343    RA(22, 7)=  .0965
          DALP(23, 7)= -.0053    RA(23, 7)=  .1060  DALP(24, 7)=  .0170    RA(24, 7)=  .1153
XE( 8)=    0.00  ALPO( 8)= 0.0000  LEAV( 8)= 24   NUM( 8)=  1    KN( 8)=  1
          DALP( 1, 8)=  .2618    RA( 1, 8)=  .0365  DALP(
```

COMPUTATION OF AERO-ACOUSTIC PROPERTIES OF SUPPRESSOR NOZZLES

CASE NO. 1   CPD 7-TUBE AR=2.3 NOZZLE - VJ=2200 FPS - TTJ=1600 DEG-R

EXIT CONDITIONS

CON-TOUR	TOTAL PRESS. (PSF)	TOTAL TEMP. (DEG R)	STATIC TEMP. (DEG R)	VELOCITY (FPS)	MACH NUMBER	MOMENTUM FLUX (LB/SQ-FT)	ENTHALPY FLUX (LB/SQ-FT)
1	2116.00	540.00	540.00	.30	.0003	.20000E-03	0.
2	5732.00	1605.00	1239.57	2199.45	1.2979	.48123E+04	.15423E+08
3	5732.00	1605.00	1239.57	2199.45	1.2979	.48123E+04	.15423E+08
4	5732.00	1605.00	1239.57	2199.45	1.2979	.48123E+04	.15423E+08
5	5732.00	1605.00	1239.57	2199.45	1.2979	.48123E+04	.15423E+08
6	5732.00	1605.00	1239.57	2199.45	1.2979	.48123E+04	.15423E+08
7	5732.00	1605.00	1239.57	2199.45	1.2979	.48123E+04	.15423E+08
8	5732.00	1605.00	1239.57	2199.45	1.2979	.48123E+04	.15423E+08

OUNDARY NO. 2 HAS BEEN DESIGNATED AS THE REFERENCE

AL = .20886E+08   ALFA = 1.00000   AK = .80000E-01   BK = 0.

ATOTAL= .02923   DEQ = .07292   IQUIT= 100   NN = 0   UREF = 2199.45

STREX= 1.25992   STRER= .01000

ALPHMC= .5000   BETAMC= .2500

CMMC= .080000   CMVP= .250000

COMPUTATION OF AERO-ACOUSTIC PROPERTIES OF SUPPRESSOR NOZZLES

CASE NO. 1   CRD 7-TUBE AR=2.3 NOZZLE - VJ=2200 FPS - TTJ=1600 DEG-R

AXIAL LOCATION = .07292 (X/DEQ = 1.00000)

M	R	ANGLE	U	DENSITY	TEMP.	U/UREF	TURB.INT.	R/DEQ
1	.00001	0.00	2199.45	.0009948	1239.57	1.00000	.00037	.00010
1	.00001	10.00	2199.45	.0009948	1239.57	1.00000	.00038	.00010
1	.00001	20.00	2199.45	.0009948	1239.57	1.00000	.00040	.00010
1	.00001	30.00	2199.45	.0009948	1239.57	1.00000	.00043	.00010
2	.00729	0.00	2199.46	.0009948	1239.57	1.00000	.00156	.10000
2	.00729	10.00	2199.46	.0009948	1239.57	1.00000	.00189	.10000
2	.00729	20.00	2199.46	.0009948	1239.57	1.00000	.00186	.10000
2	.00729	30.00	2199.46	.0009948	1239.57	1.00000	.00180	.10000
3	.01458	0.00	2199.46	.0009948	1239.57	1.00000	.00044	.20000
3	.01458	7.50	2199.46	.0009948	1239.57	1.00000	.00079	.20000
3	.01458	15.00	2199.46	.0009948	1239.57	1.00000	.00122	.20000
3	.01458	22.50	2199.46	.0009948	1239.57	1.00000	.00090	.20000
3	.01458	30.00	2199.46	.0009948	1239.57	1.00000	.00099	.20000
4	.02188	0.00	2199.20	.0009950	1239.31	.99988	.00289	.30000
4	.02188	7.50	2199.20	.0009950	1239.31	.99988	.00303	.30000
4	.02188	15.00	2199.20	.0009950	1239.31	.99988	.00288	.30000
4	.02188	22.50	2199.20	.0009950	1239.31	.99988	.00298	.30000
4	.02188	30.00	2199.19	.0009950	1239.31	.99988	.00293	.30000
5	.02917	0.00	2145.84	.0010195	1209.46	.97562	.05247	.40000
5	.02917	6.00	2145.76	.0010195	1209.52	.97559	.05261	.40000
5	.02917	12.00	2145.80	.0010195	1209.48	.97561	.05253	.40000
5	.02917	18.00	2145.80	.0010195	1209.48	.97560	.05253	.40000
5	.02917	24.00	2145.75	.0010195	1209.52	.97558	.05261	.40000
5	.02917	30.00	2145.83	.0010195	1209.46	.97562	.05247	.40000
6	.03646	0.00	1378.61	.0011597	1063.24	.62680	.13781	.50000
6	.03646	6.00	1371.48	.0011595	1063.44	.62355	.13785	.50000
6	.03646	12.00	1373.07	.0011602	1062.79	.62428	.13785	.50000
6	.03646	18.00	1373.07	.0011602	1062.79	.62428	.13785	.50000
6	.03646	24.00	1371.48	.0011595	1063.44	.62355	.13785	.50000
6	.03646	30.00	1378.61	.0011597	1063.24	.62680	.13781	.50000
7	.04375	0.00	203.54	.0016983	726.07	.09254	.04225	.60000
7	.04375	5.00	202.12	.0016972	726.54	.09189	.04202	.60000
7	.04375	10.00	202.14	.0016972	726.54	.09190	.04202	.60000
7	.04375	15.00	203.59	.0016983	726.06	.09257	.04224	.60000
7	.04375	20.00	202.17	.0016972	726.53	.09192	.04200	.60000
7	.04375	25.00	202.17	.0016972	726.53	.09192	.04200	.60000
7	.04375	30.00	203.61	.0016983	726.06	.09257	.04223	.60000
8	.05104	0.00	2.52	.0021214	581.26	.00114	.00253	.70000
8	.05104	5.00	2.53	.0021241	580.51	.00115	.00292	.70000
8	.05104	10.00	2.94	.0021451	574.83	.00134	.00294	.70000
8	.05104	15.00	3.47	.0021627	570.17	.00158	.00284	.70000
8	.05104	20.00	3.64	.0021692	568.44	.00166	.00287	.70000
8	.05104	25.00	3.86	.0021748	566.98	.00175	.00287	.70000
8	.05104	30.00	4.12	.0021794	565.79	.00187	.00278	.70000
9	.05833	.00	3.24	.0021555	572.06	.00147	.00145	.80000
9	.05833	4.29	1.35	.0020752	594.21	.00062	.00191	.80000
9	.05833	8.57	0.00	.0022835	540.00	0.00000	0.00000	.80000
9	.05833	12.86	0.00	.0022835	540.00	0.00000	0.00000	.80000

COMPUTATION OF AERO-ACOUSTIC PROPERTIES OF SUPPRESSOR NOZZLES

CASE NO. 1   CRD 7-TUBE AR=2.3 NOZZLE - VJ=2200 FPS - TTJ=1600 DEG-R

AXIAL LOCATION = .07292 (X/DEQ = 1.00000)

M	R	ANGLE	U	DENSITY	TEMP.	U/UREF	TURB.INT.	R/DEQ
9	.05833	17.14	0.00	.0022835	540.00	0.00000	0.00000	.80000
9	.05833	21.43	0.00	.0022835	540.00	0.00000	0.00000	.80000
9	.05833	25.71	0.00	.0022835	540.00	0.00000	0.00000	.80000
9	.05833	30.00	0.00	.0022835	540.00	0.00000	0.00000	.80000
10	.06563	0.00	203.37	.0016986	725.94	.09246	.04216	.90000
10	.06563	4.29	168.00	.0017420	707.84	.07638	.03710	.90000
10	.06563	8.57	95.34	.0018676	660.25	.04335	.02447	.90000
10	.06563	12.86	33.49	.0020323	606.73	.01523	.01067	.90000
10	.06563	17.14	5.84	.0021636	569.91	.00266	.00325	.90000
10	.06563	21.43	0.00	.0022835	540.00	0.00000	0.00000	.90000
10	.06563	25.71	0.00	.0022835	540.00	0.00000	0.00000	.90000
10	.06563	30.00	0.00	.0022835	540.00	0.00000	0.00000	.90000
11	.07292	0.00	1378.45	.0011598	1063.19	.62672	.13779	1.00000
11	.07292	3.75	1282.33	.0011754	1049.07	.58302	.13990	1.00000
11	.07292	7.50	1015.37	.0012396	994.75	.46165	.13664	1.00000
11	.07292	11.25	608.69	.0013846	890.58	.27674	.10947	1.00000
11	.07292	15.00	242.76	.0016504	747.13	.11037	.05941	1.00000
11	.07292	18.75	57.20	.0019585	629.60	.02600	.01884	1.00000
11	.07292	22.50	6.44	.0021637	569.90	.00293	.00379	1.00000
11	.07292	26.25	0.00	.0022835	540.00	0.00000	0.00000	1.00000
11	.07292	30.00	0.00	.0022835	540.00	0.00000	0.00000	1.00000
12	.08021	0.00	2145.74	.0010196	1209.42	.97558	.05248	1.10000
12	.08021	3.75	2124.54	.0010266	1201.14	.96594	.06481	1.10000
12	.08021	7.50	2025.14	.0010525	1171.60	.92075	.10460	1.10000
12	.08021	11.25	1717.49	.0011052	1115.68	.78087	.15852	1.10000
12	.08021	15.00	1059.87	.0012270	1004.97	.48188	.16340	1.10000
12	.08021	18.75	353.54	.0015447	798.27	.16074	.08533	1.10000
12	.08021	22.50	53.70	.0019665	627.03	.02441	.01880	1.10000
12	.08021	26.25	2.21	.0021721	567.69	.00100	.00334	1.10000
12	.08021	30.00	0.00	.0022835	540.00	0.00000	0.00000	1.10000
13	.08750	0.00	2199.19	.0009950	1239.30	.99988	.00213	1.20000
13	.08750	3.33	2198.94	.0009952	1239.07	.99977	.00350	1.20000
13	.08750	6.67	2196.64	.0009967	1237.12	.99872	.01146	1.20000
13	.08750	10.00	2175.80	.0010076	1223.80	.98925	.04213	1.20000
13	.08750	13.33	2032.46	.0010508	1173.47	.92408	.11890	1.20000
13	.08750	16.67	1500.16	.0011379	1083.61	.68206	.18610	1.20000
13	.08750	20.00	616.35	.0013828	891.74	.28023	.13029	1.20000
13	.08750	23.33	110.21	.0018367	671.34	.05011	.03566	1.20000
13	.08750	26.67	7.85	.0021552	572.14	.00357	.00463	1.20000
13	.08750	30.00	0.00	.0022835	540.00	0.00000	0.00000	1.20000
14	.09479	0.00	2199.45	.0009948	1239.57	1.00000	.00140	1.30000
14	.09479	3.33	2199.45	.0009948	1239.57	1.00000	.00161	1.30000
14	.09479	6.67	2199.44	.0009948	1239.55	.99999	.00087	1.30000
14	.09479	10.00	2198.75	.0009953	1238.90	.99968	.00583	1.30000
14	.09479	13.33	2175.18	.0010078	1223.48	.98897	.04684	1.30000
14	.09479	16.67	1911.43	.0010745	1147.62	.86905	.15684	1.30000
14	.09479	20.00	1022.36	.0012373	996.57	.46469	.17621	1.30000
14	.09479	23.33	208.70	.0016920	728.79	.09489	.06070	1.30000

COMPUTATION OF AERO-ACOUSTIC PROPERTIES OF SUPPRESSOR NOZZLES

CASE NO. 1   CRD 7-TUBE AR=2.3 NOZZLE - VJ=2200 FPS - TTJ=1600 DEG-R

AXIAL LOCATION = .7292 (X/DEQ = 1.00000)

M	R	ANGLE	U	DENSITY	TEMP.	U/UREF	TURB.INT.	R/DEQ
14	.09479	26.67	14.75	.0021165	582.59	.00671	.00707	1.30000
14	.09479	30.00	0.00	.0022835	540.00	0.00000	0.00000	1.30000
15	.10208	0.00	2199.45	.0009948	1239.57	1.00000	.00031	1.40000
15	.10208	3.00	2199.45	.0009948	1239.57	1.00000	.00186	1.40000
15	.10208	6.00	2199.45	.0009948	1239.57	1.00000	.00140	1.40000
15	.10208	9.00	2199.45	.0009948	1239.56	1.00000	.00159	1.40000
15	.10208	12.00	2198.55	.0009954	1238.72	.99959	.00723	1.40000
15	.10208	15.00	2161.63	.0010135	1216.62	.98280	.06166	1.40000
15	.10208	18.00	1801.51	.0010921	1129.12	.81907	.17685	1.40000
15	.10208	21.00	834.46	.0012917	954.61	.37939	.16055	1.40000
15	.10208	24.00	146.71	.0017738	695.16	.06670	.04583	1.40000
15	.10208	27.00	9.45	.0021459	574.63	.00430	.00516	1.40000
15	.10208	30.00	0.00	.0022835	540.00	0.00000	0.00000	1.40000
16	.10938	0.00	2199.45	.0009948	1239.57	1.00000	.00104	1.50000
16	.10938	3.00	2199.45	.0009948	1239.57	1.00000	.00222	1.50000
16	.10938	6.00	2199.45	.0009948	1239.57	1.00000	.00272	1.50000
16	.10938	9.00	2199.45	.0009948	1239.56	1.00000	.00182	1.50000
16	.10938	12.00	2198.81	.0009953	1238.95	.99971	.00629	1.50000
16	.10938	15.00	2161.18	.0010137	1216.41	.98260	.06199	1.50000
16	.10938	18.00	1752.09	.0010996	1121.40	.79660	.18152	1.50000
16	.10938	21.00	710.45	.0013394	920.63	.32301	.14531	1.50000
16	.10938	24.00	98.26	.0018615	662.41	.04468	.03259	1.50000
16	.10938	27.00	4.21	.0021836	564.70	.00192	.00363	1.50000
16	.10938	30.00	0.00	.0022835	540.00	0.00000	0.00000	1.50000
17	.11667	0.00	2199.45	.0009948	1239.57	1.00000	.00206	1.60000
17	.11667	2.73	2199.45	.0009948	1239.57	1.00000	.00239	1.60000
17	.11667	5.45	2199.45	.0009948	1239.57	1.00000	.00178	1.60000
17	.11667	8.18	2199.45	.0009948	1239.56	1.00000	.00157	1.60000
17	.11667	10.91	2198.91	.0009952	1239.04	.99975	.00557	1.60000
17	.11667	13.64	2174.93	.0010080	1223.34	.98885	.04751	1.60000
17	.11667	16.36	1906.35	.0010753	1146.73	.86674	.15670	1.60000
17	.11667	19.09	1039.03	.0012332	999.94	.47241	.17474	1.60000
17	.11667	21.82	235.07	.0016608	742.44	.10687	.06531	1.60000
17	.11667	24.55	20.71	.0020856	591.22	.00942	.00875	1.60000
17	.11667	27.27	0.00	.0022835	540.00	0.00000	0.00000	1.60000
17	.11667	30.00	0.00	.0022835	540.00	0.00000	0.00000	1.60000
18	.12396	0.00	2199.45	.0009948	1239.57	1.00000	.00154	1.70000
18	.12396	2.73	2199.45	.0009948	1239.57	1.00000	.00141	1.70000
18	.12396	5.45	2199.45	.0009948	1239.56	1.00000	.00162	1.70000
18	.12396	8.18	2199.13	.0009950	1239.25	.99985	.00436	1.70000
18	.12396	10.91	2188.71	.0010013	1231.46	.99512	.02817	1.70000
18	.12396	13.64	2051.20	.0010465	1178.33	.93259	.11403	1.70000
18	.12396	16.36	1433.87	.0011478	1074.26	.65192	.18468	1.70000
18	.12396	19.09	478.50	.0014574	846.09	.21756	.10756	1.70000
18	.12396	21.82	62.84	.0019401	635.56	.02857	.02146	1.70000
18	.12396	24.55	2.80	.0021965	561.37	.00127	.00342	1.70000
18	.12396	27.27	0.00	.0022835	540.00	0.00000	0.00000	1.70000
18	.12396	30.00	0.00	.0022835	540.00	0.00000	0.00000	1.70000

COMPUTATION OF AERO-ACOUSTIC PROPERTIES OF SUPPRESSOR NOZZLES

CASE NO. 1   CRD 7-TUBE AR=2.3 NOZZLE - VJ=2200 FPS - TTJ=1600 DEG-R

AXIAL LOCATION = .37292 (X/DEQ = 1.00000)

M	R	ANGLE	U	DENSITY	TEMP.	U/UREF	TURB.INT.	R/DEQ
19	.13125	0.00	2199.19	.0009950	1239.30	.99988	.00325	1.80000
19	.13125	2.50	2198.99	.0009951	1239.12	.99979	.00412	1.80000
19	.13125	5.00	2197.42	.0009962	1237.75	.99908	.00926	1.80000
19	.13125	7.50	2185.40	.0010030	1229.37	.99361	.02954	1.80000
19	.13125	10.00	2106.46	.0010321	1194.73	.95772	.08446	1.80000
19	.13125	12.50	1776.53	.0010963	1124.82	.80771	.15885	1.80000
19	.13125	15.00	1038.20	.0012327	1006.33	.47203	.16182	1.80000
19	.13125	17.50	318.73	.0015743	783.25	.14491	.07710	1.80000
19	.13125	20.00	47.64	.0019859	[illegible]	.02166	.01638	1.80000
19	.13125	22.50	2.88	.0021988	[illegible]	.00131	.00320	1.80000
19	.13125	25.00	0.00	.0022835	540.00	0.00000	0.00000	1.80000
19	.13125	27.50	0.00	.0022835	540.00	0.00000	0.00000	1.80000
19	.13125	30.00	0.00	.0022835	540.00	0.00000	0.00000	1.80000
20	.13854	0.00	2145.68	.0010196	1209.39	.97555	.05255	1.90000
20	.13854	2.50	2129.85	.0010249	1263.69	.96835	.06116	1.90000
20	.13854	5.00	2061.96	.0010438	1181.32	.93749	.08886	1.90000
20	.13854	7.50	1867.77	.0010820	1139.69	.84920	.13235	1.90000
20	.13854	10.00	1436.12	.0011483	1073.86	.65295	.16129	1.90000
20	.13854	12.50	756.51	.0013212	933.33	.34395	.12913	1.90000
20	.13854	15.00	231.75	.0016626	741.66	.10537	.05730	1.90000
20	.13854	17.50	37.77	.0020185	[illegible]	.01717	.01295	1.90000
20	.13854	20.00	2.50	.0022007	562.32	.00114	.00315	1.90000
20	.13854	22.50	0.00	.0022835	540.00	0.00000	0.00000	1.90000
20	.13854	25.00	0.00	.0022835	540.00	0.00000	0.00000	1.90000
20	.13854	27.50	0.00	.0022835	540.00	0.00000	0.00000	1.90000
20	.13854	30.00	0.00	.0022835	540.00	0.00000	0.00000	1.90000
21	.14583	0.00	1378.11	.0011599	1063.16	.62657	.13781	2.00000
21	.14583	2.31	1303.87	.0011715	1052.52	.59281	.13796	2.00000
21	.14583	4.62	1100.68	.0012170	1013.17	.50043	.13495	2.00000
21	.14583	6.92	773.97	.0013145	938.05	.35189	.11671	2.00000
21	.14583	9.23	414.00	.0015922	821.91	.18823	.08055	2.00000
21	.14583	11.54	154.16	.0017639	699.08	.07009	.03861	2.00000
21	.14583	13.85	37.12	.0020204	[illegible]	.01688	.01201	2.00000
21	.14583	16.15	4.97	.0021826	564.95	.00226	.00328	2.00000
21	.14583	18.46	0.00	.0022835	540.00	0.00000	0.00000	2.00000
21	.14583	20.77	0.00	.0022835	540.00	0.00000	0.00000	2.00000
21	.14583	23.08	0.00	.0022835	540.00	0.00000	0.00000	2.00000
21	.14583	25.38	0.00	.0022835	540.00	0.00000	0.00000	2.00000
21	.14583	27.69	0.00	.0022835	540.00	0.00000	0.00000	2.00000
21	.14583	30.00	0.00	.0022835	540.00	0.00000	0.00000	2.00000
22	.15313	0.00	293.27	.0016988	725.85	.09242	.04220	2.10000
22	.15313	2.14	181.15	.0017236	715.40	.08236	.03875	2.10000
22	.15313	4.29	131.99	.0018015	684.65	.06001	.03049	2.10000
22	.15313	6.43	73.29	.0019140	644.25	.03332	.01912	2.10000
22	.15313	8.57	31.17	.0020427	603.66	.01417	.00955	2.10000
22	.15313	10.71	9.03	.0021524	572.88	.00410	.00396	2.10000
22	.15313	12.86	1.10	.0021963	561.44	.00050	.00274	2.10000
22	.15313	15.00	0.00	.0022835	540.00	0.00000	0.00000	2.10000

COMPUTATION OF AERO-ACOUSTIC PROPERTIES OF SUPPRESSOR NOZZLES

CASE NO. 1   CRD 7-TUBE AR=2.3 NOZZLE - VJ=2200 FPS - TTJ=1600 DEG-R

AXIAL LOCATION = .07292 (X/DEQ = 1.00000)

M	R	ANGLE	U	DENSITY	TEMP.	U/UREF	TURB.INT.	R/DEQ
22	.15313	17.14	0.00	.0022835	540.00	0.00000	0.00000	2.10000
22	.15313	19.29	0.00	.0022835	540.00	0.00000	0.00000	2.10000
22	.15313	21.43	0.00	.0022835	540.00	0.00000	0.00000	2.10000
22	.15313	23.57	0.00	.0022835	540.00	0.00000	0.00000	2.10000
22	.15313	25.71	0.00	.0022835	540.00	0.00000	0.00000	2.10000
22	.15313	27.86	0.00	.0022835	540.00	0.00000	0.00000	2.10000
22	.15313	30.00	0.00	.0022835	540.00	0.00000	0.00000	2.10000
23	.16042	0.00	4.61	.0021890	563.29	.00210	.00280	2.20000
23	.16042	2.14	3.77	.0021944	561.93	.00172	.00285	2.20000
23	.16042	4.29	2.16	.0022076	558.56	.00098	.00276	2.20000
23	.16042	6.43	0.00	.0022835	540.00	0.00000	0.00000	2.20000
23	.16042	8.57	0.00	.0022835	540.00	0.00000	0.00000	2.20000
23	.16042	10.71	0.00	.0022835	540.00	0.00000	0.00000	2.20000
23	.16042	12.86	0.00	.0022835	540.00	0.00000	0.00000	2.20000
23	.16042	15.00	0.00	.0022835	540.00	0.00000	0.00000	2.20000
23	.16042	17.14	0.00	.0022835	540.00	0.00000	0.00000	2.20000
23	.16042	19.29	0.00	.0022835	540.00	0.00000	0.00000	2.20000
23	.16042	21.43	0.00	.0022835	540.00	0.00000	0.00000	2.20000
23	.16042	23.57	0.00	.0022835	540.00	0.00000	0.00000	2.20000
23	.16042	25.71	0.00	.0022835	540.00	0.00000	0.00000	2.20000
23	.16042	27.86	0.00	.0022835	540.00	0.00000	0.00000	2.20000
23	.16042	30.00	0.00	.0022835	540.00	0.00000	0.00000	2.20000

CIRCUMFERENTIALLY-AVERAGED PARAMETERS

NR	RADIUS	MACH NO.	TEMP.	INTENSITY	FREQUENCY
1	.0001	1.9662	2.2955	.66006E-12	0.
2	.1000	1.9662	2.2955	.24773E-06	3.
3	.2000	1.9662	2.2955	.95416E-08	0.
4	.3000	1.9666	2.2951	.21384E-04	7.
5	.4000	1.9182	2.2398	.16103E+05	2416.
6	.5000	1.2278	1.9688	.17198E+08	25958.
7	.6000	.1809	1.3452	.51043E+04	16407.
8	.7000	.0028	1.0583	.39885E-04	4377.
9	.8000	.0019	1.0777	.41234E-06	524.
10	.9000	.1277	1.2755	.10304E+04	5139.
11	1.0000	.8929	1.8257	.11824E+08	12312.
12	1.1000	1.5573	2.1133	.29016E+08	5707.
13	1.2000	1.7232	2.2014	.42213E+08	2595.
14	1.3000	1.7745	2.2247	.49008E+08	1676.
15	1.4000	1.7964	2.2343	.41582E+08	1326.
16	1.5000	1.8024	2.2367	.42918E+08	1313.
17	1.6000	1.7963	2.2339	.38624E+08	1513.
18	1.7000	1.7761	2.2255	.43543E+08	1888.
19	1.8000	1.7236	2.2014	.30032E+08	2593.
20	1.9000	1.5589	2.1139	.24184E+08	4755.
21	2.0000	.8929	1.8257	.14303E+08	8933.
22	2.1000	.1275	1.2759	.15046E+04	3436.
23	2.2000	.0029	1.0397	.19514E-04	733.

WARNING - NO. OF TURNING POINTS IS GREATER THAN 2 AT
KA= 1 X= .07292 ITH= 10 THETA= 110.00 NTP= 3

WARNING - NO. OF TURNING POINTS IS GREATER THAN 2 AT
KA= 1 X= .07292 ITH= 11 THETA= 120.00 NTP= 3

WARNING - NO. OF TURNING POINTS IS GREATER THAN 2 AT
KA= 1 X= .07292 ITH= 12 THETA= 130.00 NTP= 3

WARNING - NO. OF TURNING POINTS IS GREATER THAN 2 AT
KA= 1 X= .07292 ITH= 13 THETA= 140.00 NTP= 3

WARNING - NO. OF TURNING POINTS IS GREATER THAN 2 AT
KA= 1 X= .07292 ITH= 14 THETA= 150.00 NTP= 3

WARNING - NO. OF TURNING POINTS IS GREATER THAN 2 AT
KA= 1 X= .07292 ITH= 15 THETA= 160.00 NTP= 3

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X( 1)=    .0729  UBI( 1)= .25899E+21  FM( 1)= .2419E+01  UAVG( 1)= 1847.59  UMAX( 1)= 2199.46

WARNING - NO. OF TURNING POINTS IS GREATER THAN 2 AT
KA=  2     X=     .09187      ITH= 10      THETA=  110.00     NTP=  3

WARNING - NO. OF TURNING POINTS IS GREATER THAN 2 AT
KA=  2     X=     .09187      ITH= 11      THETA=  120.00     NTP=  3

WARNING - NO. OF TURNING POINTS IS GREATER THAN 2 AT
KA=  2     X=     .09187      ITH= 12      THETA=  130.00     NTP=  3

WARNING - NO. OF TURNING POINTS IS GREATER THAN 2 AT
KA=  2     X=     .09187      ITH= 13      THETA=  140.00     NTP=  3

WARNING - NO. OF TURNING POINTS IS GREATER THAN 2 AT
KA=  2     X=     .09187      ITH= 14      THETA=  150.00     NTP=  3

X( 2)=    .0919  UBI( 2)= .2[illegible]385E+21  FM( 2)= .2524E+01  UAVG( 2)= 1767.58  UMAX( 2)= 2199.46

WARNING - NO. OF TURNING POINTS IS GREATER THAN 2 AT
KA=  3     X=     .11575      ITH= 10      THETA=  110.00     NTP=  3

WARNING - NO. OF TURNING POINTS IS GREATER THAN 2 AT
KA=  3     X=     .11575      ITH= 11      THETA=  120.00     NTP=  3

WARNING - NO. OF TURNING POINTS IS GREATER THAN 2 AT
KA=  3     X=     .11575      ITH= 12      THETA=  130.00     NTP=  3

WARNING - NO. OF TURNING POINTS IS GREATER THAN 2 AT
KA=  3     X=     .11575      ITH= 13      THETA=  140.00     NTP=  3

WARNING - NO. OF TURNING POINTS IS GREATER THAN 2 AT
KA=  3     X=     .11575      ITH= 14      THETA=  150.00     NTP=  3

X( 3)=    .1157  UBI( 3)= .26192E+21  FM( 3)= .2669E+01  UAVG( 3)= 1674.56  UMAX( 3)= 2199.45

WARNING - NO. OF TURNING POINTS IS GREATER THAN 2 AT
KA=  4     X=     .14583      ITH= 10      THETA=  110.00     NTP=  3

WARNING - NO. OF TURNING POINTS IS GREATER THAN 2 AT
KA=  4     X=     .14583      ITH= 11      THETA=  120.00     NTP=  3
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WARNING - NO. OF TURNING POINTS IS GREATER THAN 2 AT
KA=  4      X=     .14583     ITH= 12     THETA=  130.00     NTP=  3


WARNING - NO. OF TURNING POINTS IS GREATER THAN 2 AT
KA=  4      X=     .14583     ITH= 13     THETA=  140.00     NTP=  3


X( 4)=    .1458  UBI( 4)= .25722E+21  FM( 4)= .2843E+01  UAVG( 4)= 1572.60  UMAX( 4)= 2199.41

WARNING - NO. OF TURNING POINTS IS GREATER THAN 2 AT
KA=  5      X=     .18374     ITH= 10     THETA=  110.00     NTP=  3


WARNING - NO. OF TURNING POINTS IS GREATER THAN 2 AT
KA=  5      X=     .18374     ITH= 11     THETA=  120.00     NTP=  3


WARNING - NO. OF TURNING POINTS IS GREATER THAN 2 AT
KA=  5      X=     .18374     ITH= 12     THETA=  130.00     NTP=  3


X( 5)=    .1837  UBI( 5)= .24966E+21  FM( 5)= .3047E+01  UAVG( 5)= 1467.27  UMAX( 5)= 2197.57

WARNING - NO. OF TURNING POINTS IS GREATER THAN 2 AT
KA=  6      X=     .23150     ITH= 10     THETA=  110.00     NTP=  3


WARNING - NO. OF TURNING POINTS IS GREATER THAN 2 AT
KA=  6      X=     .23150     ITH= 11     THETA=  120.00     NTP=  3


X( 6)=    .2315  UBI( 6)= .23294E+21  FM( 6)= .3277E+01  UAVG( 6)= 1364.33  UMAX( 6)= 2179.00
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COMPUTATION OF AERO-ACOUSTIC PROPERTIES OF SUPPRESSOR NOZZLES

CASE NO. 1　　CRD 7-TUBE AR=2.3 NOZZLE - VJ=2200 FPS - TTJ=1600 DEG-R

AXIAL LOCATION = .29167 (X/DEQ = 4.00000)

N	R	ANGLE	U	DENSITY	TEMP.	U/UREF	TURB.INT.	R/DEQ
1	.00001	.00	2106.11	.0010468	1177.99	.95756	.00168	.00010
1	.00001	10.00	2106.11	.0010468	1177.99	.95756	.00168	.00010
1	.00001	20.00	2106.11	.0010468	1177.99	.95756	.00168	.00010
1	.00001	30.00	2106.11	.0010468	1177.99	.95756	.00168	.00010
2	.00729	.00	2079.72	.0010551	1168.73	.94555	.05657	.10000
2	.00729	10.00	2079.72	.0010550	1168.73	.94556	.05658	.10000
2	.00729	20.00	2079.72	.0010550	1168.73	.94556	.05658	.10000
2	.00729	30.00	2079.70	.0010551	1168.73	.94555	.05658	.10000
3	.01458	0.00	1994.74	.0010776	1144.29	.90694	.08729	.20000
3	.01458	7.50	1994.74	.0010776	1144.27	.90692	.08729	.20000
3	.01458	15.00	1994.77	.0010776	1144.28	.90694	.08730	.20000
3	.01458	22.50	1994.73	.0010776	1144.27	.90692	.08730	.20000
3	.01458	30.00	1994.77	.0010776	1144.28	.90694	.08730	.20000
4	.02188	0.00	1838.10	.0011099	1111.11	.83571	.11429	.30000
4	.02188	7.50	1838.13	.0011099	1111.02	.83572	.11430	.30000
4	.02188	15.00	1838.04	.0011099	1110.97	.83568	.11431	.30000
4	.02188	22.50	1838.06	.0011099	1110.95	.83569	.11432	.30000
4	.02188	30.00	1837.99	.0011100	1110.92	.83566	.11432	.30000
5	.02917	0.00	1601.57	.0011489	1073.31	.72817	.13158	.40000
5	.02917	6.00	1601.44	.0011489	1073.23	.72811	.13160	.40000
5	.02917	12.00	1601.30	.0011491	1073.07	.72804	.13166	.40000
5	.02917	18.00	1601.02	.0011493	1072.85	.72792	.13172	.40000
5	.02917	24.00	1600.72	.0011496	1072.64	.72778	.13176	.40000
5	.02917	30.00	1600.68	.0011496	1072.58	.72776	.13178	.40000
6	.03646	0.00	1298.70	.0011959	1031.04	.59046	.13255	.50000
6	.03646	6.00	1298.61	.0011963	1030.74	.59043	.13268	.50000
6	.03646	12.00	1296.97	.0011975	1029.74	.58968	.13295	.50000
6	.03646	18.00	1295.36	.0011988	1028.56	.58895	.13329	.50000
6	.03646	24.00	1294.41	.0011999	1027.64	.58851	.13355	.50000
6	.03646	30.00	1293.49	.0012004	1027.20	.58810	.13363	.50000
7	.04375	0.00	980.18	.0012487	987.46	.44565	.11324	.60000
7	.04375	5.00	978.21	.0012502	986.28	.44475	.11362	.60000
7	.04375	10.00	973.63	.0012537	983.54	.44267	.11462	.60000
7	.04375	15.00	967.62	.0012584	979.85	.43994	.11590	.60000
7	.04375	20.00	961.38	.0012636	975.87	.43710	.11703	.60000
7	.04375	25.00	956.95	.0012673	972.99	.43508	.11782	.60000
7	.04375	30.00	955.55	.0012685	972.08	.43445	.11812	.60000
8	.05104	0.00	758.09	.0012799	963.41	.34467	.06822	.70000
8	.05104	5.00	751.56	.0012834	961.81	.34170	.07114	.70000
8	.05104	10.00	733.93	.0012928	953.81	.33369	.07705	.70000
8	.05104	15.00	710.08	.0013064	943.84	.32285	.08252	.70000
8	.05104	20.00	686.08	.0013216	933.04	.31193	.08631	.70000
8	.05104	25.00	668.47	.0013335	924.72	.30393	.08843	.70000
8	.05104	30.00	662.07	.0013379	921.68	.30101	.08911	.70000
9	.05833	0.00	758.65	.0012799	963.41	.34465	.06817	.80000
9	.05833	4.29	745.61	.0012839	960.44	.33920	.07124	.80000
9	.05833	8.57	710.47	.0012959	952.16	.32302	.07635	.80000
9	.05833	12.86	658.39	.0013121	939.74	.29934	.07855	.80000

COMPUTATION OF AERO-ACOUSTIC PROPERTIES OF SUPPRESSOR NOZZLES

CASE NO. 1　　　CRD 7-TUBE AR=2.3 NOZZLE - VJ=2200 FPS - TTJ=1600 DEG-R

AXIAL LOCATION = .29167 (X/DEQ = 4.00000)

M	R	ANGLE	U	DENSITY	TEMP.	U/UREF	TURB.INT.	R/DEQ
9	.05833	17.14	597.88	.0013330	925.00	.27183	.07582	.80000
9	.05833	21.43	540.35	.0013531	911.29	.24567	.06819	.80000
9	.05833	25.71	498.87	.0013676	901.61	.22682	.05718	.80000
9	.05833	30.00	483.69	.0013728	898.19	.21991	.05027	.80000
10	.06563	0.00	980.09	.0012487	987.45	.44561	.11321	.90000
10	.06563	4.29	958.94	.0012541	983.25	.43599	.11533	.90000
10	.06563	8.57	898.45	.0012692	971.57	.40849	.11892	.90000
10	.06563	12.86	805.40	.0012938	953.09	.36618	.11906	.90000
10	.06563	17.14	692.79	.0013244	931.01	.31498	.11248	.90000
10	.06563	21.43	579.98	.0013541	910.63	.26369	.09745	.90000
10	.06563	25.71	492.43	.0013716	899.03	.22389	.07158	.90000
10	.06563	30.00	458.84	.0013756	896.38	.20861	.03069	.90000
11	.07292	0.00	1298.64	.0011969	1031.04	.59044	.13253	1.00000
11	.07292	3.75	1278.97	.0011997	1027.81	.58150	.13588	1.00000
11	.07292	7.50	1213.17	.0012120	1017.42	.55158	.14287	1.00000
11	.07292	11.25	1109.42	.0012334	999.73	.50459	.14800	1.00000
11	.07292	15.00	977.73	.0012630	976.32	.44453	.14727	1.00000
11	.07292	18.75	829.45	.0012980	955.06	.37712	.13834	1.00000
11	.07292	22.50	686.00	.0013309	926.50	.31190	.11965	1.00000
11	.07292	26.25	576.02	.0013516	912.95	.26189	.08882	1.00000
11	.07292	30.00	533.54	.0013553	909.82	.24258	.04985	1.00000
12	.08021	0.00	1601.50	.0011489	1073.30	.72813	.13157	1.10000
12	.08021	3.75	1577.02	.0011528	1069.60	.71701	.13788	1.10000
12	.08021	7.50	1503.70	.0011648	1058.63	.68367	.15133	1.10000
12	.08021	11.25	1383.35	.0011848	1040.71	.62895	.16335	1.10000
12	.08021	15.00	1219.62	.0012135	1016.11	.55451	.16798	1.10000
12	.08021	18.75	1028.14	.0012567	985.89	.46745	.16135	1.10000
12	.08021	22.50	838.03	.0012885	956.97	.38102	.14139	1.10000
12	.08021	26.25	688.35	.0013137	938.60	.31296	.10494	1.10000
12	.08021	30.00	629.41	.0013201	934.09	.28617	.05050	1.10000
13	.08750	0.00	1838.04	.0011099	1111.01	.83568	.11428	1.20000
13	.08750	3.33	1817.98	.0011135	1107.37	.82656	.12296	1.20000
13	.08750	6.67	1756.96	.0011241	1096.90	.79882	.14180	1.20000
13	.08750	10.00	1653.43	.0011412	1080.52	.75174	.16119	1.20000
13	.08750	13.33	1507.73	.0011642	1059.16	.68550	.17533	1.20000
13	.08750	16.67	1326.82	.0011932	1033.45	.60325	.18014	1.20000
13	.08750	20.00	1116.83	.0012287	1003.54	.50778	.17240	1.20000
13	.08750	23.33	915.38	.0012641	975.46	.41619	.15031	1.20000
13	.08750	26.67	760.19	.0012869	958.20	.34563	.11059	1.20000
13	.08750	30.00	699.78	.0012926	953.93	.31816	.03942	1.20000
14	.09479	0.00	1994.74	.0010776	1144.28	.90693	.08729	1.30000
14	.09479	3.33	1974.99	.0010822	1139.4[illegible]	.89795	.10155	1.30000
14	.09479	6.67	1914.32	.0010953	1125.76	.87023	.12855	1.30000
14	.09479	10.00	1807.55	.0011154	1105.52	.82182	.15554	1.30000
14	.09479	13.33	1652.47	.0011410	1083.71	.75131	.17663	1.30000
14	.09479	16.67	1451.76	.0011721	1052.06	.66005	.18673	1.30000
14	.09479	20.00	1218.12	.0012089	1019.96	.55383	.18205	1.30000
14	.09479	23.33	982.56	.0012485	987.61	.44673	.15998	1.30000

COMPUTATION OF AERO-ACOUSTIC PROPERTIES OF SUPPRESSOR NOZZLES

CASE NO. 1   CRD 7-TUBE AR=2.3 NOZZLE - VJ=2200 FPS - TTJ=1600 DEG-R

AXIAL LOCATION = .29167 (X/DEQ = 4.00000)

M	R	ANGLE	U	DENSITY	TEMP.	U/UREF	TURB.INT.	R/DEQ
14	.09479	26.67	738.29	.0012757	966.58	.36291	.11775	1.30000
14	.09479	30.00	725.24	.0012831	961.98	.32973	.00455	1.30000
15	.10208	0.00	2079.68	.0010551	1168.72	.94554	.05655	1.40000
15	.10208	3.00	2064.03	.0010596	1163.69	.93843	.07855	1.40000
15	.10208	6.00	2015.26	.0010726	1149.60	.91626	.10976	1.40000
15	.10208	9.00	1928.64	.0010923	1128.86	.87687	.14000	1.40000
15	.10208	12.00	1799.20	.0011168	1104.08	.81802	.16625	1.40000
15	.10208	15.00	1624.99	.0011454	1076.54	.73881	.18425	1.40000
15	.10208	18.00	1411.64	.0011788	1046.01	.64181	.19610	1.40000
15	.10208	21.00	1172.55	.0012181	1012.27	.53311	.18135	1.40000
15	.10208	24.00	942.79	.0012592	979.23	.42865	.15690	1.40000
15	.10208	27.00	766.69	.0012872	957.97	.34858	.11462	1.40000
15	.10208	30.00	698.15	.0012947	952.41	.31742	.04002	1.40000
16	.10938	0.00	2106.08	.0010469	1177.88	.95755	.00131	1.50000
16	.10938	3.00	2089.92	.0010520	1172.16	.95020	.06982	1.50000
16	.10938	6.00	2039.21	.0010665	1156.23	.92714	.10518	1.50000
16	.10938	9.00	1948.12	.0010882	1133.09	.88573	.13772	1.50000
16	.10938	12.00	1810.36	.0011151	1105.80	.82310	.16571	1.50000
16	.10938	15.00	1623.35	.0011464	1075.63	.73807	.18444	1.50000
16	.10938	18.00	1393.64	.0011837	1041.76	.63363	.18980	1.50000
16	.10938	21.00	1135.88	.0012310	1002.50	.51644	.17962	1.50000
16	.10938	24.00	888.64	.0012808	962.75	.40403	.15401	1.50000
16	.10938	27.00	698.73	.0013180	935.53	.31767	.11212	1.50000
16	.10938	30.00	624.17	.00132[illegible]	927.94	.28378	.05158	1.50000
17	.11667	0.00	2079.64	.0010551	1168.69	.94553	.05661	1.60000
17	.11667	2.73	2064.86	.00105[illegible]4	1163.93	.93881	.07639	1.60000
17	.11667	5.45	2018.48	.00107[illegible]	1150.53	.91790	.10564	1.60000
17	.11667	8.18	1937.32	.0010906	1130.61	.88082	.13436	1.60000
17	.11667	10.91	1815.35	.0011144	1106.47	.82536	.15985	1.60000
17	.11667	13.64	1650.35	.0011426	1079.16	.75034	.17834	1.60000
17	.11667	16.36	1445.39	.0011768	1047.82	.65716	.18636	1.60000
17	.11667	19.09	1210.33	.00122[illegible]1	1010.61	.55029	.18208	1.60000
17	.11667	21.82	965.46	.0012752	966.93	.43895	.16525	1.60000
17	.11667	24.55	743.54	.0013331	924.94	.33806	.13778	1.60000
17	.11667	27.27	578.88	.0013749	896.83	.26319	.09931	1.60000
17	.11667	30.00	515.41	.0013875	888.71	.23434	.05403	1.60000
18	.12396	0.00	1994.59	.0010777	1144.15	.90685	.08734	1.70000
18	.12396	2.73	1977.29	.0010818	1139.85	.89899	.09823	1.70000
18	.12396	5.45	1924.[illegible]1	.0010935	1127.67	.87477	.12066	1.70000
18	.12396	8.18	1831.25	.0011116	1109.29	.83259	.14455	1.70000
18	.12396	10.91	1695.34	.0011354	1086.06	.77080	.16479	1.70000
18	.12396	13.64	1516.33	.0011654	1058.07	.68941	.17735	1.70000
18	.12396	16.36	1302.89	.0012043	1023.87	.59237	.17931	1.70000
18	.12396	19.09	1057.75	.0012582	979.99	.48091	.16939	1.70000
18	.12396	21.82	818.59	.0013262	929.78	.37218	.14918	1.70000
18	.12396	24.55	606.74	.0013991	881.32	.27586	.12107	1.70000
18	.12396	27.27	452.02	.0014540	848.04	.20551	.08595	1.70000
18	.12396	30.00	392.42	.0014709	838.30	.17842	.04972	1.70000

COMPUTATION OF AERO-ACOUSTIC PROPERTIES OF SUPPRESSOR NOZZLES

CASE NO. 1 CPD 7-TUBE AR=2.3 NOZZLE - VJ=2200 FPS - TTJ=1600 DEG-R

AXIAL LOCATION = .29167 (X/DEO = 4.00000)

M	R	ANGLE	U	DENSITY	TEMP.	U/UREF	TURB.INT.	R/DEO
19	.13125	0.00	1837.39	.0011105	1116.42	.83539	.11439	1.80000
19	.13125	2.50	1820.44	.0011136	1107.30	.82768	.12007	1.80000
19	.13125	5.00	1768.89	.0011228	1098.22	.80424	.13359	1.80000
19	.13125	7.50	1681.42	.0011379	1083.77	.76447	.14907	1.80000
19	.13125	10.00	1556.92	.0011587	1064.21	.70787	.16204	1.80000
19	.13125	12.50	1397.48	.0011866	1039.14	.63537	.16931	1.80000
19	.13125	15.00	1206.70	.0012245	1006.97	.54864	.16868	1.80000
19	.13125	17.50	997.54	.0012764	966.03	.45354	.15935	1.80000
19	.13125	20.00	787.82	.0013429	918.24	.35819	.14249	1.60000
19	.13125	22.50	593.76	.0014217	867.36	.26996	.12005	1.80000
19	.13125	25.00	431.22	.0015017	821.12	.19606	.09427	1.80000
19	.13125	27.50	316.29	.0015595	790.68	.14408	.06595	1.80000
19	.13125	30.00	273.46	.0015771	751.86	.12433	.04087	1.80000
20	.13854	0.00	1598.74	.0011516	1071.72	.72688	.13194	1.90000
20	.13854	2.50	1579.89	.0011548	1067.79	.71831	.13512	1.90000
20	.13854	5.00	1523.25	.0011644	1058.99	.69256	.14277	1.90000
20	.13854	7.50	1429.27	.0011808	1044.23	.64983	.15099	1.90000
20	.13854	10.00	1301.85	.0012052	1023.13	.59190	.15622	1.90000
20	.13854	12.50	1136.77	.0012407	993.84	.51684	.15577	1.90000
20	.13854	15.00	954.54	.0012896	956.17	.43399	.14844	1.90000
20	.13854	17.50	766.15	.0013530	911.36	.34834	.13455	1.90000
20	.13854	20.00	585.08	.0014320	861.07	.26601	.11549	1.90000
20	.13854	22.50	425.42	.0015230	809.65	.19342	.09352	1.90000
20	.13854	25.00	296.85	.0016132	764.39	.13496	.07079	1.90000
20	.13854	27.50	208.01	.0016788	734.48	.09457	.04826	1.90000
20	.13854	30.00	174.26	.0016987	725.87	.07923	.03019	1.90000
21	.14583	0.00	1287.46	.0012079	1022.84	.58535	.13417	2.00000
21	.14583	2.31	1273.23	.0012109	1018.35	.57888	.13532	2.00000
21	.14583	4.62	1221.46	.0012216	1009.39	.55535	.13771	2.00000
21	.14583	6.92	1140.20	.0012400	994.44	.51840	.13956	2.00000
21	.14583	9.23	1033.50	.0012672	973.08	.46989	.13924	2.00000
21	.14583	11.54	905.48	.0013048	944.99	.41169	.13506	2.00000
21	.14583	13.85	764.63	.0013539	910.74	.34764	.12645	2.00000
21	.14583	16.15	619.74	.0014161	870.74	.28177	.11370	2.00000
21	.14583	18.46	481.43	.0014913	826.87	.21889	.09777	2.00000
21	.14583	20.77	357.91	.0015764	782.29	.16273	.08012	2.00000
21	.14583	23.08	254.57	.0016664	739.96	.11574	.06236	2.00000
21	.14583	25.38	175.01	.0017501	704.58	.07957	.04584	2.00000
21	.14583	27.69	121.64	.0018079	682.03	.05530	.03092	2.00000
21	.14583	30.00	101.49	.0018249	675.79	.04614	.02011	2.00000
22	.15313	0.00	937.77	.0012946	952.48	.42637	.11983	2.10000
22	.15313	2.14	924.95	.0012987	949.49	.42053	.11979	2.10000
22	.15313	4.29	887.81	.0013103	941.04	.40365	.11943	2.10000
22	.15313	6.43	828.08	.0013308	926.59	.37649	.11795	2.10000
22	.15313	8.57	749.54	.0013598	906.80	.34079	.11460	2.10000
22	.15313	10.71	656.99	.0013999	881.41	.29870	.10870	2.10000
22	.15313	12.86	556.37	.0014486	851.29	.25296	.10008	2.10000
22	.15313	15.00	454.56	.0015083	817.51	.20667	.08910	2.10000

COMPUTATION OF AERO-ACOUSTIC PROPERTIES OF SUPPRESSOR NOZZLES

CASE NO. 1   CRD 7-TUBE AR=2.3 NOZZLE - VJ=2200 FPS - TTJ=1600 DEG-R

AXIAL LOCATION = .29167 (X/DEQ = 4.00000)

M	R	ANGLE	U	DENSITY	TEMP.	U/UREF	TURB.INT.	R/DEQ
22	.15313	17.14	357.45	.0015777	781.57	.16252	.07634	2.10000
22	.15313	19.29	270.54	.0016543	745.39	.12361	.06280	2.10000
22	.15313	21.43	197.22	.0017346	719.86	.08967	.04961	2.10000
22	.15313	23.57	137.95	.0018142	679.67	.06272	.03736	2.10000
22	.15313	25.71	93.70	.0018844	654.37	.04260	.02675	2.10000
22	.15313	27.86	64.47	.0019313	638.46	.02931	.01780	2.10000
22	.15313	30.00	53.60	.0019445	634.12	.02437	.01197	2.10000
23	.16042	0.00	613.13	.0014195	868.70	.27876	.09412	2.20000
23	.16042	2.14	603.28	.0014242	865.82	.27429	.09360	2.20000
23	.16042	4.29	575.24	.0014387	857.06	.26145	.09196	2.20000
23	.16042	6.43	530.39	.0014629	842.91	.24114	.08886	2.20000
23	.16042	8.57	472.73	.0014970	823.72	.21493	.08401	2.20000
23	.16042	10.71	406.78	.0015409	800.25	.18495	.07730	2.20000
23	.16042	12.86	337.15	.0015942	773.46	.15329	.06887	2.20000
23	.16042	15.00	269.33	.0016558	744.68	.12246	.05929	2.20000
23	.16042	17.14	206.72	.0017239	715.30	.09399	.04904	2.20000
23	.16042	19.29	152.21	.0017958	686.64	.06920	.03887	2.20000
23	.16042	21.43	107.77	.0018681	660.08	.04900	.02951	2.20000
23	.16042	23.57	73.44	.0019367	636.75	.03339	.02149	2.20000
23	.16042	25.71	48.22	.0019964	617.66	.02193	.01484	2.20000
23	.16042	27.86	31.74	.0020367	605.42	.01443	.00958	2.20000
23	.16042	30.00	25.54	.0020484	601.96	.01161	.00650	2.20000
24	.16771	0.00	357.30	.0015779	781.48	.16245	.06487	2.30000
24	.16771	2.00	351.61	.0015824	779.25	.15986	.06431	2.30000
24	.16771	4.00	335.59	.0015957	772.74	.15258	.06270	2.30000
24	.16771	6.00	310.68	.0016176	762.26	.14098	.05991	2.30000
24	.16771	8.00	277.07	.0016481	748.17	.12597	.05592	2.30000
24	.16771	10.00	240.00	.0016861	731.32	.10912	.05096	2.30000
24	.16771	12.00	200.67	.0017312	712.27	.09123	.04505	2.30000
24	.16771	14.00	161.87	.0017820	691.95	.07360	.03854	2.30000
24	.16771	16.00	126.11	.0018367	671.37	.05734	.03189	2.30000
24	.16771	18.00	94.96	.0018929	651.41	.04318	.02550	2.30000
24	.16771	20.00	68.67	.0019496	632.46	.03122	.01954	2.30000
24	.16771	22.00	47.91	.0020039	615.35	.02178	.01446	2.30000
24	.16771	24.00	32.27	.0020531	600.60	.01467	.01031	2.30000
24	.16771	26.00	20.97	.0020947	588.65	.00954	.00709	2.30000
24	.16771	28.00	13.73	.0021219	581.12	.00624	.00464	2.30000
24	.16771	30.00	10.98	.0021299	578.95	.00499	.00327	2.30000
25	.17500	0.00	186.12	.0017195	704.81	.08462	.03924	2.40000
25	.17500	2.00	182.65	.0017538	703.08	.08304	.03873	2.40000
25	.17500	4.00	173.41	.0017661	698.20	.07884	.03741	2.40000
25	.17500	6.00	159.16	.0017860	690.39	.07236	.03532	2.40000
25	.17500	8.00	140.63	.0018134	679.99	.06394	.03232	2.40000
25	.17500	10.00	120.08	.0018468	667.68	.05460	.02878	2.40000
25	.17500	12.00	99.15	.0018850	654.15	.04503	.02488	2.40000
25	.17500	14.00	78.44	.0019274	639.77	.03566	.02070	2.40000
25	.17500	16.00	59.91	.0019714	625.49	.02724	.01663	2.40000
25	.17500	18.00	44.13	.0020153	611.86	.02006	.01290	2.40000

COMPUTATION OF AERO-ACOUSTIC PROPERTIES OF SUPPRESSOR NOZZLES

CASE NO. 1 CRD 7-TUBE AR=2.3 NOZZLE - VJ=2200 FPS - TTJ=1600 DEG-R

AXIAL LOCATION = .29167 (X/DEQ = 4.00000)

M	R	ANGLE	U	DENSITY	TEMP.	U/UREF	TURB.INT.	R/DEQ
25	.17500	20.00	31.18	.0020583	599.09	.01418	.00964	2.40000
25	.17500	22.00	21.12	.0020987	587.55	.00960	.00694	2.40000
25	.17500	24.00	13.77	.0021344	577.71	.00626	.00481	2.40000
25	.17500	26.00	8.66	.0021636	569.92	.00394	.00334	2.40000
25	.17500	28.00	5.41	.0021826	564.96	.00246	.00232	2.40000
25	.17500	30.00	4.18	.0021877	563.64	.00190	.00192	2.40000
26	.18229	0.00	86.65	.0019098	645.67	.03940	.02081	2.50000
26	.18229	1.87	85.09	.0019131	644.56	.03869	.02052	2.50000
26	.18229	3.75	80.94	.0019217	641.64	.03680	.01974	2.50000
26	.18229	5.62	74.69	.0019357	637.02	.03396	.01860	2.50000
26	.18229	7.50	66.40	.0019552	630.67	.03019	.01697	2.50000
26	.18229	9.37	57.15	.0019786	623.19	.02598	.01510	2.50000
26	.18229	11.25	47.65	.0020048	615.05	.02166	.01303	2.50000
26	.18229	13.12	38.29	.0020337	606.33	.01741	.01087	2.50000
26	.18229	15.00	29.65	.0020641	597.40	.01348	.00879	2.50000
26	.18229	16.87	22.17	.0020942	588.81	.01008	.00693	2.50000
26	.18229	18.75	16.03	.0021229	580.84	.00729	.00534	2.50000
26	.18229	20.62	11.14	.0021561	573.50	.00507	.00396	2.50000
26	.18229	22.50	7.44	.0021746	567.95	.00338	.00293	2.50000
26	.18229	24.37	4.76	.0021955	561.63	.00216	.00224	2.50000
26	.18229	26.25	2.88	.0022116	557.56	.00131	.00172	2.50000
26	.18229	28.12	1.66	.0022189	555.72	.00076	.00151	2.50000
26	.18229	30.00	1.19	.0022174	556.08	.00054	.00132	2.50000
27	.18958	0.00	36.06	.0020411	604.12	.01640	.00971	2.60000
27	.18958	1.87	35.36	.0020436	603.37	.01608	.00957	2.60000
27	.18958	3.75	33.52	.0020550	601.50	.01524	.00917	2.60000
27	.18958	5.62	30.72	.0020610	598.59	.01397	.00858	2.60000
27	.18958	7.50	27.12	.0020736	594.64	.01233	.00776	2.60000
27	.18958	9.37	23.12	.0020955	589.84	.01046	.00681	2.60000
27	.18958	11.25	18.93	.0021087	584.75	.00861	.00587	2.60000
27	.18958	13.12	14.96	.0021285	579.32	.00680	.00485	2.60000
27	.18958	15.00	11.39	.0021486	573.90	.00518	.00392	2.60000
27	.18958	16.87	8.39	.0021685	568.62	.00378	.00304	2.60000
27	.18958	18.75	5.84	.0021868	563.87	.00265	.00246	2.60000
27	.18958	20.62	3.89	.0022033	559.65	.00177	.00192	2.60000
27	.18958	22.50	2.43	.0022167	556.26	.00111	.00165	2.60000
27	.18958	24.37	1.34	.0022241	554.42	.00061	.00160	2.60000
27	.18958	26.25	.34	.0021745	567.06	.00015	.00148	2.60000
27	.18958	28.12	0.00	.0022835	546.00	0.00000	0.00000	2.60000
27	.18958	30.00	0.00	.0022835	546.00	0.00000	0.00000	2.60000

CIRCUMFERENTIALLY-AVERAGED PARAMETERS

NR	RADIUS	MACH NO.	TEMP.	INTENSITY	FREQUENCY
1	.001	1.8824	2.1813	.68664E-07	1.
2	.1000	1.8592	2.1644	.26994E+05	722.
3	.2000	1.7832	2.1191	.11244E+07	1793.
4	.3000	1.6431	2.0574	.11132E+08	3336.
5	.4000	1.4313	1.9870	.39960E+08	5082.
6	.5000	1.1587	1.9259	.53881E+08	6414.
7	.6000	.8649	1.8144	.24459E+08	6497.
8	.7000	.6355	1.7476	.26335E+07	4183.
9	.8000	.5695	1.7321	.11638E+07	1968.
10	.9000	.6925	1.7611	.25946E+08	4375.
11	1.0000	.9658	1.8300	.12463E+09	5019.
12	1.1000	1.1205	1.9054	.28211E+09	4336.
13	1.2000	1.2928	1.9655	.43157E+09	3225.
14	1.3000	1.4069	2.0138	.54259E+09	2189.
15	1.4000	1.4638	2.0472	.61131E+09	1565.
16	1.5000	1.4704	2.0443	.63218E+09	1422.
17	1.6000	1.4314	2.0251	.59685E+09	1913.
18	1.7000	1.3472	1.9843	.50965E+09	2664.
19	1.8000	1.2142	1.9246	.39118E+09	3517.
20	1.9000	1.0335	1.8461	.26257E+09	4266.
21	2.0000	.8152	1.745	.13209E+09	4643.
22	2.1000	.5862	1.6218	.39271E+08	4499.
23	2.2000	.3809	1.4948	.57567E+07	3849.
24	2.3000	.2220	1.3533	.37244E+06	2885.
25	2.4000	.1158	1.2414	.10119E+05	1887.
26	2.5000	.0541	1.1557	.11334E+03	1078.
27	2.6000	.0226	1.0958	.54414E+00	556.

WARNING - NO. OF TURNING POINTS IS GREATER THAN 2 AT
KA= 7 X= .29167 ITH= 11 THETA= 120.00 NTP= 3

X(7)= .2917 URI(7)= .19492E+21 FM(7)= .3531E+01 UAVG(7)= 1266.03 UMAX(7)= 2106.11

X(8)= .3675 URI(8)= .13113E+21 FM(8)= .3829E+01 UAVG(8)= 1170.16 UMAX(8)= 1951.26

X(9)= .4630 URI(9)= .67935E+20 FM(9)= .4151E+01 UAVG(9)= 1077.16 UMAX(9)= 1731.67

X(10)= .5833 URI(10)= .17529E+20 FM(10)= .4533E+01 UAVG(10)= 986.98 UMAX(10)= 1506.85

X(11)= .7350 URI(11)= .39713E+19 FM(11)= .4972E+01 UAVG(11)= 899.31 UMAX(11)= 1347.75

X(12)= .9260 URI(12)= .12729E+19 FM(12)= .5529E+01 UAVG(12)= 868.47 UMAX(12)= 1276.87

COMPUTATION OF AERO-ACOUSTIC PROPERTIES OF SUPPRESSOR NOZZLES

CASE NO. 1   CRD 7-TUBE AR=2.3 NOZZLE - VJ=2200 FPS - TTJ=1600 DEG-R

AXIAL LOCATION = 1.16667 (X/DEQ = 15.99999)

M	R	ANGLE	U	DENSITY	TEMP.	U/UREF	TURB.INT.	R/DEQ
1	.00001	0.00	1238.43	.0012299	1002.62	.56306	.00079	.00016
1	.00001	10.00	1238.43	.0012299	1002.62	.56306	.00079	.00016
1	.00001	20.00	1238.43	.0012299	1002.62	.56306	.00079	.00016
1	.00001	30.00	1238.43	.0012299	1002.62	.56306	.00079	.00016
2	.01167	0.00	1236.43	.0012310	1001.65	.56215	.01959	.16000
2	.01167	10.00	1236.43	.0012310	1001.65	.56215	.01960	.16000
2	.01167	20.00	1236.44	.0012310	1001.66	.56216	.01961	.16000
2	.01167	30.00	1236.44	.0012310	1001.66	.56216	.01960	.16000
3	.02333	0.00	1230.90	.0012345	998.88	.55964	.02794	.32000
3	.02333	7.50	1230.89	.0012345	998.87	.55963	.02794	.32000
3	.02333	15.00	1230.90	.0012345	998.88	.55964	.02797	.32000
3	.02333	22.50	1230.92	.0012345	998.88	.55965	.02797	.32000
3	.02333	30.00	1230.98	.0012344	998.90	.55967	.02798	.32000
4	.03500	0.00	1221.34	.0012405	994.04	.55529	.03476	.48000
4	.03500	7.50	1221.47	.0012404	994.07	.55535	.03477	.48000
4	.03500	15.00	1221.39	.0012404	994.07	.55532	.03482	.48000
4	.03500	22.50	1221.41	.0012404	994.08	.55532	.03489	.48000
4	.03500	30.00	1221.32	.0012404	994.07	.55528	.03491	.48000
5	.04667	0.00	1206.88	.0012493	986.99	.54872	.04115	.64000
5	.04667	6.00	1206.94	.0012493	987.02	.54875	.04119	.64000
5	.04667	12.00	1206.98	.0012493	987.05	.54876	.04135	.64000
5	.04667	18.00	1206.85	.0012492	987.07	.54871	.04154	.64000
5	.04667	24.00	1206.74	.0012492	987.1[illegible]	.54865	.04169	.64000
5	.04667	30.00	1206.84	.0012492	987.12	.54870	.04170	.64000
6	.05833	0.00	1187.62	.0012613	977.66	.53996	.04768	.80000
6	.05833	6.00	1187.62	.0012612	977.69	.53996	.04783	.80000
6	.05833	12.00	1187.26	.0012611	977.75	.53980	.04814	.80000
6	.05833	18.00	1187.06	.0012610	977.86	.53971	.04850	.80000
6	.05833	24.00	1187.09	.0012608	977.98	.53972	.04878	.80000
6	.05833	30.00	1187.07	.0012608	978.03	.53971	.04888	.80000
7	.07000	0.00	1162.27	.0012765	966.01	.52843	.05460	.96000
7	.07000	5.00	1162.31	.0012764	966.08	.52845	.05478	.96000
7	.07000	10.00	1161.97	.0012762	966.24	.52830	.05520	.96000
7	.07000	15.00	1161.48	.0012759	966.44	.52808	.05571	.96000
7	.07000	20.00	1161.28	.0012755	966.7[illegible]	.52799	.05618	.96000
7	.07000	25.00	1160.97	.0012753	966.86	.52784	.05648	.96000
7	.07000	30.00	1160.92	.0012752	966.94	.52782	.05655	.96000
8	.08167	.00	1130.21	.0012946	952.48	.51386	.06181	1.12000
8	.08167	5.00	1130.05	.0012944	952.61	.51378	.06208	1.12000
8	.08167	10.00	1129.59	.0012940	952.92	.51358	.06272	1.12000
8	.08167	15.00	1128.75	.0012935	953.32	.51320	.06347	1.12000
8	.08167	20.00	1128.07	.0012928	953.79	.51289	.06411	1.12000
8	.08167	25.00	1127.39	.0012924	954.1[illegible]	.51258	.06453	1.12000
8	.08167	30.00	1127.07	.0012923	954.2[illegible]	.51243	.06465	1.12000
9	.09333	.00	1090.28	.0013155	937.34	.49570	.06894	1.28000
9	.09333	4.29	1090.08	.0013153	937.5[illegible]	.49561	.06919	1.28000
9	.09333	8.57	1089.36	.0013147	937.91	.49529	.06987	1.28000
9	.09333	12.86	1088.33	.0013139	938.49	.49482	.07072	1.28000

COMPUTATION OF AERO-ACOUSTIC PROPERTIES OF SUPPRESSOR NOZZLES

CASE NO. 1   CRD 7-TUBE AR=2.3 NOZZLE - VJ=2200 FPS - TTJ=1600 DEG-R

AXIAL LOCATION = 1.16667 (X/DEQ = 15.99999)

M	R	ANGLE	U	DENSITY	TEMP.	U/UREF	TURB.INT.	R/DEQ
9	.09333	17.14	1087.31	.0013129	939.17	.49436	.07151	1.28000
9	.09333	21.43	1086.54	.0013122	939.73	.49378	.07268	1.28000
9	.09333	25.71	1085.25	.0013115	940.17	.49342	.07242	1.28000
9	.09333	30.00	1084.88	.0013113	940.31	.49325	.07253	1.28000
10	.10500	0.00	1042.41	.0013387	921.08	.47394	.07553	1.44000
10	.10500	4.29	1041.87	.0013386	921.26	.47369	.07585	1.44000
10	.10500	8.57	1040.72	.0013376	921.88	.47317	.07667	1.44000
10	.10500	12.86	1038.96	.0013363	922.76	.47237	.07767	1.44000
10	.10500	17.14	1037.13	.0013348	923.78	.47154	.07854	1.44000
10	.10500	21.43	1035.17	.0013336	924.64	.47065	.07914	1.44000
10	.10500	25.71	1033.91	.0013326	925.39	.47007	.07946	1.44000
10	.10500	30.00	1033.26	.0013323	925.51	.46978	.07954	1.44000
11	.11667	0.00	985.90	.0013642	903.86	.44829	.08105	1.60000
11	.11667	3.75	985.47	.0013639	904.08	.44815	.08133	1.60000
11	.11667	7.50	984.09	.0013629	904.73	.44742	.08206	1.60000
11	.11667	11.25	981.92	.0013615	905.71	.44644	.08298	1.60000
11	.11667	15.00	979.34	.0013598	906.84	.44526	.08384	1.60000
11	.11667	18.75	976.76	.0013580	908.[illegible]	.44409	.08448	1.60000
11	.11667	22.50	974.14	.0013565	908.99	.44299	.08488	1.60000
11	.11667	26.25	972.75	.0013556	909.65	.44225	.08504	1.60000
11	.11667	30.00	972.31	.0013551	909.95	.44217	.08516	1.60000
12	.12833	0.00	921.76	.0013917	885.49	.41969	.08510	1.76000
12	.12833	3.75	920.97	.0013914	886.24	.41873	.08538	1.76000
12	.12833	7.50	918.91	.0013901	887.02	.41779	.08610	1.76000
12	.12833	11.25	915.85	.0013883	888.21	.41640	.08701	1.76000
12	.12833	15.00	912.22	.0013861	889.63	.41475	.08781	1.76000
12	.12833	18.75	908.30	.0013838	891.05	.41297	.08835	1.76000
12	.12833	22.50	904.86	.0013820	892.27	.41140	.08861	1.76000
12	.12833	26.25	902.56	.0013807	893.09	.41036	.08866	1.76000
12	.12833	30.00	901.71	.0013802	893.38	.40997	.08866	1.76000
13	.14000	.00	850.11	.0014216	867.36	.38651	.08730	1.92000
13	.14000	3.33	849.37	.0014212	867.60	.38617	.08750	1.92000
13	.14000	6.67	847.35	.0014201	868.33	.38523	.08805	1.92000
13	.14000	10.00	843.77	.0014183	869.38	.38363	.08876	1.92000
13	.14000	13.33	839.44	.0014161	870.72	.38166	.08943	1.92000
13	.14000	16.67	834.79	.0014138	872.18	.37954	.08988	1.92000
13	.14000	20.00	830.35	.0014115	873.58	.37753	.09009	1.92000
13	.14000	23.33	826.85	.0014096	874.76	.37593	.09009	1.92000
13	.14000	26.67	824.45	.0014084	875.51	.37484	.09001	1.92000
13	.14000	30.00	823.73	.0014079	875.81	.37452	.08998	1.92000
14	.15167	0.00	772.49	.0014541	847.97	.35122	.08750	2.08000
14	.15167	3.33	771.38	.0014538	848.19	.35072	.08767	2.08000
14	.15167	6.67	768.55	.0014525	848.91	.34943	.08813	2.08000
14	.15167	10.00	764.35	.0014506	850.06	.34752	.08871	2.08000
14	.15167	13.33	759.21	.0014482	851.47	.34519	.08918	2.08000
14	.15167	16.67	753.47	.0014455	853.05	.34257	.08943	2.08000
14	.15167	20.00	747.99	.0014430	854.52	.34008	.08941	2.08000
14	.15167	23.33	743.72	.0014410	855.79	.33814	.08923	2.08000

COMPUTATION OF AERO-ACOUSTIC PROPERTIES OF SUPPRESSOR NOZZLES

CASE NO. 1   CRD 7-TUBE AR=2.3 NOZZLE - VJ=2200 FPS - TTJ=1600 DEG-R

AXIAL LOCATION = 1.16667 (X/DEQ = 15.99999)

M	R	ANGLE	U	DENSITY	TEMP.	U/UREF	TURB.INT.	R/DEQ
14	.15167	26.67	740.75	.0014395	856.58	.33679	.08902	2.08000
14	.15167	30.00	739.65	.0014391	856.84	.33629	.08893	2.08000
15	.16333	0.00	690.42	.0014898	827.68	.31391	.08564	2.24000
15	.16333	3.00	689.59	.0014894	827.88	.31353	.08575	2.24000
15	.16333	6.00	686.80	.0014885	828.43	.31226	.08603	2.24000
15	.16333	9.00	682.73	.0014868	829.35	.31041	.08638	2.24000
15	.16333	12.00	677.69	.0014846	83[illegible].56	.30812	.08667	2.24000
15	.16333	15.00	671.85	.0014822	831.9[illegible]	.30546	.08677	2.24000
15	.16333	18.00	665.83	.0014799	833.24	.30272	.08666	2.24000
15	.16333	21.00	660.62	.0014775	834.56	.30035	.08640	2.24000
15	.16333	24.00	656.27	.0014757	835.59	.29838	.08605	2.24000
15	.16333	27.00	653.51	.0014745	836.28	.29712	.08578	2.24000
15	.16333	30.00	652.68	.0014740	836.57	.29675	.08568	2.24000
16	.17500	0.00	606.81	.0015289	806.53	.27589	.08184	2.40000
16	.17500	3.00	605.99	.0015285	806.75	.27552	.08193	2.40000
16	.17500	6.00	602.90	.0015276	807.2[illegible]	.27411	.08208	2.40000
16	.17500	9.00	598.56	.0015260	808.06	.27214	.08227	2.40000
16	.17500	12.00	592.66	.0015240	809.09	.26946	.08234	2.40000
16	.17500	15.00	586.4[illegible]	.0015216	810.36	.26661	.08225	2.40000
16	.17500	18.00	579.83	.0015192	811.65	.26362	.08193	2.40000
16	.17500	21.00	574.[illegible]	.0015169	812.9[illegible]	.26097	.08149	2.40000
16	.17500	24.00	569.29	.0015150	813.93	.25883	.08101	2.40000
16	.17500	27.00	566.13	.0015138	814.56	.25740	.08062	2.40000
16	.17500	30.00	565.13	.0015133	814.81	.25694	.08049	2.40000
17	.18667	0.00	524.23	.0015714	784.69	.23834	.07644	2.56000
17	.18667	2.73	523.45	.0015711	784.83	.23799	.07647	2.56000
17	.18667	5.45	520.84	.00157[illegible]5	785.15	.23680	.07651	2.56000
17	.18667	8.18	516.92	.0015693	785.74	.23502	.07655	2.56000
17	.18667	10.91	511.73	.0015678	786.5[illegible]	.23266	.07649	2.56000
17	.18667	13.64	505.65	.0015661	787.38	.22990	.07627	2.56000
17	.18667	16.36	499.45	.0015640	788.42	.22708	.07592	2.56000
17	.18667	19.09	493.33	.0015619	789.45	.22430	.07540	2.56000
17	.18667	21.82	487.93	.0015600	79[illegible].42	.22184	.07483	2.56000
17	.18667	24.55	483.66	.0015585	791.2[illegible]	.21990	.07429	2.56000
17	.18667	27.27	481.[illegible]2	.0015574	791.74	.21873	.07392	2.56000
17	.18667	30.00	480.13	.0015570	791.94	.21829	.07378	2.56000
18	.19833	0.00	444.85	.0016173	762.41	.20226	.06978	2.72000
18	.19833	2.73	444.06	.0016171	762.53	.20190	.06978	2.72000
18	.19833	5.45	441.44	.0016166	762.75	.20070	.06974	2.72000
18	.19833	8.18	437.39	.0016157	763.17	.19886	.06964	2.72000
18	.19833	10.91	432.15	.0016145	763.74	.19648	.06942	2.72000
18	.19833	13.64	426.1[illegible]	.0016130	764.46	.19373	.06906	2.72000
18	.19833	16.36	419.72	.0016113	765.27	.19083	.06854	2.72000
18	.19833	19.[illegible]9	413.45	.0016095	766.1[illegible]	.18798	.06790	2.72000
18	.19833	21.82	407.99	.0016078	766.94	.18550	.06722	2.72000
18	.19833	24.55	403.63	.0016064	767.62	.18352	.06660	2.72000
18	.19833	27.27	400.90	.0016054	768.08	.18227	.06616	2.72000
18	.19833	30.00	399.90	.0016051	768.23	.18182	.06600	2.72000

COMPUTATION OF AERO-ACOUSTIC PROPERTIES OF SUPPRESSOR NOZZLES

CASE NO. 1   CRD 7-TUBE AR=2.3 NOZZLE - VJ=2200 FPS - TTJ=1600 DEG-R

AXIAL LOCATION = 1.16667 (X/DEQ = 15.99999)

M	R	ANGLE	U	DENSITY	TEMP.	U/UREF	TURB.INT.	R/DEQ
19	.21000	0.00	370.73	.0016662	740.06	.16855	.06228	2.88000
19	.21000	2.50	370.01	.0016661	740.13	.16823	.06225	2.88000
19	.21000	5.00	367.92	.0016658	740.23	.16728	.06217	2.88000
19	.21000	7.50	364.58	.0016653	740.45	.16576	.06200	2.88000
19	.21000	10.00	360.11	.0016647	740.74	.16373	.06172	2.88000
19	.21000	12.50	354.93	.0016637	741.15	.16137	.06133	2.88000
19	.21000	15.00	349.35	.0016625	741.68	.15883	.06081	2.88000
19	.21000	17.50	343.58	.0016613	742.23	.15621	.06017	2.88000
19	.21000	20.00	338.18	.0016599	742.84	.15376	.05948	2.88000
19	.21000	22.50	333.44	.0016587	743.41	.15160	.05879	2.88000
19	.21000	25.00	329.79	.0016576	743.89	.14994	.05821	2.88000
19	.21000	27.50	327.48	.0016569	744.21	.14889	.05781	2.88000
19	.21000	30.00	326.69	.0016566	744.32	.14853	.05767	2.88000
20	.22167	0.00	303.31	.0017173	718.03	.13790	.05436	3.04000
20	.22167	2.50	302.67	.0017173	718.02	.13758	.05431	3.04000
20	.22167	5.00	300.64	.0017172	718.06	.13669	.05418	3.04000
20	.22167	7.50	297.45	.0017171	718.13	.13524	.05394	3.04000
20	.22167	10.00	293.36	.0017167	718.30	.13338	.05359	3.04000
20	.22167	12.50	288.49	.0017161	718.52	.13116	.05312	3.04000
20	.22167	15.00	283.14	.0017155	718.80	.12873	.05252	3.04000
20	.22167	17.50	277.74	.0017145	719.18	.12628	.05183	3.04000
20	.22167	20.00	272.66	.0017136	719.60	.12394	.05109	3.04000
20	.22167	22.50	268.15	.0017125	720.03	.12192	.05038	3.04000
20	.22167	25.00	264.66	.0017117	720.41	.12033	.04977	3.04000
20	.22167	27.50	262.47	.0017111	720.66	.11933	.04937	3.04000
20	.22167	30.00	261.72	.0017108	720.75	.11899	.04922	3.04000
21	.23333	0.00	243.54	.0017699	696.68	.11073	.04640	3.20000
21	.23333	2.31	243.02	.0017700	696.67	.11049	.04635	3.20000
21	.23333	4.62	241.46	.0017701	696.63	.10978	.04621	3.20000
21	.23333	6.92	239.06	.0017701	696.62	.10869	.04598	3.20000
21	.23333	9.23	235.80	.0017701	696.61	.10721	.04564	3.20000
21	.23333	11.54	231.86	.0017701	696.62	.10542	.04520	3.20000
21	.23333	13.85	227.52	.0017699	696.70	.10344	.04466	3.20000
21	.23333	16.15	222.94	.0017695	696.83	.10136	.04404	3.20000
21	.23333	18.46	218.46	.0017690	697.04	.09932	.04336	3.20000
21	.23333	20.77	214.31	.0017683	697.31	.09744	.04268	3.20000
21	.23333	23.08	210.74	.0017676	697.58	.09582	.04204	3.20000
21	.23333	25.38	208.00	.0017670	697.83	.09457	.04152	3.20000
21	.23333	27.69	206.28	.0017666	698.00	.09379	.04118	3.20000
21	.23333	30.00	205.69	.0017664	698.07	.09352	.04106	3.20000
22	.24500	0.00	191.94	.0018229	676.44	.08727	.03874	3.36000
22	.24500	2.14	191.56	.0018230	676.41	.08709	.03869	3.36000
22	.24500	4.29	190.41	.0018231	676.35	.08657	.03857	3.36000
22	.24500	6.43	188.54	.0018234	676.25	.08572	.03835	3.36000
22	.24500	8.57	186.04	.0018237	676.15	.08459	.03804	3.36000
22	.24500	10.71	183.00	.0018240	676.04	.08320	.03765	3.36000
22	.24500	12.86	179.58	.0018242	675.97	.08165	.03718	3.36000
22	.24500	15.00	175.91	.0018242	675.94	.07998	.03664	3.36000

COMPUTATION OF AERO-ACOUSTIC PROPERTIES OF SUPPRESSOR NOZZLES

CASE NO. 1   CRD 7-TUBE AR=2.3 NOZZLE - VJ=2200 FPS - TTJ=1600 DEG-R

AXIAL LOCATION = 1.16667 (X/DEQ = 15.99999)

M	R	ANGLE	U	DENSITY	TEMP.	U/UREF	TURB.INT.	R/DEQ
22	.24500	17.14	172.18	.0018241	675.97	.07828	.03605	3.36000
22	.24500	19.29	168.57	.0018239	676.07	.07664	.03544	3.36000
22	.24500	21.43	165.28	.0018235	676.21	.07515	.03484	3.36000
22	.24500	23.57	162.49	.0018231	676.37	.07388	.03430	3.36000
22	.24500	25.71	160.36	.0018226	676.53	.07291	.03386	3.36000
22	.24500	27.86	159.03	.0018223	676.64	.07231	.03358	3.36000
22	.24500	30.00	158.58	.0018222	676.68	.07210	.03348	3.36000
23	.25667	.00	148.57	.0018751	657.61	.06755	.03165	3.52000
23	.25667	2.14	148.24	.0018752	657.58	.06740	.03160	3.52000
23	.25667	4.29	147.26	.0018754	657.48	.06695	.03147	3.52000
23	.25667	6.43	145.67	.0018759	657.34	.06623	.03126	3.52000
23	.25667	8.57	143.53	.0018764	657.16	.06526	.03096	3.52000
23	.25667	10.71	140.94	.0018769	656.97	.06408	.03058	3.52000
23	.25667	12.86	138.01	.0018774	656.79	.06275	.03013	3.52000
23	.25667	15.00	134.87	.0018778	656.66	.06132	.02962	3.52000
23	.25667	17.14	131.67	.0018780	656.58	.05987	.02906	3.52000
23	.25667	19.29	128.57	.0018780	656.57	.05846	.02849	3.52000
23	.25667	21.43	125.74	.0018779	656.62	.05717	.02794	3.52000
23	.25667	23.57	123.33	.0018776	656.71	.05607	.02744	3.52000
23	.25667	25.71	121.49	.0018774	656.81	.05524	.02704	3.52000
23	.25667	27.86	120.34	.0018771	656.89	.05471	.02678	3.52000
23	.25667	30.00	119.95	.0018771	656.92	.05453	.02669	3.52000
24	.26833	.00	112.78	.0019255	640.38	.05132	.02529	3.68000
24	.26833	2.00	112.64	.0019256	640.34	.05121	.02526	3.68000
24	.26833	4.00	111.93	.0019260	640.24	.05089	.02515	3.68000
24	.26833	6.00	110.78	.0019264	640.08	.05037	.02497	3.68000
24	.26833	8.00	109.22	.0019271	639.87	.04966	.02473	3.68000
24	.26833	10.00	107.32	.0019278	639.64	.04879	.02442	3.68000
24	.26833	12.00	105.13	.0019285	639.41	.04780	.02406	3.68000
24	.26833	14.00	102.75	.0019291	639.19	.04672	.02364	3.68000
24	.26833	16.00	100.27	.0019296	639.02	.04559	.02319	3.68000
24	.26833	18.00	97.79	.0019300	638.90	.04446	.02272	3.68000
24	.26833	20.00	95.44	.0019302	638.84	.04339	.02224	3.68000
24	.26833	22.00	93.31	.0019302	638.83	.04242	.02179	3.68000
24	.26833	24.00	91.51	.0019301	638.87	.04161	.02139	3.68000
24	.26833	26.00	90.16	.0019299	638.92	.04099	.02108	3.68000
24	.26833	28.00	89.31	.0019298	638.97	.04060	.02088	3.68000
24	.26833	30.00	89.02	.0019297	638.99	.04047	.02081	3.68000
25	.28000	.00	84.19	.0019734	624.84	.03828	.01978	3.84000
25	.28000	2.00	84.[illegible]	.0019735	624.8[illegible]	.03819	.01975	3.84000
25	.28000	4.00	83.42	.0019739	624.69	.03793	.01966	3.84000
25	.28000	6.00	82.56	.0019745	624.51	.03751	.01950	3.84000
25	.28000	8.00	81.24	.0019752	624.28	.03694	.01928	3.84000
25	.28000	10.00	79.7[illegible]	.0019761	624.01	.03624	.01901	3.84000
25	.28000	12.00	77.94	.0019769	623.74	.03544	.01868	3.84000
25	.28000	14.00	76.[illegible]1	.0019777	623.48	.03456	.01832	3.84000
25	.28000	16.00	74.[illegible]	.0019785	623.25	.03365	.01792	3.84000
25	.28000	18.00	71.99	.0019793	623.08	.03273	.01751	3.84000

COMPUTATION OF AERO-ACOUSTIC PROPERTIES OF SUPPRESSOR NOZZLES

CASE NO. 1　　　　　　CRD 7-TUBE AR=2.3 NOZZLE - VJ=2200 FPS - TTJ=1600 DEG-R

AXIAL LOCATION = 1.16667 (X/DEQ = 15.99999)

M	R	ANGLE	U	DENSITY	TEMP.	U/UREF	TURB.INT.	R/DEQ
25	.28000	20.00	70.17	.0019794	622.97	.03186	.01710	3.84000
25	.28000	22.00	68.33	.0019795	622.91	.03107	.01671	3.84000
25	.28000	24.00	66.87	.0019795	622.91	.03040	.01637	3.84000
25	.28000	26.00	65.76	.0019795	622.93	.02990	.01611	3.84000
25	.28000	28.00	65.[illegible]6	.0019794	622.96	.02958	.01593	3.84000
25	.28000	30.00	64.83	.0019793	622.97	.02947	.01587	3.84000
26	.29167	.00	61.63	.0020180	611.04	.02802	.01514	4.00000
26	.29167	1.87	61.55	.0020181	611.00	.02796	.01512	4.00000
26	.29167	3.75	61.11	.0020185	610.9[illegible]	.02778	.01505	4.00000
26	.29167	5.62	60.46	.0020190	610.73	.02749	.01493	4.00000
26	.29167	7.50	59.59	.0020197	610.52	.02709	.01476	4.00000
26	.29167	9.37	58.51	.0020206	610.26	.02660	.01455	4.00000
26	.29167	11.25	57.26	.0020215	609.99	.02603	.01431	4.00000
26	.29167	13.12	55.88	.0020224	609.71	.02540	.01403	4.00000
26	.29167	15.00	54.41	.0020232	609.46	.02474	.01373	4.00000
26	.29167	16.87	52.91	.0020240	609.24	.02406	.01341	4.00000
26	.29167	18.75	51.44	.0020245	609.06	.02339	.01308	4.00000
26	.29167	20.62	50.[illegible]	.0020249	608.95	.02276	.01277	4.00000
26	.29167	22.50	48.81	.0020252	608.88	.02219	.01247	4.00000
26	.29167	24.37	47.76	.0020252	608.86	.02172	.01222	4.00000
26	.29167	26.25	46.96	.0020252	608.86	.02136	.01202	4.00000
26	.29167	28.12	46.49	.0020252	608.87	.02114	.01189	4.00000
26	.29167	30.00	46.32	.0020252	608.88	.02106	.01185	4.00000
27	.30333	.00	44.28	.0020548	598.94	.02013	.01135	4.16000
27	.30333	1.87	44.18	.0020549	598.90	.02009	.01133	4.16000
27	.30333	3.75	43.89	.0020562	598.80	.01995	.01127	4.16000
27	.30333	5.62	43.39	.0020598	598.63	.01973	.01117	4.16000
27	.30333	7.50	42.72	.0020606	598.42	.01942	.01103	4.16000
27	.30333	9.37	41.89	.0020614	598.16	.01904	.01086	4.16000
27	.30333	11.25	40.93	.0020624	597.88	.01861	.01066	4.16000
27	.30333	13.12	39.87	.0020634	597.66	.01813	.01043	4.16000
27	.30333	15.00	38.74	.0020643	597.34	.01761	.01018	4.16000
27	.30333	16.87	37.58	.0020651	597.11	.01709	.00992	4.16000
27	.30333	18.75	36.45	.0020658	596.91	.01657	.00966	4.16000
27	.30333	20.62	35.37	.0020662	596.77	.01608	.00940	4.16000
27	.30333	22.50	34.41	.0020665	596.69	.01564	.00916	4.16000
27	.30333	24.37	33.60	.0020667	596.65	.01528	.00895	4.16000
27	.30333	26.25	32.99	.0020667	596.63	.01500	.00879	4.16000
27	.30333	28.12	32.61	.0020667	596.64	.01482	.00869	4.16000
27	.30333	30.00	32.48	.0020667	596.64	.01477	.00865	4.16000
28	.31500	.00	31.22	.0020955	588.45	.01419	.00832	4.32000
28	.31500	1.76	31.15	.0020956	588.42	.01416	.00831	4.32000
28	.31500	3.53	30.95	.0020959	588.34	.01407	.00827	4.32000
28	.31500	5.29	30.63	.0020964	588.19	.01392	.00819	4.32000
28	.31500	7.06	30.19	.0020970	588.01	.01372	.00810	4.32000
28	.31500	8.82	29.62	.0020978	587.78	.01347	.00798	4.32000
28	.31500	10.59	28.97	.0020987	587.54	.01317	.00783	4.32000
28	.31500	12.35	28.25	.0020996	587.28	.01284	.00767	4.32000

COMPUTATI[illegible] OF AE[illegible]-ACOUSTIC PROPERTIES [illegible] SUPPRESSOR NOZZLES

CASE NO. [illegible]   CRD 7-TUBE AR=2.3 NOZZLE - VJ=2200 FPS - TTJ=1600 DEG-R

AXIAL LOCATION = 1.16667 (X/DEQ = 15.99999)

M	R	ANGLE	U	DENSITY	TEMP.	U/UREF	TURB.INT.	R/DEQ
28	.31500	14.12	27.47	.0021046	587.32	.01249	.00749	4.32000
28	.31500	15.88	26.66	.0021014	586.78	.01212	.00730	4.32000
28	.31500	17.65	25.84	.0021022	586.57	.01175	.00710	4.32000
28	.31500	19.41	25.[illegible]5	.0021028	586.41	.01139	.00691	4.32000
28	.31500	21.18	24.31	.0021032	586.28	.01105	.00672	4.32000
28	.31500	22.94	23.64	.0021035	586.2[illegible]	.01075	.00655	4.32000
28	.31500	24.71	23.09	.0021036	586.16	.01050	.00640	4.32000
28	.31500	26.47	22.68	.0021037	586.15	.01031	.00629	4.32000
28	.31500	28.24	22.42	.0021037	586.14	.01020	.00622	4.32000
28	.31500	3[illegible].00	22.34	.0021037	586.14	.01016	.00619	4.32000

CIRCUMFERENTIALLY-AVERAGED PARAMETERS

NR	RADIUS	MACH NO.	TEMP.	INTENSITY	FREQUENCY
1	.0002	1.1097	1.8567	.36459E-08	0.
2	.1600	1.1052	1.8553	.16573E+03	36.
3	.3200	1.1033	1.8494	.39818E+04	75.
4	.4800	1.0918	1.8429	.27782E+05	117.
5	.6400	1.0784	1.8279	.12514E+06	167.
6	.8000	1.0613	1.8138	.45802E+06	230.
7	.9600	1.0383	1.7898	.14834E+07	312.
8	1.1200	1.0089	1.7655	.42972E+07	416.
9	1.2800	.9722	1.7386	.10842E+08	540.
10	1.4400	.9278	1.7098	.23371E+08	683.
11	1.6000	.8753	1.6794	.42290E+08	828.
12	1.7600	.8151	1.6475	.63877E+08	972.
13	1.9200	.7482	1.6139	.80312E+08	1102.
14	2.0800	.676	1.5783	.84269E+08	1208.
15	2.2400	.6065	1.5426	.73889E+08	1282.
16	2.4000	.5242	1.5069	.54403E+08	1319.
17	2.5600	.4494	1.4594	.32814E+08	1317.
18	2.7200	.3782	1.4167	.17811E+08	1279.
19	2.8800	.3124	1.3739	.79784E+07	1209.
20	3.0400	.2533	1.3316	.30469E+07	1113.
21	3.2000	.2016	1.2909	.99454E+06	998.
22	3.3600	.1574	1.2523	.27804E+06	872.
23	3.5200	.1207	1.2167	.66704E+05	743.
24	3.6800	.0909	1.1842	.13745E+05	618.
25	3.8400	.0671	1.1551	.24359E+04	501.
26	4.0000	.0487	1.1293	.37173E+03	396.
27	4.1600	.0346	1.1068	.48923E+02	306.
28	4.3200	.0241	1.0874	.55651E+01	231.

X(13)= 1.1667 UBI(13)= .76410E+18 FM(13)= .6247E+01 UAVG(13)= 715.30 UMAX(13)= 1238.43

X(14)= 1.4699 UBI(14)= .56688E+18 FM(14)= .7156E+01 UAVG(14)= 623.99 UMAX(14)= 1165.93

X(15)= 1.8520 UBI(15)= .35723E+18 FM(15)= .8293E+01 UAVG(15)= 537.77 UMAX(15)= 1043.83

X(16)= 2.3333 UBI(16)= .90889E+18 FM(16)= .9976E+01 UAVG(16)= 446.90 UMAX(16)= 892.50

X(17)= 2.9398 UBI(17)= .42769E+18 FM(17)= .1217E+02 UAVG(17)= 366.21 UMAX(17)= 737.45

X(18)= 3.7039 UBI(18)= .14890E+18 FM(18)= .1471E+02 UAVG(18)= 302.27 UMAX(18)= 595.63

* * * V G R * * * PAGE 24

COMPUTATION OF AFRO-ACOUSTIC PROPERTIES OF SUPPRESSOR NOZZLES

CASE NO. 1 CRD 7-TUBE AR=2.3 NOZZLE - VJ=2200 FPS - TTJ=1600 DEG-R

AXIAL LOCATION = 4.56667 (X/DEQ = 63.99995)

M	R	ANGLE	U	DENSITY	TEMP.	U/UREF	TURB.INT.	R/DEQ
1	.00005	0.00	474.5[illegible]	.0017583	701.27	.21573	.08242	.00064
2	.04667	0.00	469.72	.0017601	7[illegible].58	.21356	.08109	.64000
3	.09333	0.00	455.47	.0017665	698.44	.20708	.07720	1.28000
4	.14000	0.00	432.79	.0017745	694.9[illegible]	.19677	.07119	1.92000
5	.18667	0.00	402.88	.0017872	689.95	.18317	.06377	2.56000
6	.23333	0.00	367.44	.0018037	683.64	.16706	.05599	3.20000
7	.28000	0.00	328.34	.0018239	676.36	.14928	.04928	3.84000
8	.32667	0.00	287.48	.0018476	667.39	.13071	.04473	4.48000
9	.37333	0.00	246.62	.0018745	657.82	.11213	.04208	5.12000
10	.42000	0.00	207.33	.0019039	647.65	.09426	.04001	5.76000
11	.46667	0.00	170.82	.0019353	637.15	.07766	.03750	6.40000
12	.51333	0.00	137.95	.0019678	626.63	.06272	.03426	7.03999
13	.56000	0.00	109.22	.0020007	616.34	.04966	.03041	7.67999
14	.60667	0.00	84.77	.0020331	606.5[illegible]	.03854	.02621	8.31999
15	.65333	0.00	64.52	.0020645	597.29	.02933	.02197	8.95999
16	.70000	0.00	48.15	.0020941	588.82	.02189	.01791	9.59999
17	.74667	0.00	35.23	.0021217	581.17	.01602	.01423	10.23999

CIRCUMFERENTIALLY-AVERAGED PARAMETERS

NO.	RADIUS	MACH NO.	TEMP.	INTENSITY	FREQUENCY
1	.[illegible]	.424	1.2987	.10796E+08	0.
2	.6406	.4197	1.2974	.21987E+09	45.
3	1.2[illegible]	.4070	1.2934	.31172E+09	88.
4	1.[illegible]	.3867	1.2869	.26523E+09	126.
5	2.56[illegible]	.3549	1.2777	.16353E+09	157.
6	3.[illegible]	.3283	1.266[illegible]	.62295E+08	181.
7	3.84[illegible]	.2937	1.252	.40375E+08	197.
8	4.4[illegible]	.2568	1.2359	.23990E+08	204.
9	5.12[illegible]	.2222	1.2182	.17821E+08	203.
10	5.76[illegible]	.1851	1.1994	.14079E+08	195.
11	6.4[illegible]	.1529	1.1799	.59452E+07	182.
12	7.[illegible]	.1231	1.1614	.58110E+07	164.
13	7.68[illegible]	.0974	1.1414	.27496F+07	145.
14	8.32[illegible]	.0755	1.1232	.10540E+07	124.
15	8.96[illegible]	.0574	1.1061	.32955E+06	103.
16	9.6[illegible]	.0428	1.0904	.84690E+05	84.
17	10.24[illegible]	.0312	1.0763	.18014E+05	66.

X(19)=	4.6667	URI(19)=	.421[illegible]8E+17	FM(19)=	.1815E+02	UAVG(19)=	244.56	UMAX(19)=	474.50
X(20)=	5.8796	URI(20)=	.1[illegible]4[illegible]7E+17	FM(20)=	.2238E+02	UAVG(20)=	197.74	UMAX(20)=	375.14
X(21)=	7.4079	URI(21)=	.23617E+16	FM(21)=	.2746E+02	UAVG(21)=	160.31	UMAX(21)=	295.51
X(22)=	9.3333	URI(22)=	.5[illegible]788E+15	FM(22)=	.3491E+02	UAVG(22)=	126.19	UMAX(22)=	232.49
X(23)=	11.7593	URI(23)=	.1[illegible]568E+15	FM(23)=	.4246E+02	UAVG(23)=	102.85	UMAX(23)=	182.92
X(24)=	14.8157	URI(24)=	.21549E+14	FM(24)=	.5098E+02	UAVG(24)=	84.39	UMAX(24)=	144.02

*** SOUND PRESSURE LEVEL DIRECTIVITY ***

JET MACH NO. = 1.6662 JET DENSITY RATIO = .4356

JET VELOCITY = 2199.16 JET EQUIV. DIAM. = .6729

9.0 FT. ARC

ANGLE = FREQ.	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0	130.0	140.0	150.0	160.0	PWL
100	73.4	73.7	74.1	74.7	75.5	75.4	77.6	[illegible]	[illegible]	83.1	85.6	88.6	92.7	97.6	102.1	119.6
125	76.0	76.3	76.8	77.4	78.2	79.1	80.3	[illegible]	[illegible]	[illegible]	88.3	91.4	95.7	100.6	104.9	122.5
160	78.5	78.8	79.4	80.0	80.9	81.9	83.2	[illegible]	[illegible]	[illegible]	91.2	94.4	99.0	103.7	107.8	125.4
200	80.4	80.8	81.4	82.1	83.1	84.2	85.5	[illegible]	[illegible]	91.1	93.6	97.6	101.7	106.3	110.1	127.9
250	82.1	82.5	83.1	83.9	85.0	86.2	87.6	[illegible]	91.1	93.3	95.0	99.5	104.4	108.8	112.2	130.2
315	83.7	84.2	84.8	85.6	86.7	87.9	89.4	91.2	93.2	95.5	98.2	102.0	107.0	111.1	114.1	132.4
400	85.4	85.9	86.5	87.3	88.3	89.6	91.1	[illegible]	96.1	97.5	100.3	104.4	109.4	113.3	115.9	134.5
500	86.7	87.2	87.9	[illegible]	89.8	91.3	92.6	[illegible]	96.7	[illegible]	102.1	106.5	111.4	115.1	117.4	136.2
630	87.4	88.3	89.0	[illegible]	91.1	92.5	94.1	[illegible]	[illegible]	[illegible]	103.7	108.4	113.2	116.6	118.5	137.7
800	89.2	89.4	90.0	91.0	[illegible]	93.6	95.3	[illegible]	[illegible]	[illegible]	105.2	110.0	114.7	117.7	119.3	138.8
1000	90.2	90.4	91.0	91.8	93.0	94.4	96.2	[illegible]	[illegible]	[illegible]	106.5	111.3	115.6	118.3	119.5	139.5
1250	91.6	91.9	92.3	92.9	93.9	95.2	96.4	[illegible]	[illegible]	[illegible]	107.6	112.4	116.1	118.3	119.2	139.7
1600	93.9	94.1	94.3	94.7	95.2	96.2	97.6	[illegible]	[illegible]	105.2	109.7	113.4	116.4	117.9	118.2	139.7
2000	96.1	96.3	96.4	96.7	97.0	97.6	[illegible]	[illegible]	[illegible]	[illegible]	109.3	114.1	116.6	117.4	117.4	139.6
2500	98.1	98.3	98.5	98.8	99.1	99.5	[illegible]	101.1	[illegible]	[illegible]	109.8	114.5	116.8	117.3	117.3	139.9
3150	99.5	99.9	100.2	100.7	101.1	101.6	102.9	[illegible]	[illegible]	[illegible]	110.3	[illegible]	117.4	118.6	117.8	140.5
4000	100.5	100.9	101.4	102.0	102.8	103.5	104.1	[illegible]	[illegible]	[illegible]	111.6	116.0	118.6	119.2	118.4	141.6
5000	101.4	101.6	102.1	102.8	103.7	104.7	105.7	[illegible]	[illegible]	[illegible]	112.2	117.3	120.2	120.3	118.6	142.8
6300	103.6	103.3	103.2	103.5	104.3	105.4	106.7	[illegible]	[illegible]	[illegible]	113.9	119.0	121.8	121.1	118.4	144.1
8000	108.4	107.4	106.2	105.3	105.1	105.9	107.3	[illegible]	111.3	111.0	115.8	120.7	123.2	121.4	117.7	145.3
10000	114.5	113.2	111.4	[illegible]	107.5	[illegible]	107.6	[illegible]	111.2	112.4	117.2	122.0	124.1	121.2	116.7	146.4
12500	113.8	114.0	114.3	114.7	112.2	109.4	[illegible]	[illegible]	111.5	[illegible]	118.1	[illegible]	124.4	120.5	115.4	147.2
16000	112.5	112.7	113.0	113.4	114.0	114.7	111.2	[illegible]	111.5	[illegible]	118.3	[illegible]	124.1	119.2	113.8	147.3
20000	111.3	111.5	111.8	112.2	112.7	113.4	114.3	111.7	111.1	113.5	117.7	122.5	123.2	117.8	112.4	147.0
25000	110.0	110.2	110.5	110.9	111.4	112.1	[illegible]	114.2	111.6	112.7	117.0	121.5	122.0	116.3	111.2	146.4
31500	108.5	108.7	109.0	109.3	109.9	110.5	111.4	112.5	114.2	111.4	115.5	119.9	120.4	114.7	110.1	145.5
40000	106.7	106.9	107.2	107.6	108.1	108.7	109.5	[illegible]	112.2	111.8	113.0	117.7	118.4	112.9	109.9	144.3
50000	104.8	105.0	105.2	105.6	106.1	106.8	107.6	108.6	[illegible]	111.7	110.6	115.2	116.3	110.9	107.3	143.3
63000	102.3	102.5	102.8	103.2	103.7	104.3	[illegible]	106.1	[illegible]	[illegible]	107.9	112.0	113.6	108.0	105.0	142.0
80000	99.2	99.4	99.7	100.1	100.6	101.2	102.0	103.0	104.3	105.6	108.2	107.6	109.9	104.0	101.1	141.0
OVERALL	121.0	120.8	120.7	120.9	120.7	121.0	121.1	121.5	122.3	123.3	127.2	131.9	133.6	131.8	130.6	157.2
PNL	126.2	125.6	124.8	124.3	124.9	125.7	126.7	128.0	129.3	130.6	134.8	139.7	142.6	143.0	142.6	
PNLT	129.6	128.9	128.1	127.7	128.2	129.0	130.1	131.3	132.6	134.0	138.2	143.0	146.0	146.3	145.9	

4.8 PROGRAM SOURCE CODE LISTING

This section contains the FORTRAN IV source code listing for the aeroacoustic prediction model, suitable for running on the CDC 7600 computer. The listing of subroutines is in alphabetical order, as follows:

1. MAIN Program (MGB)
2. ARRCCOS
3. ATMOS
4. CRD
5. ERF
6. LSPFIT
7. OUTPUT
9. PNLC
9. SHOCK
10. SLICE
11. TPNLC

```
PROGRAM MGB        76/76    OPT=1                            FTN 4.5+410           10/10/77  14.30.05

      PROGRAM MGB(INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT)                     MGB        2
CM*G*B       MANI*GLIEBE*BALSA JET NOISE PREDICTION                          MGB        3
C            HIGH VELOCITY SUPPRESSOR NOZZLE JET NOISE                       MGB        4
C                                                                            MGB        5
C     GENERAL ELECTRIC COMPANY - AIRCRAFT ENGINE GROUP                       MGB        6
C     PROGRAM NO. J2851M    --  SEPTEMBER 1977                               MGB        7
C                                                                            MGB        8
C        BASED ON JET NOISE THEORY DUE TO R. MANI(C.R.+D.C.)                 MGB        9
C        AERODYNAMIC FLOW FIELD PREDICTION  DUE TO R. KENDALL                MGB       10
C        ACOUSTIC SOURCE INTENSITY SPECTRUM MODEL DUE TO P. GLIEBE           MGB       11
C        ACOUSTIC  PROPAGATION MODEL DUE TO T. BALSA (C.R.+D.C.)             MGB       12
C        PROGRAM WRITTEN BY P. GLIEBE                                        MGB       13
C                                                                            MGB       14
C     ** PROGRAM REVISED 10/20/76 TO REFLECT MODIFICATIONS DEVELOPED         MGB       15
C        ON CDC VERSION AT C.R.+D.C. AUG.-OCT.,1976 **                       MGB       16
C                                                                            MGB       17
C                                                                            MGB       18
      COMMON/NOIS/ALFA,BETA,AK,BK,DIA,ASR,AL,NUMANG,DIST                     MGB       19
      COMMON/AERO/SUF,FIRSTU,KX,KA,CM,CG,RHOE,ATOTAL,RJET,NPRINT,NPR         MGB       20
     1,UM,RHOM,ALPHMC,BETAMC,NN                                              MGB       21
      COMMON/PROFL/ UR(200),TAUR(200),RHOR(200),SIGR(200)                    MGB       22
     1,DRDR(200),D2RDR2(200),DUDR(200)                                       MGB       23
      COMMON/FARFLD/ SSTN(34),OBSTN(34),FO(34),SPLO(34),RADIUS(19),          MGB       24
     1THETA(19),THETD(19),DSPL(19,34),SPL(19,34),PWL(34),OASPL(19)           MGB       25
     2,FMIN,FMAX                                                             MGB       26
      COMMON/SHLD/ G2(200),RIN(200),MACH(200),TEMP(200),PSIG(19,5),          MGB       27
     1TERM(200),SHIFLD(200),MCIN(200),THE,CT,NTP,NP,ALPHT(19),ITH            MGB       28
      COMMON/AREA/X(24),UMAX(24),UAVG(24),FM(24),UBI(24)                     MGB       29
      COMMON/SHKDTA/PT,PS,UE,AC,DEC,DS,UEST,GAM,NCELL                        MGB       30
C                                                                            MGB       31
      DIMENSION       DSIG(24),XE(110),ALPO(110),LEAV(110),NUM(110),         MGB       32
     1KN(110),DALP(40,110),PA(40,110),PT(110),TT(110),TE(110),PU2E(110),     MGB       33
     2UE(110),EF(110),ACH(110),IDENT(10),RMIN(24),NOV(24)                    MGB       34
     3,RCBDY(40),XCBDY(40),AAA(200),BETAIN(24),DELTIN(24)                    MGB       35
     4,AMUIN(24),DS(110),DEG(110),NCELL(110)                                 MGB       36
      INTEGER FO,FMIN,FMAX                                                   MGB       37
C                                                                            MGB       38
      DATA FO/50,63,80,100,125,160,200,250,315,400,500,630,800,1000,         MGB       39
     11250,1600,2000,2500,3150,4000,5000,6300,8000,10000,12500,16000,        MGB       40
     220000,25000,31500,40000,50000,63000,80000,100000/                      MGB       41
      DATA ALPHT/19*0.5/, BETAIN/24*4.0/, DELTIN/24*4.0/, AMUIN/24*0.2/      MGB       42
C                                                                            MGB       43
C                                                                            MGB       44
```

```
      NAMELIST/INPUT/      KX,KEST,LPHI,ISYM,NOV,CM,CH,GAM,CP,DTHM,RU2M,  MGB
     1PS,K,DSIG,XE,ALPO,LEAV,NUM,KN,DALP,RA,PT,                            MGB
     2TT,IQUIT,ALFA,AK,BK,ATOTAL,DEG,NN,NUMANG,DIST,                       MGB
     3NCASE,DE,NBREF,CMMC,CMVR,RMIN,NPRINT,STPFX,                          MGB
     4STPFR,NCBDY,RCBDY,XCBDY,ALPHT,BETAIN,DELTIN,                         MGB
     5AMUIN,FMIN,FMAX,ALPHMC,BETAMC,DS,NCELL                               MGB
C                                                                          MGB
C     INITIALIZE                                                           MGB
C                                                                          MGB
      NN=0                                                                 MGB
      KX=15                                                                MGB
      IQUIT=50                                                             MGB
      NPRINT=1                                                             MGB
      LPHI=9999                                                            MGB
      NCASE=1                                                              MGB
      KNCAS=0                                                              MGB
      NPAGE=0                                                              MGB
      NBREF=2                                                              MGB
      FMIN=50                                                              MGB
      FMAX=100000                                                          MGB
      PI=3.1415927                                                         MGB
      PI2=6.2831853                                                        MGB
      ROOT2=SQRT(2.)                                                       MGB
      DTHM=0.1                                                             MGB
      RU2M=3.0                                                             MGB
      CM=0.075                                                             MGB
      CH=1.150                                                             MGB
      CMVR=0.25                                                            MGB
      CMMC=0.08                                                            MGB
      STPFX=1.259921                                                       MGB
      STPFR=.01                                                            MGB
      ALPHMC=0.5                                                           MGB
      BETAMC=0.325                                                         MGB
      ALFA=1.0                                                             MGB
      AK   =0.08                                                           MGB
      BK   =0.0                                                            MGB
C                                                                          MGB
    1 KNCAS=KNCAS+1                                                        MGB
      READ(5,554)  (IDENT(K),K=1,8)                                        MGB
      READ(5,INPUT)                                                        MGB
      NPAGE=NPAGE +1                                                       MGB
      IT=1                                                                 MGB
      WRITE(6,500) NPAGE,KNCAS,(IDENT(K),K=1,8 )                           MGB
C                                                                          MGB
C     WRITE  INPUT DATA                                                    MGB
C                                                                          MGB
```

```
      IF(CP.LE.0.) CP=1716.*GAM/(GAM-1.)
      WRITE(6,502)
      WRITE(6,504)KX,NEST,LPHI,ISYM,NPRINT,CM,CH,GAM,CP,
     1OTHM,PU2M,PS
      IF(X(1).LE.0.0) X(1)=DEG(1)
      IF(DSIG(1).LE.0.0) DSIG(1)=STREF*X(1)
      DO 20 KA=2,KX
      IF(X(KA).LE.0.) X(KA)=STREX*X(KA-1)
      IF(DSIG(KA).LE.0.) DSIG(KA)=STREF*X(KA)
   20 CONTINUE
      IF(NCRDY.LE.0) GO TO 15
      CALL LSPFIT(XCRDY,RCRDY,NCRDY,X,RMIN,KX,0, AAA)
   15 CONTINUE
      WRITE(6,506)
      WRITE(6,508)(I,X(I),DSIG(I),RMIN(I),NOV(I),RETAIN(I),DELTIN(I),
     1AMUIN(I),I=1,KX)
C
      GAMA=GAM-1.0
      PGC=CP*GAMA/GAM
C
      LINE=30+KX
      N=1
      DO 100 K=2,NEST
      WRITE(6,510)K,XE(K),K,ALPO(K),K,LEAV(K),
     1K,NUM(K),K,KN(K)
      NUMK=NUM(K)
      WRITE(6,512)(N,K,DALP(N,K),N,K,RA(N,K),N=1,NUMK)
      LINE=LINE+NUMK
      IF(LINE.LT.50) GO TO 100
      IF(K.GE.NEST) GO TO 100
      NPAGE=NPAGE +1
      WRITE(6,500) NPAGE,KNCAS,(IDENT(N),N=1,8 )
      LINE=4
  100 CONTINUE
C
      DO 200 K=1,NEST
      ACH2=2.0*((PT(K    )/PS)**(1.0-1.0/GAM)-1.0)/GAMA
      TE(K)=TT(K)/(1.0+.5*GAMA*ACH2)
      SV2  =GAM*PGC*TE(K)
      PU2E(K)=ACH2*GAM*PS
      UE(K)=0.0
      FF(K)=0.0
      IF(ACH2.EQ.0.0) GO TO 200
      UE(K)=SQRT(ACH2*SV2)
      FF(K)=PU2E(K)*CP*(TT(K)-TT(1))/UE(K)
```

```
      IF(ACH2.GT.0.0) GO TO 200
      WRITE(6,516)   ACH2
      STOP
  200 ACH(K)=SQRT(ACH2)
      UREF=UE(NBREF)
      RU2REF=RU2E(NBREF)
      FIRSTU=UE(1)
      SUE=UREF
      TAA=TE(1)
      PAA=PS
      RHOE=PAA/(1716.0*TAA)
      CO=SQRT(1716.0*GAM*TAA)
      AO=CO
      AL=RHOE*(SUE/CO)**5*SUE**3*ATOTAL
      ASP=PS*GAM*GAM*RGC*SQRT(GAM*RGC*TE(1))*TE(1)
      RJET=TAA/TE(NBREF)
      DIA=DEQ(1)
      DJET=DIA
      UJET=SUE-FIRSTU
      EMACH=UJET/CO
      UNITS=478.8*478.8*.25E8*RHOE*CO
C
C     WRITE  EXIT CONDITIONS
C
      NPAGE=NPAGE +1
      WRITE(6,500) NPAGE,KNCAS,(IDENT(K),K=1,8 )
      WRITE(6,518)
      WRITE(6,520)(K,PT(K),TT(K),TE(K),UF(K),ACH(K),RU2E(K),EF(K),
     1K=1,NEST)
      WRITE(6,540) NBREF
C
C     WRITE ADDITIONAL INPUT
C
      BETA=BETAIN(1)
      AMULT=AMUIN(1)
      WRITE(6,522) AL,ALFA,AK,PK,ATOTAL,DIA,IQUIT,NN,UREF
      WRITE(6,548) STRFX,STREP
      WRITE(6,550) ALPHMC,BETAMC
      WRITE(6,542) CMMC,CMVR
C
C
C     BEGINNING OF X LOOP ( KA = INDEX ON X )
C
      NPR=NPRINT
      IF(NPRINT.LE.0) WRITE(6,552)
```

```
      DO 2000 KA=1,KX                                                  MGB  181
      NPR=NPR+1                                                        MGB  182
      LINE = 60                                                        MGB  183
      SIG=.001*DSIG(KA)                                                MGB  184
      RUG=SIG                                                          MGB  185
      SIG=SIG+RMIN(KA)                                                 MGB  186
      SRU2M=0.0                                                        MGB  187
      SRUM=0.0                                                         MGB  188
      SURM=0.0                                                         MGB  189
      TSTO=0.0                                                         MGB  190
      UMAX(KA)=0.0                                                     MGB  191
      XND=X(KA)/DIA                                                    MGB  192
      DX=X(KA)*(STREX-1.0)/(STREX+1.0)                                 MGB  193
      BETA=BETAIN(KA)                                                  MGB  194
      DELTA=DELTIN(KA)                                                 MGB  195
      AMULT=AMUIN(KA)                                                  MGB  196
C                                                                      MGB  197
C                                                                      MGB  198
C     INTEGRATION WITH RESPECT TO RADIUS ( M=INDEX ON R)               MGB  199
C                                                                      MGB  200
      DO 1500 M=1,IQUIT                                                MGB  201
      TSTHL=0.0                                                        MGB  202
      SRU2 =0.0                                                        MGB  203
      SRU =0.0                                                         MGB  204
      SUB =0.0                                                         MGB  205
      SDU=0.0                                                          MGB  206
      SEFE=0.0                                                         MGB  207
C                                                                      MGB  208
      GO TO(104,106),IT                                                MGB  209
  104 IS=(44*(M-1))/(7*LPHI)+3                                         MGB  210
      IF(LPHI.GT.500) IS=1                                             MGB  211
  106 DPHI=LPHI*IS                                                     MGB  212
      DPHI=PI2/DPHI                                                    MGB  213
      ISSY=IS+1-ISYM                                                   MGB  214
      PHI=0.0                                                          MGB  215
C                                                                      MGB  216
C                                                                      MGB  217
C     INTEGRATION WITH RESPECT TO ANGLE ( I = INDEX ON PHI )           MGB  218
C                                                                      MGB  219
      DO 1200 I=1,ISSY                                                 MGB  220
      PHID=180.*PHI/PI                                                 MGB  221
      RU2 =RU2F(1)                                                     MGB  222
      EFF =0.0                                                         MGB  223
      STR =0.0                                                         MGB  224
      STC =0.0                                                         MGB  225
      STX=0.0                                                          MGB  226
      TAU =0.0                                                         MGB  227
      UB  =0.0                                                         MGB  228
      RU=0.0                                                           MGB  229
```

```
      DU=0.0
C
C
C     INITIALIZATION AND BOUNDARY INTEGRATION ( K = INDEX ON BOUNDARY )
C
      DO 1100 K=2,NEST
      NODE=2
      SIC=0.0
      SIP=0.0
      SIX=0.0
      VI=0.0
      TI=0.0
      NUMK=NUM(K)
      LEAF=LEAV(K)
      KNK=KN(K)
      IMH=1
      IF(X(KA).LE.XE(K)) GO TO 1100
      IF((UE(K).EQ.0.0).AND.(UE(KNK).EQ.0.0)) GO TO 1100
      VMAX=AMAX1(UE(K),UE(KNK))
      VMIN=AMIN1(UE(K),UE(KNK))
      VR=VMIN/VMAX
      CVR=1./(1.+CMVR*VR)
      CMC=1.+CMMC*ACH(K)
      DBDX=CM*CVR/CMC
      DHDX=CH*DBDX
      IF(DHDX.EQ.DBDX) IMH=2
      CMX=DBDX*(X(KA)-XE(K))
      CHX=DHDX*(X(KA)-XE(K))
      PHAL=PHI-ALPO(K)
  560 ARPA=ABS(PHAL)
      IF(ARPA.LE.PI)GO TO 575
      PHAL=PHAL-SIGN(PI2,PHAL)
      GO TO 560
C
  575 COSPA=COS(ARPA)
      DELSIG=SIG
      DELRA=RA(NUMK,K)
      IF(NCBDY.LE.0) GO TO 605
      CALL LSPFIT(XCBDY,RCBDY,NCBDY,XE(K),RMINEX,1,0,AAA)
      RMNSQE=RMINEX*RMINEX
      SIGSQ=SIG*SIG
      RMINSQ=RMIN(KA)*RMIN(KA)
      RASQ=RA(NUMK,K)*RA(NUMK,K)
      DELSIG=SQRT(SIGSQ-RMINSQ)
      DELRA=SQRT(RASQ-RMNSQE)
  605 CONTINUE
```

```
      RADO=SQRT((DELRA-DELSIG)*(DELRA-DELSIG)                       MGB 276
     1+2.0*DELRA*DELSIG*(1.0-COSPA))                                MGB 277
C                                                                   MGB 278
      IF(RADO.GT.(.0005*DELSIG)) GO TO 600                          MGB 279
      NODE=1                                                        MGB 280
      GO TO 650                                                     MGB 281
  600 COSTO=(DELSIG-DELRA*COSPA)/RADO                               MGB 282
C                                                                   MGB 283
      IF(ABS(COSTO).LT.1.0)GO TO 610                                MGB 284
      THO=(PI-SIGN(PI,COSTO))/2.0                                   MGB 285
      SINTO=0.0                                                     MGB 286
      GO TO 620                                                     MGB 287
C                                                                   MGB 288
  610 SINTO=SIGN(SQRT(1.0-COSTO*COSTO),PHAL)                        MGB 289
      THO=PI-SIGN(PI-ARCCOS(COSTO),PHAL)                            MGB 290
C                                                                   MGB 291
  620 RADX=RADO/CMX                                                 MGB 292
      POWER=RADX*RADX                                               MGB 293
      IF(POWER.GT.25.0) GO TO 625                                   MGB 294
      VAO=1.0-EXP(-POWER)                                           MGB 295
      GO TO(630,640),IMH                                            MGB 296
  630 TAO=1.0-EXP(-(RADO/CHX)*(RADO/CHX))                           MGB 297
  640 SA=DBDX*(0.88623*ERF(RADX)+RADX*(VAO-1.0))                    MGB 298
      SARO=SA*COSTO                                                 MGB 299
      SACO=SA*SINTO                                                 MGB 300
      SAXO=((DBDX*RADX)**2)*(1.-VAO)                                MGB 301
      GO TO 635                                                     MGB 302
  625 CONTINUE                                                      MGB 303
      VAO=1.0                                                       MGB 304
      TAO=1.0                                                       MGB 305
      SA =0.88623*DBDX                                              MGB 306
      SARO=SA*COSTO                                                 MGB 307
      SACO=SA*SINTO                                                 MGB 308
      SAXO=0.0                                                      MGB 309
  635 CONTINUE                                                      MGB 310
C                                                                   MGB 311
C     LEAF INTEGRATION                                              MGB 312
C     J = LEAF NUMBER OF BOUNDARY K                                 MGB 313
C     N = POINT NUMBER OF BOUNDARY K                                MGB 314
C                                                                   MGB 315
  650 DO 1000 J=1,LEAF                                              MGB 316
      DO 1000 N=1,NUMK                                              MGB 317
      PHAL=PHAL-DALP(N,K)                                           MGB 318
  660 ABPA=ABS(PHAL)                                                MGB 319
      IF(ABPA.LE.PI)GO TO 670                                       MGB 320
      PHAL=PHAL-SIGN(PI2,PHAL)                                      MGB 321
      GO TO 660                                                     MGB 322
C                                                                   MGB 323
  670 COSPA=COS(ABPA)                                               MGB 324
      DELRA=RA(N,K)                                                 MGB 325
```

```
      IF(NCHDY.GT.0) DELRA=SQRT(RA(N,K)*RA(N,K)-RMNSQE)                 MGB 326
      RAD =SQRT((DELRA-DELSIG)*(DELRA-DELSIG)                           MGB 327
     1+2.0*DELRA*DELSIG*(1.0-COSPA))                                    MGB 328
      IF(RAD.GT.(.0005*DELSIG)) GO TO 680                               MGB 329
      NODE=1                                                            MGB 330
      GO TO 900                                                         MGB 331
C                                                                       MGB 332
  680 COST=(DELSIG-DELRA*COSPA)/RAD                                     MGB 333
      IF(ABS(COST).LT.1.0)GO TO 690                                     MGB 334
      TH=(PI-SIGN(PI,COST))/2.0                                         MGB 335
      SINT=0.0                                                          MGB 336
      GO TO 710                                                         MGB 337
C                                                                       MGB 338
  690 SINT=SIGN(SQRT(1.0-COST*COST),PHAL)                               MGB 339
      TH=PI-SIGN(PI-ARCCOS(COST),PHAL)                                  MGB 340
      GO TO(700,710),NODE                                               MGB 341
  700 NODE=2                                                            MGB 342
      DTH=0.0                                                           MGB 343
      GO TO 800                                                         MGB 344
C                                                                       MGB 345
  710 DTH=TH-THO                                                        MGB 346
      ABDTH=ABS(DTH)                                                    MGB 347
      IF(ABDTH.LE.DTHM) GO TO 800                                       MGB 348
      IF(ABDTH.LE.PI)GO TO 730                                          MGB 349
C                                                                       MGB 350
C     CORRECTION--0-360                                                 MGB 351
C                                                                       MGB 352
  720 THO=THO+SIGN(PI2,DTH)                                             MGB 353
      GO TO 710                                                         MGB 354
C                                                                       MGB 355
C     INITIATION OF AUXILIARY INTEGRATION                               MGB 356
C                                                                       MGB 357
  730 LQ=ABDTH/DTHM+1.0                                                 MGB 358
      Q=LQ                                                              MGB 359
      DTH=DTH/Q                                                         MGB 360
      RCRC=RADO*COSTO-RAD*COST                                          MGB 361
      RCRC=RCRC+SIGN(.00000001,RCRC)                                    MGB 362
      ABLE=(RADO*SINTO-RAD*SINT)/RCRC                                   MGB 363
      BKP=RADO*SINTO-ABLE*RADO*COSTO                                    MGB 364
C                                                                       MGB 365
C     AUXILIARY INTEGRATION                                             MGB 366
C                                                                       MGB 367
      DO 790 L=1,LQ                                                     MGB 368
      TH=THO+DTH                                                        MGB 369
      COST=COS(TH)                                                      MGB 370
```

```
      SINT=SIN(TH)                                                      MGB  371
      RAD=RRR/(SINT-ABLE*COST)                                          MGB  372
      RADX=RAD/CMX                                                      MGB  373
      POWER=RADX*RADX                                                   MGB  374
      IF(POWER.GT.25.0) GO TO 725                                       MGB  375
      VA =1.0-EXP(-POWER)                                               MGB  376
      SA=DRDX*(0.88623*ERF(RADX)+RADX*(VA-1.0))                         MGB  377
      SAR=SA*COST                                                       MGB  378
      SAC=SA*SINT                                                       MGB  379
      SAX=((DRDX*RADX)**2)*(1.-VA)                                      MGB  380
      GO TO 735                                                         MGB  381
  725 CONTINUE                                                          MGB  382
      VA=1.0                                                            MGB  383
      TA=1.0                                                            MGB  384
      SA=0.88623*DRDX                                                   MGB  385
      SAR=SA*COST                                                       MGB  386
      SAC=SA*SINT                                                       MGB  387
      SAX=0.0                                                           MGB  388
  735 CONTINUE                                                          MGB  389
      VI=VI+(VA+VAO)*DTH                                                MGB  390
      SIR=SIR+(SAR+SARO)*DTH                                            MGB  391
      SIC=SIC+(SAC+SACO)*DTH                                            MGB  392
      SIX=SIX+(SAX+SAXO)*DTH                                            MGB  393
      GO TO(740,750),IMH                                                MGB  394
C                                                                       MGB  395
  740 CONTINUE                                                          MGB  396
      IF(POWER.GT.25.0) GO TO 745                                       MGB  397
      TA=-EXP(-(RAD/CHX)*(RAD/CHX))+1.0                                 MGB  398
  745 CONTINUE                                                          MGB  399
      TI=TI+(TA+TAO)*DTH                                                MGB  400
      TAO=TA                                                            MGB  401
C                                                                       MGB  402
  750 VAO=VA                                                            MGB  403
      SACO=SAC                                                          MGB  404
      SARO=SAR                                                          MGB  405
      SAXO=SAX                                                          MGB  406
      THO=TH                                                            MGB  407
  790 CONTINUE                                                          MGB  408
      GO TO 900                                                         MGB  409
C                                                                       MGB  410
C     MAIN LINE INTEGRATION                                             MGB  411
C                                                                       MGB  412
  800 RADX=RAD/CMX                                                      MGB  413
      POWER=RADX*RADX                                                   MGB  414
      IF(POWER.GT.25.0) GO TO 825                                       MGB  415
```

```
      VA =1.0-EXP(-POWER)                                               MGB 416
      SA=DRDX*(0.88623*ERF(RADX)+RADX*(VA-1.0))                         MGB 417
      SAR=SA*COST                                                       MGB 418
      SAC=SA*SINT                                                       MGB 419
      SAX=((DRDX*RADX)**2)*(1.-VA)                                      MGB 420
      GO TO 835                                                         MGB 421
  825 CONTINUE                                                          MGB 422
      VA=1.0                                                            MGB 423
      TA=1.0                                                            MGB 424
      SA=0.88623*DRDX                                                   MGB 425
      SAR=SA*COST                                                       MGB 426
      SAC=SA*SINT                                                       MGB 427
      SAX=0.0                                                           MGB 428
  835 CONTINUE                                                          MGB 429
      VI=VI+(VA+VAO)*DTH                                                MGB 430
      SIR=SIR+(SAR+SARO)*DTH                                            MGB 431
      SIC=SIC+(SAC+SACO)*DTH                                            MGB 432
      SIX=SIX+(SAX+SAXO)*DTH                                            MGB 433
      GO TO(810,820),IMH                                                MGB 434
C                                                                       MGB 435
  810 CONTINUE                                                          MGB 436
      IF(POWER.GT.25.0) GO TO 845                                       MGB 437
      TA=-EXP(-(RAD/CHX)*(RAD/CHX))+1.0                                 MGB 438
  845 CONTINUE                                                          MGB 439
      TI=TI+(TA+TAO)*DTH                                                MGB 440
      TAO=TA                                                            MGB 441
C                                                                       MGB 442
  820 VAO=VA                                                            MGB 443
      SACO=SAC                                                          MGB 444
      SARO=SAR                                                          MGB 445
      SAXO=SAX                                                          MGB 446
      THO=TH                                                            MGB 447
  900 RADO=RAD                                                          MGB 448
      COSTO=COST                                                        MGB 449
      SINTO=SINT                                                        MGB 450
 1000 CONTINUE                                                          MGB 451
C                                                                       MGB 452
C     NEST SUMMATIONS                                                   MGB 453
C                                                                       MGB 454
      GO TO(1020,1010),IMH                                              MGB 455
 1010 TI=VI                                                             MGB 456
 1020 CONTINUE                                                          MGB 457
C                                                                       MGB 458
 1050 UGLY=.07957747*(RU2E(K)-RU2E(KNK))                                MGB 459
      EFE =.07957747*(EF(K)-EF(KNK))*TI+EFE                             MGB 460
 1060 RU2=UGLY*VI+RU2                                                   MGB 461
      UGLY=.07957747*(UE(K)**2-UE(KNK)**2)                              MGB 462
```

```
      STC=UGLY*SIC+STC                                                  MGB  463
      STR=UGLY*SIR+STR                                                  MGB  464
      STX=10.0*UGLY*SIX+STX                                             MGB  465
 1100 CONTINUE                                                          MGB  466
C                                                                       MGB  467
C     FINAL CALCULATIONS                                                MGB  468
C                                                                       MGB  469
      IF(RU2.GT.0.0) GO TO 1110                                         MGB  470
C                                                                       MGB  471
      U=0.0                                                             MGB  472
      RHO=RHOE                                                          MGB  473
      T=TT(1  )                                                         MGB  474
      UND=0.0                                                           MGB  475
      TURBIN=0.0                                                        MGB  476
      RU2=0.0                                                           MGB  477
      RU =0.0                                                           MGB  478
      TAU=0.0                                                           MGB  479
      DU =0.0                                                           MGB  480
      UB =0.0                                                           MGB  481
      FFE=0.0                                                           MGB  482
      IF(NPRINT.LE.0) GO TO 1116                                        MGB  483
      IF(NPR.LT.NPRINT) GO TO 1116                                      MGB  484
      GO TO 1117                                                        MGB  485
C                                                                       MGB  486
 1110 RMP=RU2*PGC/PS                                                    MGB  487
      UAP=SQRT(RMP* TT(    1))                                          MGB  488
      RM=RMP/(2.0*CP)                                                   MGB  489
      HM=FFE*RM/(UAP*RU2)                                               MGB  490
      PSI=RU2/2.0+CP*PS/PGC                                             MGB  491
      HPSI=FFE/(2.0*PSI)                                                MGB  492
      U=HPSI+SQRT(HPSI**2+RU2*CP*TT(1)/PSI)                             MGB  493
      IF(U.GT.UMAX(KA)) UMAX(KA)=U                                      MGB  494
C                                                                       MGB  495
 1113 T=U*U/RMP                                                         MGB  496
      TAU=SQRT(STR*STR + DELTA*STC*STC + BETA*STX*STX)                  MGB  497
      ACHM=U/SQRT(GAM*PGC*T)                                            MGB  498
      RU=RU2/U                                                          MGB  499
      RHO=RU/U                                                          MGB  500
C                                                                       MGB  501
      UB=TAU**3.5                                                       MGB  502
      DU=SQRT(STR*STR+AMULT*STC*STC)                                    MGB  503
C                                                                       MGB  504
      IF(NPRINT.LE.0) GO TO 1116                                        MGB  505
      IF(NPR.LT.NPRINT) GO TO 1116                                      MGB  506
      UND=U/UREF                                                        MGB  507
      TURBIN=SQRT( TAU )/UREF                                           MGB  508
 1117 CONTINUE                                                          MGB  509
      RND=SIG/DIA                                                       MGB  510
 1115 LINE=LINE+1                                                       MGB  511
      IF(LINE.LE.55) GO TO 1120                                         MGB  512
      NPAGE=NPAGE +1                                                    MGB  513
      WRITE(6,500) NPAGE,KNCAS,(IDENT(K),K=1,8 )                        MGB  514
```

```
      WRITE(6,534) X(KA),XND                                            MGB
      LINE=8                                                            MGB
 1120 CONTINUE                                                          MGB
      WRITE(6,536) M,SIG,PHID,I,RHO,T,UND,TURBIN,RND                    MGB
 1116 CONTINUE                                                          MGB
      IF(I.GT.1)GO TO 1130                                              MGB
C                                                                       MGB
      TSTH=RU2-RU2E(1)                                                  MGB
      TSTL=TSTH                                                         MGB
      GO TO 1140                                                        MGB
 1130 TSTH=MAX1(TSTH,(RU2-RU2E(1)))                                     MGB
      TSTL=MIN1(TSTL,(RU2-RU2F(1)))                                     MGB
      IF(I.NE.ISSY)GO TO1145                                            MGB
 1140 IF(ISYM.EQ.1)GO TO1145                                            MGB
C                                                                       MGB
      SUB=SUB+UB/2.0                                                    MGB
      SRU=SRU+RU/2.0                                                    MGB
      SRU2=SRU2+RU2/2.0                                                 MGB
      SDU=SDU+DU/2.0                                                    MGB
      SEFF=SEFF+EFF/2.0                                                 MGB
      GO TO 1150                                                        MGB
C                                                                       MGB
 1145 CONTINUE                                                          MGB
      SRU=SRU+RU                                                        MGB
      SUB=SUB+UB                                                        MGB
      SRU2=SRU2+RU2                                                     MGB
      SDU=SDU+DU                                                        MGB
      SEFE=SEFE+EFE                                                     MGB
 1150 CONTINUE                                                          MGB
C                                                                       MGB
      PHI=PHI+DPHI                                                      MGB
 1200 CONTINUE                                                          MGB
      FIS=IS                                                            MGB
      TSTD=MAX1(TSTD,ABS(TSTH-TSTL))                                    MGB
      SUBM=SUB/FIS*SIG+SUBM                                             MGB
      SRUM=SRU/FIS*SIG+SRUM                                             MGB
      SRU2M=SRU2/FIS*SIG+SRU2M                                          MGB
      TAUR(M)=(SUB/FIS)**0.2857143                                      MGB
      DUDR(M)=SDU/FIS                                                   MGB
      IF(SRU.LE.0.0) GO TO 1210                                         MGB
      IF(SRU2.LE.0.0) GO TO 1210                                        MGB
      UR(M)=SRU2/SRU                                                    MGB
      HTR=SFFE/SRU                                                      MGB
      TTR=HTR/CP+TT(1)                                                  MGB
      TSR=TTR-0.5*UR(M)*UR(M)/CP                                        MGB
      RHOR(M)=PS/(RGC*TSR)                                              MGB
```

AD-A094 298 GENERAL ELECTRIC CO CINCINNATI OH AIRCRAFT ENGINE GROUP F/G 20/1
HIGH VELOCITY JET NOISE SOURCE LOCATION AND REDUCTION. TASK 6. --ETC(U)
MAR 79 P R GLIEBE, R E MOTSINGER, A SIECKMAN DOT-OS-30034
UNCLASSIFIED R79AEG290 FAA-RD-76-79-6A NL

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      GO TO 1220
 1210 CONTINUE
      UR(M)=0.0
      RHOR(M)=RHOE
      TAUR(M)=0.0
      DUDR(M)=0.0
 1220 CONTINUE
      SIGR(M)=SIG
      TSTHL=AMAX1(TSTHL,ABS(TSTH),ABS(TSTL))
      IF(M.LE.NOV(KA)) GO TO 1260
      IF(TSTHL.LE.RU2M)GO TO 1510
 1260 SIG=SIG+DSIG(KA)-BUG
      BUG=0.0
 1500 CONTINUE
 1510 IF(TSTD.GT.2.0*RU2M)GO TO 1600
      IT=2
      IS=1
      IF(TSTD.GT.RU2M)GO TO 1600
      ISYM=1
 1600 CONTINUE
C
C
      CALL LSPFIT(SIGR,RHOR,M,SIGR,DRDP,M,1,D2RDR2)
      CMX=CM*X(KA)
      DO 1605 IR=1,M
      IF(UR(IR).LE.0.0) GO TO 1605
      DUDR(IR)=DUDR(IR)/(UR(IR)*CM*CMX)
 1605 CONTINUE
      FM  (KA)=PI2*SRUM*DSIG(KA)*32.17405
      UAVG(KA)=SRU2M/SRUM
      UBI (KA)=PI2*SUBM*DSIG(KA)*UMAX(KA)/X(KA)
      IF(NN.EQ.4) GO TO 1800
      CALL SLICE(X(KA),DSIG(KA),DX,M)
 1800 CONTINUE
      WRITE(6,524)
      WRITE(6,526) KA,X(KA),KA,UBI(KA),KA,FM(KA),KA,UAVG(KA),KA,UMAX(KA)
      IF(NPR.GE.NPRINT) NPR=0
 2000 CONTINUE
C
      IF(NN.EQ.4) GO TO 4000
      CALL OUTPUT(EMACH,DJET,RJET,UJET,UNITS)
 4000 CONTINUE
      IF(KNCAS.LT.NCASE) GO TO 1
      STOP
C
C     FORMAT SECTION
C
```

```
  500 FORMAT(1H1,10X,21H* * *  M  G  R  * * *,20X,4HPAGEI4///5X,61HCOMPU MGB
     1TATION OF AERO-ACOUSTIC PROPERTIES OF SUPPRESSOR NOZZLES///2X,     MGB
     228HCASF NO.I5,5X,8A10//)                                            MGB
  502 FORMAT(1H0,40X,10HINPUT DATA//)                                    MGB
  504 FORMAT(            9H0      KX=I3,13H         NEST=I3,12H      LPHI= MGB
     1I5,12H         ISYM=I2,14H         NPRINT=I3,  11H         CM=F6.3// MGB
     2          9H      CH=F6.3,9H      GAM=F6.3,8H      CP=F7.1,10H     DTH MGB
     3M=F7.4,10H     RU2M=F7.4,8H      PS=F7.1/)                         MGB
  506 FORMAT(1H0,//15X,82HCOMPUTATION MESH CONTROL PARAMETERS............ MGB
     1............./  TURBULENCE CONSTANTS//15X,9HSLICE NO.,5X,1HX,14X,  MGB
     224HDSIG,11X,4HRMIN,09X,3HNOV,6X,4HBETA,5X,5HDELTA,6X,2HMU//)       MGB
  508 FORMAT(I20,3F15.5,I10,3F10.2)                                      MGB
  510 FORMAT(13H0            XE(I2,2H)=F8.2,                    7H  ALPO MGB
     1(I2,2H)=F7.4,     7H  LEAV(I2,2H)=I3, 7H   NUM(I2,2H)=I3,7H     KN(I MGB
     22,2H)=I3)                                                          MGB
  512 FORMAT(23H0                    DALP(I2,1H,I2,2H)=F7.4,7H    RA(I2,1H, MGB
     1I2,2H)=F7.4,7H  DALP(I2,1H,I2,2H)=F7.4,7H    RA(I2,1H,I2,2H)=F7.4) MGB
  516 FORMAT(//80H**** ERROR - MACH NO. SQUARE IS NOT GREATER THAN ZERO  MGB
     1- CASE WILL TERMINATE ****)                                        MGB
  518 FORMAT(1H0,35X,15HEXIT CONDITIONS//3X,4HCON-,2X,5HTOTAL,6X,5HTOTAL MGB
     1,5X,6HSTATIC,2X,8HVELOCITY,5X,4HMACH,5X,8HMOMENTUM,6X,8HENTHALPY/  MGB
     23X,4HTOUR,2X,6HPRESS.,5X,5HTEMP.,5X,5HTEMP.,4X,5H(FPS),6X,6HNUMBER MGB
     3,6X,4HFLUX,10X,4HFLUX/9X,5H(PSF),5X,7H(DEG R),3X,7H(DEG R),23X,    MGB
     410H(LB/SQ-FT),4X,10H(LB/SQ-FT)//)                                  MGB
  520 FORMAT(I6,4F10.2,F10.4,2E14.5)                                     MGB
  522 FORMAT(1H0, 5X,5H AL =F11.5,  5X,6HALFA =F10.5,                    MGB
     15X,4HAK =E12.5,5X,4HBK =E12.5// 6X,7HATOTAL=F 9.5,5X,6HDEQ  =F10.5 MGB
     2,  5X,6HIQUIT=I5, 5X,4HNN =I3,    5X,6HUREF =F10.2)                MGB
  524 FORMAT(1H )                                                        MGB
  526 FORMAT(3H X(I2,2H)=F9.4,6H  UBI(I2,2H)=E11.5,5H  FM(I2,2H)=E10.4,  MGB
     17H  UAVG(I2,2H)=F8.2,7H  UMAX(I2,2H)=F8.2)                         MGB
  528 FORMAT(6E12.5)                                                     MGB
  534 FORMAT(17H AXIAL LOCATION =F10.5,11H  (X/DEQ = F10.5,1H)//        MGB
     13X,1HM,5X,1HR,7X,5HANGLE,5X,1HU,7X,7HDENSITY,6X,5HTEMP.,3X6HU/UREF MGB
     2,2X,9HTURB.INT,2X,5HR/DEQ//)                                       MGB
  536 FORMAT(I4,F10.5,F8.2,F9.2,F12.7,F10.2,3F9.5)                       MGB
  540 FORMAT(1H0,//12HBOUNDARY NO. I05,38H  HAS BEEN DESIGNATED AS THE R MGB
     1EFERENCE//)                                                        MGB
  542 FORMAT(1H0, 5X,5HCMMC=F11.6,05X,5HCMVR=F11.6//)                    MGB
  548 FORMAT(1H0, 5X,6HSTRFX=F10.5,5X,6HSTRFR=F10.5  )                   MGB
  550 FORMAT(1H0,5X,7HALPHMC=F9.4,5X,7HBETAMC=F9.4)                      MGB
  552 FORMAT(1H1)                                                        MGB
  554 FORMAT(8A10)                                                       MGB
      END                                                                MGB
```

```
FUNCTION ARCCOS      76/76    OPT=1                          FTN 4.5+410        10/10/77  14.30.05$

          CARCCOS     ARC COSINE  (PRINCIPAL VALUE)                              ARCCOS      2
                FUNCTION ARCCOS(X)                                                ARCCOS      3
                IF(X.GT.0.0) GO TO 5                                              ARCCOS      4
                IF(X.LT.0.0) GO TO 10                                             ARCCOS      5
                ARCCOS = 1.5707963                                                ARCCOS      6
                GO TO 15                                                          ARCCOS      7
              5 ARCCOS = ATAN(SQRT(1.-X**2)/X)                                    ARCCOS      8
                GO TO 15                                                          ARCCOS      9
             10 ARCCOS = ATAN(SQRT(1.-X**2)/X)+3.1415927                          ARCCOS     10
             15 RETURN                                                            ARCCOS     11
                END                                                               ARCCOS     12


SUBROUTINE ATMOS      76/76    OPT=1                          FTN 4.5+410        10/10/77  14.30.05$

          C             ATMOSPHERIC ATTENUATION SUBROUTINE                       ATMOS       2
          C                                                                      ATMOS       3
          C                                                                      ATMOS       4
          C     ATMOSPHERIC AIR ATTENUATION CORRECTIONS FOR STANDARD DAY         ATMOS       5
          C     (59 DEG. F AND 70 PCT. REL. HUM.)  FROM SAE ARP 866 (1964)       ATMOS       6
          C     ARE ADDED TO LOSSLESS SPECTRA                                    ATMOS       7
          C                                                                      ATMOS       8
          C                                                                      ATMOS       9
                SUBROUTINE ATMOS(SPL,RADIUS)                                     ATMOS      10
          C                                                                      ATMOS      11
          C                                                                      ATMOS      12
                DIMENSION SPL(19,34),RADIUS(19),AA(34)                           ATMOS      13
                DATA AA/.07,.09,.11,.14,.18,.23,.29,.36,.45,.58,.72,.92,         ATMOS      14
               11.17,1.47,1.85,2.39,3.03,3.97,5.47,7.73,9.03,12.87,18.76,26.97,  ATMOS      15
               238.98,58.67,84.58,121.56,175.77,256.39,363.19,519.95,752.16,     ATMOS      16
               31015.82/                                                         ATMOS      17
          C                                                                      ATMOS      18
          C                                                                      ATMOS      19
                DO 1 I=1,19                                                      ATMOS      20
                DO 1 J=1,34                                                      ATMOS      21
                IF(SPL(I,J).LE.0.0 ) GO TO 1                                     ATMOS      22
                SPL(I,J)=SPL(I,J)-RADIUS(I)*AA(J)/1000.0                         ATMOS      23
              1 CONTINUE                                                         ATMOS      24
                RETURN                                                           ATMOS      25
                END                                                              ATMOS      26
```

```
              SURROUTINE CRD                                                  CRD       2
        *                                                                     CRD       3
        *                                                                     CRD       4
              COMMON/SHLD/ G2(200),RIN(200),MACH(200),TEMP(200),RSIG(19,5),   CRD       5
             1TERM(200),SHIELD(200),MCIN(200),THE,CT,NTP,NR,ALPHT(19),ITH     CRD       6
              REAL MACH,MCIN,MC,KIN,K,M0                                      CRD       7
        *                                                                     CRD       8
        *     CALCULATION OF DIRECTIVITY                                      CRD       9
        *                                                                     CRD      10
        *                                                                     CRD      11
              PI=3.1415926                                                    CRD      12
              PIO2=PI/2.                                                      CRD      13
              DO 11 IR=1,NR                                                   CRD      14
              R0=RIN(IR)                                                      CRD      15
              MC=MCIN(IR)                                                     CRD      16
              SHIELD(IR)=0.0                                                  CRD      17
        **********                                                            CRD      18
              IF(THE.GT.PIO2 ) GO TO 260                                      CRD      19
        **********                                                            CRD      20
        *                                                                     CRD      21
        *     FINDING RELATIONSHIP BETWEEN R0 AND TURNING PTS.                CRD      22
        *                                                                     CRD      23
              IF(NTP.EQ.0) GO TO 260                                          CRD      24
              IF(NTP.EQ.1) GO TO 230                                          CRD      25
              IF(NTP.EQ.2) GO TO 250                                          CRD      26
              RSIG(ITH,1)=RSIG(ITH,NTP-1)                                     CRD      27
              RSIG(ITH,2)=RSIG(ITH,NTP)                                       CRD      28
              NTP=2                                                           CRD      29
              GO TO 250                                                       CRD      30
        230   CONTINUE                                                        CRD      31
        *                                                                     CRD      32
        *     ONE TURNING POINT                                               CRD      33
        *                                                                     CRD      34
              RSIG1=RSIG(ITH,1)                                               CRD      35
              IF(R0.GE.RSIG1) GO TO 260                                       CRD      36
              R1=R0                                                           CRD      37
              R2=RSIG1                                                        CRD      38
              GO TO 261                                                       CRD      39
        250   CONTINUE                                                        CRD      40
        *                                                                     CRD      41
        *     TWO TURNING POINTS                                              CRD      42
        *                                                                     CRD      43
              RSIG1=RSIG(ITH,1)                                               CRD      44
              RSIG2=RSIG(ITH,2)                                               CRD      45
```

```
      IF(R0.GE.RSIG2) GO TO 260                                        CRD  46
      IF(R0.LE.RSIG1) GO TO 262                                        CRD  47
      R1=R0                                                            CRD  48
      R2=RSIG2                                                         CRD  49
      GO TO 261                                                        CRD  50
  262 CONTINUE                                                         CRD  51
      R1=RSIG1                                                         CRD  52
      R2=RSIG2                                                         CRD  53
  261 CONTINUE                                                         CRD  54
*                                                                      CRD  55
*     CALCULATION OF EXP. SHIELDING                                    CRD  56
*                                                                      CRD  57
*     FINDING INTERVAL INTO WHICH R1 AND R2 FALL                       CRD  58
*                                                                      CRD  59
      DO 265 J=1,NR                                                    CRD  60
      IF(RIN(J).GT.R1) GO TO 266                                       CRD  61
  265 CONTINUE                                                         CRD  62
  266 CONTINUE                                                         CRD  63
      J1=J                                                             CRD  64
      J11=J1-1                                                         CRD  65
      DO 267 J=1,NR                                                    CRD  66
      IF(RIN(J).GT.R2) GO TO 268                                       CRD  67
  267 CONTINUE                                                         CRD  68
  268 CONTINUE                                                         CRD  69
      J2=J                                                             CRD  70
      J21=J2-1                                                         CRD  71
*                                                                      CRD  72
*     EVALUATION OF INTEGRAL OF G                                      CRD  73
*                                                                      CRD  74
      IF(J1.EQ.J2) GO TO 269                                           CRD  75
      IF(J1.EQ.J21) GO TO 270                                          CRD  76
      J211=J21-1                                                       CRD  77
      SUM=0.                                                           CRD  78
      DO 281 J=J1,J211                                                 CRD  79
      GM=.5*(SQRT(ABS(G2(J)))+SQRT(ABS(G2(J+1))))                      CRD  80
      SUM=SUM+GM*(RIN(J+1)-RIN(J))                                     CRD  81
  281 CONTINUE                                                         CRD  82
      GO TO 284                                                        CRD  83
  269 CONTINUE                                                         CRD  84
*                                                                      CRD  85
*     J1=J2                                                            CRD  86
*                                                                      CRD  87
      SGN1=1.                                                          CRD  88
      SGN2=1.                                                          CRD  89
      IF(G2(J11).LT.0.) SGN1=-1.                                       CRD  90
      IF(G2(J1).LT.0.) SGN2=-1.                                        CRD  91
      SG1=SQRT(ABS(G2(J11)))*SGN1                                      CRD  92
      SG2=SQRT(ABS(G2(J1)))*SGN2                                       CRD  93
```

```
      SLOPE=(SG2-SG1)/(RIN(J1)-RIN(J11))                                CRD  94
      SUM=SG1*R2+SLOPE*(.5*R2**2-RIN(J11)*R2)                           CRD  95
     A-SG1*R1-SLOPE*(.5*R1**2-RIN(J11)*R1)                              CRD  96
      SUM=-SUM                                                          CRD  97
      GO TO 280                                                         CRD  98
  279 CONTINUE                                                          CRD  99
      SUM=0.                                                            CRD 100
  284 CONTINUE                                                          CRD 101
*                                                                       CRD 102
*     CALCULATION OF END CONTRIBUTIONS                                  CRD 103
*                                                                       CRD 104
      SGN1=1.                                                           CRD 105
      SGN2=1.                                                           CRD 106
      IF(G2(J11).LT.0.) SGN1=-1.                                        CRD 107
      IF(G2(J1).LT.0.) SGN2=-1.                                         CRD 108
      SG1=SQRT(ABS(G2(J11)))*SGN1                                       CRD 109
      SG2=SQRT(ABS(G2(J1)))*SGN2                                        CRD 110
      SLOPE=(SG2-SG1)/(RIN(J1)-RIN(J11))                                CRD 111
      SUM1=SG1*RIN(J1)+SLOPE*(.5*RIN(J1)**2                             CRD 112
     A-RIN(J11)*RIN(J1))-SG1*R1                                         CRD 113
     B-SLOPE*(.5*R1**2-RIN(J11)*R1)                                     CRD 114
      SUM1=-SUM1                                                        CRD 115
      SGN1=1.                                                           CRD 116
      SGN2=1.                                                           CRD 117
      IF(G2(J21).LT.0.) SGN1=-1.                                        CRD 118
      IF(G2(J2).LT.0.) SGN2=-1.                                         CRD 119
      SG1=SQRT(ABS(G2(J21)))*SGN1                                       CRD 120
      SG2=SQRT(ABS(G2(J2)))*SGN2                                        CRD 121
      SLOPE=(SG2-SG1)/(RIN(J2)-RIN(J21))                                CRD 122
      SUM2=SG1*R2+SLOPE*(.5*R2**2                                       CRD 123
     A-RIN(J21)*R2)-SG1*RIN(J21)                                        CRD 124
     B-SLOPE*(.5*RIN(J21)**2-RIN(J21)*RIN(J21))                         CRD 125
      SUM2=-SUM2                                                        CRD 126
      SUM=SUM1+SUM2+SUM                                                 CRD 127
  283 CONTINUE                                                          CRD 128
      SHIELD(IR)=SUM                                                    CRD 129
  260 CONTINUE                                                          CRD 130
*                                                                       CRD 131
*     CALCULATION OF UNSHIELDED SOLUTION                                CRD 132
*                                                                       CRD 133
      GOSQ=ABS(G2(IR))                                                  CRD 134
      IF(G2(IR).LT.0.0) GOSQ=0.0                                        CRD 135
      T0=TEMP(IR)                                                       CRD 136
      TERM(IR)=(CT*CT+GOSQ)**2/T0                                       CRD 137
   79 CONTINUE                                                          CRD 138
   11 CONTINUE                                                          CRD 139
      RETURN                                                            CRD 140
      END                                                               CRD 141
```

```
FUNCTION ERF          76/76    OPT=1                        FTN 4.5+410        10/10/77  14.30.05$

      CERF          ERROR FUNCTION APPROXIMATION                              ERF         2
            FUNCTION ERF(X)                                                   ERF         3
            SIGN=1.0                                                          ERF         4
            IF(X.LT.0.0) SIGN=-1.0                                            ERF         5
            IF(ABS(X).GT.5.0) GO TO 50                                        ERF         6
            T=1.0/(1.0+0.47047*ABS(X))                                        ERF         7
            ERF=1.0-(0.3480242*T-0.0958798*T*T+0.7478556*T*T*T)*EXP(-X*X)     ERF         8
            ERF=ERF*SIGN                                                      ERF         9
        100 RETURN                                                            ERF        10
         50 ERF=SIGN                                                          ERF        11
            GO TO 100                                                         ERF        12
            END                                                               ERF        13
```

```
SUBROUTINE LSPFIT     76/76    OPT=1                        FTN 4.5+410        10/10/77  14.30.05$

      *LSPFIT     INTEGRATE OR INTERPOLATE                                    LSPFIT      2
      C                                                                       LSPFIT      3
      C     INTEGRATE OR INTERPOLATE USING A PARABOLA WHICH PASSED THROUGH THE LSPFIT     4
      C     AND (I+1) POINTS BUT MISSES THE (I-1) AND (I+2) POINTS (IF THEY 90 LSPFIT     5
      C     EXIST) SUCH THAT THE SQUARE OF THE DEVIATION IS A MINIMUM.  NOTE  LSPFIT      6
      C     THAT  I  IS GENERALLY SELECTED SUCH THAT                          LSPFIT      7
      C              X(I).LE.XC.LT.X(I+1)                                     LSPFIT      8
      C     THE EQUATION FOR THE PARABOLA IS                                  LSPFIT      9
      C              Y-Y(I) = B*(X-X(I)) + C*(X-X(I))**2                      LSPFIT     10
                                                                              LSPFIT     11
            SUBROUTINE LSPFIT(X,Y,NPTS,XC,YC,NXC,ND,AAA)                      LSPFIT     12
            DIMENSION AAA(100)                                                LSPFIT     13
            DIMENSION X(10),Y(10), XC(10),YC(10)                              LSPFIT     14
      C      NOTE. THE DIMENSION #10# DOES NOT NEED TO AGREE WITH THE CALLING LSPFIT     15
                                                                              LSPFIT     16
      C    INPUT-                                                             LSPFIT     17
      C     X, Y     PTS. ON CURVE                                            LSPFIT     18
      C     NPTS     NO. OF X                                                 LSPFIT     19
      C     XC       LIST OF X AT WHICH CALC TO BE DONE                       LSPFIT     20
      C     YC(1)    INTEGRATION CONSTANT IF   ND=-1                          LSPFIT     21
      C     NXC      NO. OF XC                                                LSPFIT     22
      C     ND       =0 TO GET COORD.  =1 TO GET 1ST DERIVATIVE.              LSPFIT     23
      C              =-1 FOR INTEGRATION                                      LSPFIT     24
                                                                              LSPFIT     25
```

```
C     OUTPUT                                                              LSPFIT    26
C      YC       COORDINATE OR DERIVATIVE AT XC     OP                     LSPFIT    27
C               YC(IC)= INTEGRAL(Y*DX) FROM XC(1) TO XC(IC) WHERE IC=2,NXC LSPFIT   28
                                                                          LSPFIT    29
C     NOTES-                                                              LSPFIT    30
C      ≠X≠ MAY BE IN EITHER ASCENDING OR DESCENDING ORDER.                LSPFIT    31
C      FOR INTEGRATION ≠XC≠ MUST BE IN THE SAME ORDER AS ≠X≠.  FOR INTERP LSPFIT    32
C         NO SPECIAL ORDER IS REQUIRED.                                   LSPFIT    33
                                                                          LSPFIT    34
       COMMON /CLSPF / I                                                  LSPFIT    35
                                                                          LSPFIT    36
       LOGICAL WITHIN                                                     LSPFIT    37
                                                                          LSPFIT    38
       N      = NPTS-1                                                    LSPFIT    39
       I      = MAX0(1,MIN0(I,N))                                         LSPFIT    40
       IF(ND.EQ.(-1)) I=1                                                 LSPFIT    41
       ISAVE = 0                                                          LSPFIT    42
       SGN    = SIGN(1.,X(N+1)-X(1))                                      LSPFIT    43
                                                                          LSPFIT    44
C     BEGIN INTERPOLATION LOOP FOR XC(IC)   IC=1,NXC                      LSPFIT    45
       IC     = 1                                                         LSPFIT    46
                                                                          LSPFIT    47
C     LOCATE APPROPRIATE INTERVAL                                         LSPFIT    48
  100 WITHIN= .FALSE.                                                     LSPFIT    49
       NCOUNT= N                                                          LSPFIT    50
  102 IF(NCOUNT) 119,103,103                                              LSPFIT    51
  103 NCOUNT= NCOUNT-1                                                    LSPFIT    52
                                                                          LSPFIT    53
       XI     = X(I)                                                      LSPFIT    54
       XD     = XC(IC)-XI                                                 LSPFIT    55
       IF(N) 104,120,104                                                  LSPFIT    56
  104 IF(SGN*XD) 105,107,110                                              LSPFIT    57
                                                                          LSPFIT    58
C       F.LT.0. (F IS THE FRACTIONAL POSITION IN THE INTERVAL)            LSPFIT    59
  105 IF(I.EQ.1)      GO TO 120                                           LSPFIT    60
       IF(ND.EQ.(-1)) GO TO 119                                           LSPFIT    61
       I     = I-1                                                        LSPFIT    62
       GO TO 102                                                          LSPFIT    63
                                                                          LSPFIT    64
C       F.EQ.0                                                            LSPFIT    65
  107 IF(X(I+1).NE.XI) GO TO 120                                          LSPFIT    66
       GO TO 116                                                          LSPFIT    67
                                                                          LSPFIT    68
C       F.GT.0.                                                           LSPFIT    69
  110 IF(SGN*(XC(IC)-X(I+1))) 120,112,114                                 LSPFIT    70
                                                                          LSPFIT    71
C       F.EQ.1.0.  CHECK FOR INTEGRATION AND DOUBLE POINT BEFORE INCREMEN LSPFIT    72
  112 IF((ND.EQ.(-1)) .OR. (I.NE.N .AND. X(I+1).EQ.X(I+2))) GO TO 120     LSPFIT    73
```

```
C        F.GT.1.0
  114 IF(I.EQ.N) GO TO 120
      IF(ND.EQ.(-1)) GO TO 122
  116 I     = I+1
      GO TO 102

  119 CONTINUE

C     PRELIMINARY CALCULATIONS FOR INTERPOLATION OR INTEGRATION
  120 WITHIN=.TRUE.
  122 IF(I-ISAVE) 124,129,124
  124 ISAVE = I
      YI     = Y(I)
      X3     = X(I+1)-XI
      Y3     = Y(I+1)-YI
      C      = 0.
      TOP    = 0.
      BOT    = 0.
      IF(I.LE.1) GO TO 127
      X1     = X(I-1)-XI
      X13    = X(I-1)-X(I+1)
      TOP    = X1*(Y3*X1-(Y(I-1)-YI)*X3)*X13
      BOT    = X1*X1*X13*X13*X3
  127 IF(I.GE.N .OR. (XD.EQ.0. .AND. BOT.NE.0.)) GO TO 128
      X4     = X(I+2)-XI
      X43    = X(I+2)-X(I+1)
      TOP    = TOP + X4*(Y3*X4-(Y(I+2)-YI)*X3)*X43
      BOT    = BOT + X4*X4*X43*X43*X3
  128 IF(BOT.NE.0.) C = -TOP/BOT
      B      = 0.
      IF(N.GT.0 .AND. X3.NE.0.) B = (Y(I+1)-YI)/X3 - C*X3
  129 IF(ND) 130,140,141

C     ND=-1. INTEGRATE
  130 IF(.NOT.WITHIN) XD=X3
      S1     = (YI + (B/2. + C/3.*XD)*XD)*XD
      IF(WITHIN) GO TO 135
C     ≠I≠ IS BEING INCREMENTED TO FIND APPROPRIATE INTERVAL.  HENCE.
C       CUMULATE THE INTEGRAL OF THE ITH INTERVAL.
      SA    = SA + S1
      GO TO 116
C     APPROPRIATE INTERVAL FOUND.   X(I)-XC(IC)-X(I+1)
  135 IF(IC.EQ.1) SA=YC(IC)-S1
      IF(IC.NE.1) YC(IC)=SA+S1
      GO TO 150
```

```
C     ND=0.  INTERPOLATE FOR COORDINATES                                LSPFIT   121
  140 YC(IC)= YI + (B + C*XD)*XD                                        LSPFIT   122
      GO TO 150                                                         LSPFIT   123
                                                                        LSPFIT   124
C     ND=1.  FIRST DERIVATIVE                                           LSPFIT   125
  141 YC(IC)= B + 2.*C*XD                                               LSPFIT   126
      GO TO 150                                                         LSPFIT   127
                                                                        LSPFIT   128
  150 IC     = IC+1                                                     LSPFIT   129
      AAA(IC-1)=2.*C                                                    LSPFIT   130
      IF(NXC-IC) 900,160,160                                            LSPFIT   131
  160 IF(ND.NE.(-1).AND.XC(IC).EQ.XC(IC-1)) I=I+1                       LSPFIT   132
      GO TO 100                                                         LSPFIT   133
                                                                        LSPFIT   134
  900 RETURN                                                            LSPFIT   135
      END                                                               LSPFIT   136
```

SUBROUTINE OUTPUT   76/76   OPT=1   FTN 4.5+410   10/10/77 14.30.05$

```
      SUBROUTINE OUTPUT(EMACH,DJET,RJET,UJET,UNITS)                     OUTPUT     2
      COMMON/NOIS/ALFA,BETA,AK,BK,DIA,ASR,AL,NUMANG,DIST                OUTPUT     3
      COMMON/FARFLD/ SSTN(34),OBSTN(34),FO(34),SPLO(34),RADIUS(19),     OUTPUT     4
     1THETA(19),THETD(19),DSPL(19,34),SPL(19,34),PWL(34),OASPL(19)      OUTPUT     5
     2,FMIN,FMAX                                                        OUTPUT     6
      DIMENSION AAA(19)                                                 OUTPUT     7
      DIMENSION TSPL(33,19),PNL(19),PNLT(19)                            OUTPUT     8
      INTEGER FO,FMIN,FMAX                                              OUTPUT     9
C                                                                       OUTPUT    10
C                                                                       OUTPUT    11
      PI=3.1415926                                                      OUTPUT    12
      DELTH=PI/18.                                                      OUTPUT    13
      DO 34 J=1,34                                                      OUTPUT    14
      IF(FO(J).LE.FMIN) JMIN=J                                          OUTPUT    15
      IF(FO(J).LE.FMAX) JMAX=J                                          OUTPUT    16
      OBSTN(J)=FLOAT(FO(J))*DJET/UJET                                   OUTPUT    17
   34 CONTINUE                                                          OUTPUT    18
C                                                                       OUTPUT    19
C                                                                       OUTPUT    20
C       CONVERSION FROM NARROW-BAND TO 1/3-OCTAVE                       OUTPUT    21
C                                                                       OUTPUT    22
      DO 5 I=1,15                                                       OUTPUT    23
      COEF=UNITS*AK/(2.0*PI*ASR*RADIUS(I )**2)                          OUTPUT    24
      DO 5 J=JMIN,JMAX                                                  OUTPUT    25
```

```
      IF(DSPL(I,J).LE.0.0) GO TO 7
      IF(OBSTN(J).GT.30.0) GO TO 7
      SPL(I,J)=10.*ALOG10(COFF*DSPL(I,J))
      RFO=FLOAT(FO(J))
      SPL(I,J)=SPL(I,J)+10.*ALOG10(RFO)-6.3536
      GO TO 5
    7 CONTINUE
      SPL(I,J)=0.0
    5 CONTINUE
C
      CALL SHOCK
C
C     OVERALL POWER LEVEL CALCULATION
C
      SUM=0.0
      DO 70 J=JMIN,JMAX
      IF(OBSTN(J).GT.30.0) GO TO 70
      PWR=0.0
      DO 60 I=1,15
      PSQ=10.**(SPL(I,J)/10.)
      PWR=PWR+PSQ*(RADIUS(I)**2)*SIN(THETA(I))
   60 CONTINUE
      PWR=2.0*PI/UNITS*DELTH*PWR
      PWL(J)=130.+10.*ALOG10(1.3558*PWR)
      SUM=SUM+PWR
   70 CONTINUE
      OAPWL=130.0+10.*ALOG10(1.3558*SUM)
      CALL ATMOS(SPL,RADIUS)
C
C     COMPUTE PNL AND PNLT
C
      DO 55 I=1,19
      DO 54 J=1,33
       TSPL(J,I)=SPL(I,J)
   54  CONTINUE
       CALL PNLC(TSPL(1,I),.15,PNL(I),OASPL(I))
       CALL TPNLC(TSPL(1,I),PNLT(I))
       PNLT(I)=PNLT(I)+PNL(I)
   55  CONTINUE
C
C      OVERALL SOUND PRESSURE LEVEL CALCULATION
C
       DO 80 I=1,15
       SUM=0.0
       DO 90 J=JMIN,JMAX
       IF(OBSTN(J).GT.30.0) GO TO 90
       SUM=SUM+10.**(SPL(I,J)/10.)
   90  CONTINUE
       OASPL(I)=10.*ALOG10(SUM)
   80  CONTINUE
```

```
C                                                                       OUTPUT  76
C     PRINT OBSERVED SOUND PRESSURE LEVEL SPECTRA                       OUTPUT  77
C                                                                       OUTPUT  78
      WRITE(6,100) EMACH,RJET,UJET,DJET                                 OUTPUT  79
      IF(NUMANG.LE.1) WRITE(6,114) RADIUS(8)                            OUTPUT  80
      IF(NUMANG.GE.2) WRITE(6,116) RADIUS(8)                            OUTPUT  81
      WRITE(6,106)(THETD(I),I=1,15)                                     OUTPUT  82
      DO 40 J=JMIN,JMAX                                                 OUTPUT  83
      IF(OBSTN(J).GT.30.0) GO TO 40                                     OUTPUT  84
      WRITE(6,110) FO(J),(SPL(I,J),I=1,15),PWL(J)                       OUTPUT  85
   40 CONTINUE                                                          OUTPUT  86
      WRITE(6,112)(OASPL(I),I=1,15),OAPWL                               OUTPUT  87
      WRITE(6,128) (PNL(I),I=1,15)                                      OUTPUT  88
      WRITE(6,130) (PNLT(I),I=1,15)                                     OUTPUT  89
      RETURN                                                            OUTPUT  90
C                                                                       OUTPUT  91
C     FORMAT SECTION                                                    OUTPUT  92
C                                                                       OUTPUT  93
  100 FORMAT(1H1//20X,40H*** SOUND PRESSURE LEVEL DIRECTIVITY ***//     OUTPUT  94
     110X,15HJET MACH NO. = F10.4,5X,20HJET DENSITY RATIO = F10.4//     OUTPUT  95
     210X,15HJET VELOCITY = F10.2,5X,20HJET EQUIV. DIAM.  = F10.4//)    OUTPUT  96
  106 FORMAT(1H0,7HANGLE =15F7.1,3X,3HPWL/8H   FREQ.)                   OUTPUT  97
  110 FORMAT(I8,16F7.1)                                                 OUTPUT  98
  112 FORMAT(8H0OVERALL,16F7.1)                                         OUTPUT  99
  114 FORMAT(1H0,30X,F10.1,2X,7HFT. ARC//)                              OUTPUT 100
  116 FORMAT(1H0,27X,F10.1,2X,12HFT. SIDELINE//)                        OUTPUT 101
  128 FORMAT (8H0  PNL  ,15F7.1)                                        OUTPUT 102
  130 FORMAT (8H0  PNLT ,15F7.1)                                        OUTPUT 103
      END                                                               OUTPUT 104
```

```
*PNLC        CALCULATION OF PNDB,OASPL,PT. CORR.,TPNL
      SUBROUTINE PNLC(SS,FAC,PNDB,OASPL)
      REAL MAXNOY,NOY
      DIMENSION PC(9,24),SS(24)

*     DATA FROM SAE ARP 865A (1969 REVISION)

      DATA  ((PC(I,J),I=1,9),J=1,12)/
     149.,0.079520,55.,0.058098,64.,0.043478,91.01,0.030103,52.,
     144.,0.068160,51.,0.058098,60.,0.040570,85.88,0.030103,51.,
     139.,0.068160,46.,0.052288,56.,0.036831,87.32,0.030103,49.,
     134.,0.059640,42.,0.047534,53.,0.036831,79.85,0.030103,47.,
     130.,0.053013,39.,0.043573,51.,0.035336,79.76,0.030103,46.,
     127.,0.053013,36.,0.043573,48.,0.033333,75.96,0.030103,45.,
     124.,0.053013,33.,0.040221,46.,0.033333,73.96,0.030103,43.,
     121.,0.053013,30.,0.037349,44.,0.032051,74.91,0.030103,42.,
     118.,0.053013,27.,0.034859,42.,0.030675,94.63,0.030103,41.,
     116.,0.053013,25.,0.034859,40.,0.030103,100.00,0.030103,40.,
     116.,0.053013,25.,0.034859,40.,0.030103,100.00,0.030103,40.,
     116.,0.053013,25.,0.034859,40.,0.030103,100.00,0.030103,40./
      DATA  ((PC(I,J),I=1,9),J=13,24)/
     116.,0.053013,25.,0.034859,40.,0.030103,100.00,0.030103,40.,
     116.,0.053013,25.,0.034859,40.,0.030103,100.00,0.030103,40.,
     115.,0.059640,23.,0.034859,38.,0.030103,100.00,0.030103,38.,
     112.,0.053013,21.,0.040221,34.,0.029960,100.00,0.029960,34.,
     19.,0.053013,18.,0.037349,32.,0.029960,100.00,0.029960,32.,
     15.,0.047712,15.,0.034859,30.,0.029960,100.00,0.029960,30.,
     14.,0.047712,14.,0.034859,29.,0.029960,100.00,0.029960,29.,
     15.,0.053013,14.,0.034859,29.,0.029960,100.00,0.029960,29.,
     16.,0.053013,15.,0.034859,30.,0.029960,100.00,0.029960,30.,
     110.,0.068160,17.,0.037349,31.,0.029960,100.00,0.029960,31.,
     117.,0.079520,23.,0.037349,37.,0.042285,44.29,0.029960,34.,
     121.,0.059640,29.,0.043573,41.,0.042285,50.72,0.029960,37./

      SUMSPL=0.
      SUMNOY=0.
      MAXNOY=0.

* FIND MAXIMUM NOY VALUE AND SUM OF NOY VALUES AND SUMSPL

      DO 50 K=1,24
      I=K
      IF(FAC.LT..2) GO TO 10
      I=3*K-1
```

```
      IF(I.GT.23) GO TO 55                                        PNLC   46
   10 EXPSPL=10.**(.1*SS(I))                                      PNLC   47
      SUMSPL=SUMSPL+EXPSPL                                        PNLC   48
      IF(SS(I).GE.PC(7,I)) GO TO 300                              PNLC   49
      IF(SS(I).GE.PC(5,I)) GO TO 280                              PNLC   50
      IF(SS(I).GE.PC(3,I)) GO TO 260                              PNLC   51
      IF(SS(I).GE.PC(1,I)) GO TO 240                              PNLC   52
      NOY=0.                                                      PNLC   53
      GO TO 30                                                    PNLC   54
  240 NOY=.1*10.**(PC(2,I)*(SS(I)-PC(1,I)))                       PNLC   55
      GO TO 30                                                    PNLC   56
  260 NOY=10.**(PC(4,I)*(SS(I)-PC(5,I)))                          PNLC   57
      GO TO 30                                                    PNLC   58
  280 NOY=10.**(PC(6,I)*(SS(I)-PC(5,I)))                          PNLC   59
      GO TO 30                                                    PNLC   60
  300 NOY=10.**(PC(8,I)*(SS(I)-PC(9,I)))                          PNLC   61
   30 SUMNOY=SUMNOY+NOY                                           PNLC   62
      IF(MAXNOY.GT.NOY) GO TO 50                                  PNLC   63
      MAXNOY=NOY                                                  PNLC   64
   50 CONTINUE                                                    PNLC   65
                                                                  PNLC   66
*  CALCULATE OASPL,PNDB,TPNL                                      PNLC   67
                                                                  PNLC   68
   55 OASPL=10.*ALOG10(SUMSPL)                                    PNLC   69
      PNL=MAXNOY+FAC*(SUMNOY-MAXNOY)                              PNLC   70
      IF(PNL.GT..0625) GO TO 60                                   PNLC   71
      PNDB=0.                                                     PNLC   72
      RETURN                                                      PNLC   73
   60 PNDB=40.+33.22*ALOG10(PNL)                                  PNLC   74
      RETURN                                                      PNLC   75
      END                                                         PNLC   76
```

SUBROUTINE SHOCK   76/76   OPT=1   FTN 4.5+410   10/10/77 14.30.05$

```
CSHOCK        EMPIRICAL SHOCK-CELL NOISE CORRELATION                  SHOCK   2
C                                                                     SHOCK   3
C                                                                     SHOCK   4
C     EMPIRICAL SHOCK CELL NOISE PREDICTION BASED ON SNECMA CORRELATION SHOCK   5
C     AND MODIFICATIONS BY GLIEBE (GE TM 76-673)                      SHOCK   6
C                                                                     SHOCK   7
C                                                                     SHOCK   8
      SUBROUTINE SHOCK                                                SHOCK   9
C                                                                     SHOCK  10
```

```
      COMMON/FARFLD/ SSTN(34),OBSTN(34),FO(34),SPLO(34),RADIUS(19),
     1THETA(19),THETD(19),DSPL(19,34),SPL(19,34),PWL(34),OASPL(19)
     2,FMIN,FMAX
      COMMON/SHKDTA/PT,PS,UE,CO,DEQ,DS,NEST,GAM,NCELL
      DIMENSION SSPL(19,34),PT(110),UE(110),DEQ(110),NCELL(110),DS(110)
      REAL MJ,MC,LAVG,L1
      INTEGER FO,FMIN,FMAX
C
C
      IF(NCELL(1).LE.0) RETURN
      DO 2 J=1,34
      IF(FO(J).LE.FMIN) JMIN=J
      IF(FO(J).LE.FMAX) JMAX=J
    2 CONTINUE
C
C     INDEX OVER BOUNDARY NUMBER - NB
C
      GEXP=(GAM-1.0)/GAM
      PRCRIT=(0.5*(GAM+1.0))**(GAM/(GAM-1.0))
C
      DO 1 NB=2,NEST
      N=NCELL(NB)
      IF(N.LE.0) GO TO 1
      PR=PT(NB)/PS
      IF(PR.LE.PRCRIT) GO TO 1
      MJ=SQRT((2.0/(GAM-1.0))*(PR**GEXP-1.0))
      BETA=SQRT(MJ**2-1.0)
      DSPL1=40.0*ALOG10(BETA)
     1 + 10.0*ALOG10(FLOAT(N)/8.0)
     3 + 10.0*ALOG10(DS(NB)/DEQ(NB))
      LAVG=1.1*BETA*DEQ(NB)
      UC=0.7*(UE(NB)-UE(1))
      MC=UC/CO
      VO=UE(1)
C
C     INDEX OVER EACH OBSERVER ANGLE
C
      DO 10 I=1,15
      DO 14 J=JMIN,JMAX
      SSPL(I,J)=0.0
   14 CONTINUE
      THT=0.01745329*THETD(I)
      CTH=COS(THT)
      THCR=3.1415926
      IF(MC.LE.1.0) GO TO 12
      THCR=THCR-ATAN(SQRT(MC**2-1.0))
   12 CONTINUE
      IF(THT.GE.THCR) GO TO 10
```

```
C                                                                       SHOCK
C     COMPUTE PEAK FREQUENCY AND MAXIMUM SPL                            SHOCK
C                                                                       SHOCK
      CONV=1.0+MC*CTH                                                   SHOCK
      FP  =UC/LAVG/CONV/(1.0-VO*CTH/CO)                                 SHOCK
      DSPL2=20.0*ALOG10(DEJ(NH)/RADIUS(I))                              SHOCK
      SPLMAX=151.6+DSPL1+DSPL2                                          SHOCK
     2  - 40.0*ALOG10(1.0-VO*CTH/CO)                                    SHOCK
C                                                                       SHOCK
C     COMPUTE SPECTRA                                                   SHOCK
C                                                                       SHOCK
      DO 16 J=JMIN,JMAX                                                 SHOCK
      FR=FLOAT(FO(J))/FP                                                SHOCK
      IF(FR.GT.1.0) GO TO 18                                            SHOCK
      SSPL(I,J)=SPLMAX+ 70.0*ALOG10(FR)                                 SHOCK
      GO TO 19                                                          SHOCK
   18 CONTINUE                                                          SHOCK
      SSPL(I,J)=SPLMAX-10.0*ALOG10(FR)                                  SHOCK
   19 CONTINUE                                                          SHOCK
   16 CONTINUE                                                          SHOCK
   10 CONTINUE                                                          SHOCK
C                                                                       SHOCK
C     ADD SHOCK NOISE TO TOTAL NOISE                                    SHOCK
C                                                                       SHOCK
      DO 40 I=1,15                                                      SHOCK
      DO 40 J=JMIN,JMAX                                                 SHOCK
      IF(SSPL(I,J).LT.0.0) GO TO 40                                     SHOCK
      PSOM=10.0**(SPL(I,J)/10.0)                                        SHOCK
      PSOS=10.0**(SSPL(I,J)/10.0)                                       SHOCK
      PSOT=PSOM+PSOS                                                    SHOCK
      SPL(I,J)=10.0*ALOG10(PSOT)                                        SHOCK
   40 CONTINUE                                                          SHOCK
    1 CONTINUE                                                          SHOCK
      RETURN                                                            SHOCK
      END                                                               SHOCK
```

```
SUBROUTINE SLICE       76/76    OPT=1                        FTN 4.5+410          10/10/77  14.30.05

      CSLICE       RADIAL PROFILE PARAMETER CALCULATION
      C
            SUBROUTINE SLICE(X,DSIG,DX,M)
      C
            COMMON/NOIS/ALFA,BETA,AK,BK,DEQ,ASP,AL,NUMANG,DIST
            COMMON/AERO/SUE,FIRSTU,KX,KA,CM,CO,RHOE,ATOTAL,HJET,NPRINT,NPR
           1,UM,RHOM,ALPHMC,BETAMC,NN
            COMMON/PROFL/ UE(200),TAUR(200),RHOP(200),SIGR(200)
           1,DRDR(200),D2RDR2(200),DUDR(200)
            COMMON/FARFLD/ SSTN(34),OBSTN(34),FO(34),SPLO(34),RADIUS(19),
           1THETA(19),THETD(19),DSPL(19,34),SPL(19,34),PWL(34),OASPL(19)
           2,FMIN,FMAX
            COMMON/SHLD/ G2(200),KIN(200),MACH(200),TEMP(200),RSIG(19,5),
           1TERM(200),SHIELD(200),MCIN(200),THE,CT,NTP,NR,ALPHT(19),ITH
            DIMENSION DS(200),FS(200),AAA(200)
            REAL MACH,MCIN,MC,KIN,K,MO
            INTEGER FO,FMIN,FMAX
      C
      C
      C     INITIALIZE CONSTANTS AND ARENA GEOMETRY
      C
            IF(KA.GT.1) GO TO 10
            PI=3.1415926
            RAD=PI/180.
            CON1=SQRT(PI/2.0)
            CON2=SQRT(PI)
            CNST=6.2831853
            RHOESQ=RHOE**2
            UJET= SUE-FIRSTU
            EMACH=UJET/CO
            DDTHED=.01
            DTHED=10.0
            DDTHE=DDTHED*RAD
            THETD(1)=20.0
            THETA(1)=160.0*RAD
            DO 11 I=1,15
            IF(I.EQ.1) GO TO 12
            THETD(I)=THETD(I-1)+DTHED
            THETA(I)=RAD*(180.0-THETD(I))
         12 CONTINUE
            DO 11 J=1,34
            DSPL(I,J)=0.0
            SPL(I,J)=0.0
         11 CONTINUE
            IF(NUMANG.LE.1) GO TO 7
```

```
      DO 8 I=1,15                                                       SLICE  47
      RADIUS(I)=DIST/SIN(RAD*THETO(I))                                  SLICE  48
    8 CONTINUE                                                          SLICE  49
      GO TO 2                                                           SLICE  50
    7 CONTINUE                                                          SLICE  51
      IF(DIMANG.GT.0) GO TO 4                                           SLICE  52
      WRITE(6,110)                                                      SLICE  53
  110 FORMAT(49H0*** ARC RADIUS OMITTED - 100 FT. ARC ASSUMED ***)      SLICE  54
      DIST=100.0                                                        SLICE  55
    4 CONTINUE                                                          SLICE  56
      DO 3 I=1,15                                                       SLICE  57
      RADIUS(I)=DIST                                                    SLICE  58
    3 CONTINUE                                                          SLICE  59
    2 CONTINUE                                                          SLICE  60
   10 CONTINUE                                                          SLICE  61
C                                                                       SLICE  62
C                                                                       SLICE  63
C     CALCULATION OF DIMENSIONLESS RADIAL PROFILES                      SLICE  64
C                                                                       SLICE  65
      DO 1 NR=1,M                                                       SLICE  66
      RIN(NR)=SIGR(NR)/DEQ                                              SLICE  67
      MACH(NR)=(UR(NR)-FIRST(1))/CO                                     SLICE  68
      MCIN(NR)=ALPHMC*MACH(NR)+BETAMC*EMACH                             SLICE  69
      TEMP(NR)=RHOF/RHOR(NR)                                            SLICE  70
    1 CONTINUE                                                          SLICE  71
C                                                                       SLICE  72
C                                                                       SLICE  73
C     SOURCE STRENGTH EVALUATION                                        SLICE  74
C                                                                       SLICE  75
      DV=.25*PI*(DSIG**2)*DX                                            SLICE  76
      DRMIN=DSIG/2.0                                                    SLICE  77
      DO 5 NR=1,M                                                       SLICE  78
      IF(NR.EQ.1.AND.SIGR(1).LE.DRMIN) GO TO 6                          SLICE  79
      DV=2.*PI*SIGR(NR)*DSIG*DX                                         SLICE  80
    6 CONTINUE                                                          SLICE  81
      DS(NR)=0.0                                                        SLICE  82
      OMEGR=ABS(DUDR(NR))                                               SLICE  83
      IF(OMEGR.LE.0.0) GO TO 5                                          SLICE  84
      UPR=SQRT(TAUR(NR))                                                SLICE  85
      DS(NR)=RHOESQ*DV*UPR**7                                           SLICE  86
      FS(NR)=0.5*ALFA*OMEGR/PI                                          SLICE  87
    5 CONTINUE                                                          SLICE  88
      IF(NPRINT.LE.0) GO TO 135                                         SLICE  89
      IF(NPR.GE.NPRINT) WRITE(6,120)                                    SLICE  90
  120 FORMAT(1H1///20X,37HCIRCUMFERENTIALLY-AVERAGED PARAMETERS//4X,2HNR SLICE  91
     16X,6HRADIUS,5X,8HMACH NO.,5X,5HTEMP.,5X,9HINTENSITY,5X,9HFREQUENCY SLICE  92
     2//)                                                               SLICE  93
```

```
      IF(NPR.GE.NPRINT) WRITE(6,125)(NR,RIN(NR),MACH(NR),TEMP(NR),DS(NR) SLICE  94
     1,FS(NR),NR=1,M)                                                  SLICE  95
  125 FORMAT(I6,3F12.4,E14.5,F10.0)                                    SLICE  96
  135 CONTINUE                                                         SLICE  97
C                                                                      SLICE  98
C                                                                      SLICE  99
C     INDEX OF THETA FOR SHIELDING/DIRECTIVITY                         SLICE 100
C                                                                      SLICE 101
      NR=M                                                             SLICE 102
      NR1=NR-1                                                         SLICE 103
      DO 15 ITH=1,15                                                   SLICE 104
*                                                                      SLICE 105
*     CALCULATION OF G AND ITS ZEROS                                   SLICE 106
*                                                                      SLICE 107
      THE=THETA(ITH)                                                   SLICE 108
43    CONTINUE                                                         SLICE 109
      CT=COS(THE)                                                      SLICE 110
      CTSQ=CT*CT                                                       SLICE 111
*                                                                      SLICE 112
*     CALCULATION OF G-SQUARE                                          SLICE 113
*                                                                      SLICE 114
      DO 20 J=1,NR                                                     SLICE 115
      G2(J)=(1.0-MACH(J)*CT)**2/TEMP(J)-CTSQ                           SLICE 116
      IF(G2(J).EQ.0.) GO TO 42                                         SLICE 117
20    CONTINUE                                                         SLICE 118
      GO TO 44                                                         SLICE 119
42    CONTINUE                                                         SLICE 120
      THE=THE+DDTHE                                                    SLICE 121
      GO TO 43                                                         SLICE 122
44    CONTINUE                                                         SLICE 123
*                                                                      SLICE 124
*     CALCULATION OF ZEROS OF G                                        SLICE 125
*                                                                      SLICE 126
      RSIG(ITH,1)=0.                                                   SLICE 127
      RSIG(ITH,2)=0.                                                   SLICE 128
      RSIG(ITH,3)=0.                                                   SLICE 129
      RSIG(ITH,4)=0.                                                   SLICE 130
      RSIG(ITH,5)=0.                                                   SLICE 131
      NTP=0                                                            SLICE 132
      DO 21 J=1,NR1                                                    SLICE 133
      SLOPE=(G2(J+1)-G2(J))/(RIN(J+1)-RIN(J))                          SLICE 134
      IF(SLOPE.EQ.0.) GO TO 21                                         SLICE 135
      ROOT=RIN(J+1)-G2(J+1)/SLOPE                                      SLICE 136
      IF(ROOT.GE.RIN(J).AND.ROOT.LE.RIN(J+1)) GO TO 40                 SLICE 137
      GO TO 21                                                         SLICE 138
40    CONTINUE                                                         SLICE 139
      NTP=NTP+1                                                        SLICE 140
```

```
      RSIG(ITH,NTP)=ROOT                                                 SLICE 141
   21 CONTINUE                                                           SLICE 142
      IF(NTP.GT.0) GO TO 41                                              SLICE 143
      IF(G2(NR1).GT.0.0) GO TO 41                                        SLICE 144
      NTP=1                                                              SLICE 145
      RSIG(ITH,1)=RIN(NR)                                                SLICE 146
   41 CONTINUE                                                           SLICE 147
      IF(NTP.GT.2) WRITE(6,150)KA,X,ITH,THETO(ITH),NTP                   SLICE 148
  150 FORMAT(53H0WARNING - NO. OF TURNING POINTS IS GREATER THAN 2 AT /  SLICE 149
     14H KA=I3,5X,2HX=F10.5,5X,4HITH=I3,5X,6HTHETA=F8.2,5X,4HNTP=I3//)   SLICE 150
C                                                                        SLICE 151
C                                                                        SLICE 152
C     CALCULATION OF DIRECTIVITY                                         SLICE 153
C                                                                        SLICE 154
      XOR=X/RADIUS(ITH)                                                  SLICE 155
      RSORSQ=1.0-2.0*XOR*CT+XOR**2                                       SLICE 156
      RSTAR=RADIUS(ITH)*SQRT(RSORSQ)                                     SLICE 157
      CONVF=ABS(1.0+FIRSTU*CT/CO)                                        SLICE 158
      CALL CRD                                                           SLICE 159
      DO 30 IR=1,M                                                       SLICE 160
      IF(FS(IR).LE.0.0) GO TO 30                                         SLICE 161
      MC=MCIN(IR)                                                        SLICE 162
      CONVO=1.0-MC*CT                                                    SLICE 163
      CONV2=CONVO**2+TAUR(IR)*(ALPHT(ITH)/CO)**2                         SLICE 164
      IF(NN.GT.1) CONV2=1.0                                              SLICE 165
      IF(NN.GT.0.AND.NN.LT.3) SHIELD(IR)=0.0                             SLICE 166
      DO 45 J=1,34                                                       SLICE 167
      FC=FLOAT(FO(J))                                                    SLICE 168
      K=CNST*FC*DEQ/CO                                                   SLICE 169
      FR=FC/FS(IR)                                                       SLICE 170
      FRSQ=FR*FR                                                         SLICE 171
      POWER=0.125*FRSQ*CONV2                                             SLICE 172
      IF(POWER.GT.20.0) GO TO 45                                         SLICE 173
      EXPON=EXP(-POWER)                                                  SLICE 174
      HF=FRSQ*FRSQ*EXPON                                                 SLICE 175
      DIRECT=TERM(IR)                                                    SLICE 176
      IF(SHIELD(IR).GT.0.) GO TO 46                                      SLICE 177
      GO TO 47                                                           SLICE 178
   46 CONTINUE                                                           SLICE 179
      POWER=2.0*K*SHIELD(IR)                                             SLICE 180
      IF(POWER.GT.20.0) GO TO 45                                         SLICE 181
      DIRECT=DIRECT*EXP(-POWER)                                          SLICE 182
   47 CONTINUE                                                           SLICE 183
      DSPL(ITH,J)=DSPL(ITH,J)+HF*DS(IR)*DIRECT/RSORSQ/CONV2              SLICE 184
     1/CONVF                                                             SLICE 185
   45 CONTINUE                                                           SLICE 186
   30 CONTINUE                                                           SLICE 187
   15 CONTINUE                                                           SLICE 188
      RETURN                                                             SLICE 189
      END                                                                SLICE 190
```

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      *TPNLC        THIS SECTION CALCULATES TONE CORRECTED PNL             TPNLC     2
C                   SPECTRAL IRREGULARITY CORRECTION                       TPNLC     3
C                                                                          TPNLC     4
C                   THIS PROCEDURE DETERMINES A SPECTRAL IRREGULARITY      TPNLC     5
C                   (E.G.,PURE TONE) CORRECTION FACTOR ECF VIA SECTION #36.3   TPNLC     6
C                   OF THE FAA NOISE CERTIFICATION DOCUMENT (NOV 17,1969) AS   TPNLC     7
C                   A FUNCTION OF THE UNCORRECTED 1/3 OCTAVE SPECTRUM,SPL.     TPNLC     8
C                                                                          TPNLC     9
      SUBROUTINE TPNLC(SPL,PTCOR)                                          TPNLC    10
      DIMENSION SPL(24),ISPLF(24),S(24),SPLP(24),SPLPP(24),SP(25),         TPNLC    11
     1 SBAR(24),F(24)                                                      TPNLC    12
C                                                                          TPNLC    13
C    *INITIALIZE SPL FLAG*                                                 TPNLC    14
      DO 1 I=1,24                                                          TPNLC    15
    1 ISPLF(I) = 0                                                         TPNLC    16
C                                                                          TPNLC    17
C    *STEP 1*                                                              TPNLC    18
      DO 5 I=4,24                                                          TPNLC    19
    5 S(I)=SPL(I) - SPL(I-1)                                               TPNLC    20
C                                                                          TPNLC    21
C    *STEP 2 AND 3*                                                        TPNLC    22
      DO 10 I=5,24                                                         TPNLC    23
      IF(ABS(S(I)-S(I-1)).LE.5.0) GO TO 10                                 TPNLC    24
      IF(S(I).GT.0.0.AND.S(I).GT.S(I-1)) ISPLF(I)=1                        TPNLC    25
      IF(S(I).LE.0.0.AND.S(I-1).GT.0.0) ISPLF(I-1)=1                       TPNLC    26
   10 CONTINUE                                                             TPNLC    27
C                                                                          TPNLC    28
C    *STEP 4*                                                              TPNLC    29
      DO 25 I=1,24                                                         TPNLC    30
      IF(ISPLF(I).EQ.0) GO TO 20                                           TPNLC    31
      IF(I.EQ.24) GO TO 15                                                 TPNLC    32
C             STEP 4B MODIFIED SUCH THAT PRECEDING AND FOLLOWING           TPNLC    33
C             NON-FLAGGED SOUND PRESSURE LEVELS EMPLOYED IN AVERAGE.       TPNLC    34
      II = I                                                               TPNLC    35
      DO 11 J=1,20                                                         TPNLC    36
      II = II-1                                                            TPNLC    37
      IF(ISPLF(II).EQ.0) GO TO 12                                          TPNLC    38
   11 CONTINUE                                                             TPNLC    39
   12 SPLL = SPL(II)                                                       TPNLC    40
      IP1 = I+1                                                            TPNLC    41
      DO 13 J=IP1,24                                                       TPNLC    42
      IF(ISPLF(J).EQ.0) GO TO 14                                           TPNLC    43
   13 CONTINUE                                                             TPNLC    44
      J = 24                                                               TPNLC    45
```

```
   14 SPLU = SPL(J)
      SPLP(I) = (SPLL+SPLU)/2.
      GO TO 25
   15 SPLP(24) = SPL(23)+S(23)
      GO TO 25
   20 SPLP(I) = SPL(I)
   25 CONTINUE
C
C    *STEP 5*
      DO 30 I=4,24
   30 SP(I) = SPLP(I)-SPLP(I-1)
      SP(3) = SP(4)
      SP(25) = SP(24)
C
C    *STEP 6*
      DO 35 I=3,23
   35 SHAR(I) = (SP(I)+SP(I+1)+SP(I+2))/3.
C
C    *STEP 7*
      SPLPP(1) = SPL(1)
      SPLPP(2) = SPL(2)
      SPLPP(3) = SPL(3)
      DO 40 I=4,24
   40 SPLPP(I) = SPLPP(I-1)+SHAR(I-1)
C
C    *STEP 8*
      DO 45 I=1,24
   45 F(I) = SPL(I)-SPLPP(I)
C
C    *STEP 9 AND 10*
      CMAX = 0.0
      DO 65 I=1,24
      IF(I.GE.11.AND.I.LE.21) GO TO 50
C     *FREQ 500HZ OR FREQ%5000HZ*
      TC2 = F(I)/6.
      TC3 = 3.333
      GO TO 55
C     *500 =FREQ =5000HZ*
   50 TC2 = F(I)/3.
      TC3 = 6.666
   55 IF(F(I).LT.3.0) GO TO 65
      IF(F(I).GE.20.0) GO TO 60
      CMAX = AMAX1(CMAX,TC2)
      GO TO 65
   60 CMAX = AMAX1(CMAX,TC3)
   65 CONTINUE
      PTCOR=CMAX
  500 RETURN
      END
```

4.0 REFERENCES

1. Gliebe, P.R., "High Velocity Jet Noise Source Location and Reduction: Task 2 Supplement - Computer Program for Calculating the Aeroacoustic Characteristics of Jets From Nozzles of Arbitrary Shapes," General Electric Company, FAA-RD-76-79, IIa, May, 1978.

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4. Anon, "Standard Values of Atmospheric Absorption as a Function of Temperature and Humidity for Use in Evaluating Aircraft Flyover Noise," SAE ARP 866, 1964.

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6. Lee, R., Kendal, R.M., et al, "Research Investigation of the Generation and Suppression of Jet Noise," General Electric Company Contractor Report No. NOAS 59-6160-C, January 1961.

7. Anon, "Noise Standards: Aircraft Type Certification," FAA Part 36, Vol. III, Appendix B, 1969.

5.0 CONCLUDING REMARKS

Two computer programs capable of predicting the jet noise of high velocity exhausts from nozzles of arbitrary geometry are presented. The computerized procedures presented herein provide reasonably accurate methods of predicting maximum sideline PNL as well as EPNL (with and without flight effects) over the range of flow conditions and observer angles of interest.

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