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V/STOL ROTARY PROPULSION SYSTEMS NOISE PREDICTION AND REDUCTION

Volume III - Computer Program User's Manual

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Final Report

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16. Abstract

A computer program is presented which allows a user to make performance and far-field acoustic noise predictions for free-air propellers, variable pitch fans with inlet guide vanes, variable pitch fans with outlet guide vanes, fixed pitch fans, helicopter rotors, tilt rotors, fixed pitch lift vanes with remote, integral, and tip-turbine drives, and variable pitch lift fans with remote and integral drives. Noise prediction methodology for drive engines, single stream and coaxial jets, and gearboxes are also included, as well as noise reduction and performance losses of partly sonic inlets and duct acoustic treatment.

A description of the program, detailed instructions for its use, required inputs, and sample cases are presented.

Related documents include Volume I - Identification of Sources, Noise Generating Mechanisms, Noise Reduction Mechanisms, and Prediction Methodology and Volume II - Graphical Prediction Methods.

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Helicopter Noise	Noise Prediction	
Lift Fan Noise	V/STOL Noise	

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161 400

METRIC CONVERSION FACTORS

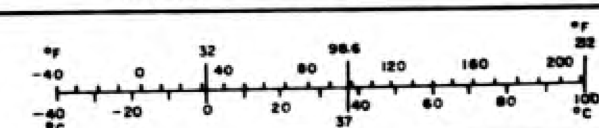
Approximate Conversions to Metric Measures

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 DOT/FAA Contract DOT-FA74WA-3477, V/STOL Noise Prediction and Reduction, Rotary Propulsion Systems. The results are presented in three volumes which are a logical separation of the major tasks. The three volumes are:

- Volume I - Identification of Sources, Noise Generating Mechanisms, Noise Reduction Mechanisms, and Prediction Methodology
- Volume II - Graphical Prediction Methods
- Volume III - Computer Program User's Manual

Volume I presents the major results of the work performed under contract in identifying the sources of noise in VTOL and STOL rotary propulsors, defining the noise generating mechanisms, defining noise reduction mechanisms, and describing the aerodynamic performance and noise prediction methodology developed under contract. Volumes II and III present the noise prediction methods developed for estimating noise and performance of VTOL and STOL rotary propulsors. Volume II contains the graphical procedures. Volume III describes the computer program and its usage and includes sample cases and a program listing.

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INTRODUCTION

The noise prediction methodology which was developed under contract DOT-FA74WA-3477 and described in Volume I has been incorporated into a computer program which allows estimates of the noise from V/STOL rotary propulsion systems. The computer program calculates the aerodynamic performance of the user-defined propulsion system, the noise from the major components of the system, the effects on noise and performance of noise reduction methods, the total propulsion system noise spectra, and Effective Perceived Noise Levels.

This volume of the report is the user's manual for the V/STOL rotary propulsion system noise prediction program. A description of the program organization, input data format, options, and sample cases are included in this manual.

COMPUTER PROGRAM ORGANIZATION

INTRODUCTION

The computer program prepared under this contract is divided into a main program, 42 subroutines and 3 functions in order to facilitate revisions. An overall flow chart of the program is presented in Figure 1. A brief description of each of these programs follows.

MODULE DESCRIPTION

Main Program - The main program controls the overall flow of program. It calls appropriate subroutines to predict the noise produced by the ten major noise-producing units on the vehicle.

Subroutine ATTN - ATTN calculates the coefficients defining the atmospheric absorption of sound for the given temperature and relative humidity, per SAE ARP 866 (Reference 1).

Block Data - This subroutine initializes the variables in the common blocks.

PNLC - PNLC prints a table listing SPL, dBA, PNL and PNLT versus azimuth angles. PNL and PNLT are calculated according to the procedure outlined in FAR Part 36 (Reference 2).

JETN and SPECTR - JETN predicts jet noise from single and coaxial nozzles.

HELI - HELI calls the subroutines used to predict helicopter noise, ROTOR and SHTR.

ROTOR - ROTOR predicts the noise due to the helicopter main rotor and the free-air tail rotor.

BJSIGN - BJSIGN determines the sign of a Bessel function.

FPFAN - FPFAN predicts the noise of a fixed-pitch fan with adjustments for duct treatment, jet noise, integral engine, partly-sonic inlet, gearbox noise, and thrust reverser noise.

FAPROP - FAPROP predicts the noise of a free-air propeller with adjustments for integral engine and gearbox noise. A geometry generalization is included.

COENG - COENG predicts the noise of the compressor, combustor, turbine and jet of an engine. A typical turboshaft engine generalization is included as an option. The subroutine also is used to predict the noise of a tip turbine of a fixed-pitch lift fan.

RVINT - RVINT predicts noise due to inlet-guide-vane/rotor and rotor/outlet guide vane interactions in a variable-pitch fan.

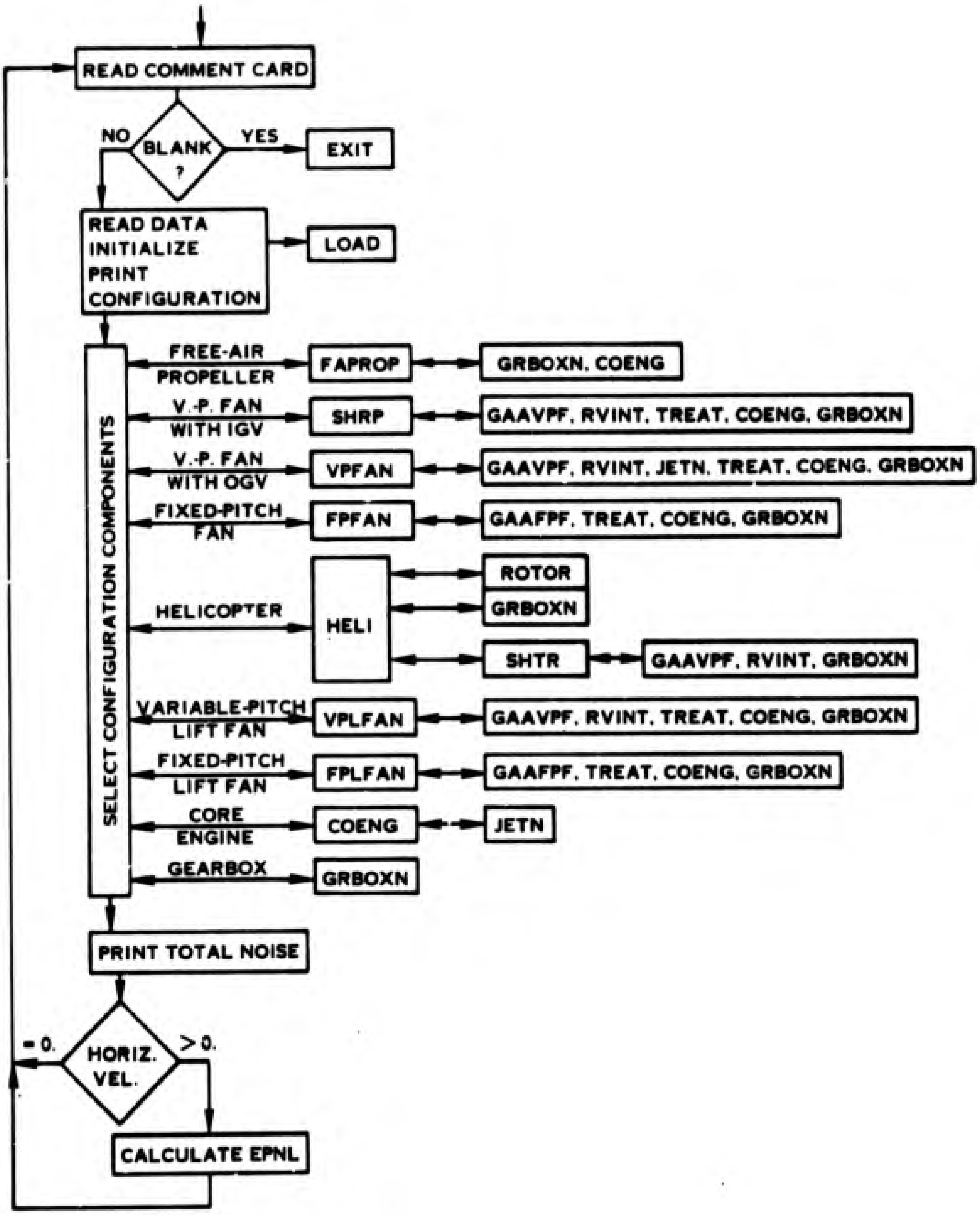

FIGURE 1. V/STOL ROTARY PROPULSOR NOISE CALCULATION PROGRAM ORGANIZATION

REVN - REVN predicts the noise due to a thrust reverser for a fixed pitch fan.

SHRP - SHRP predicts the noise of a variable-pitch fan with inlet guide vanes including adjustments for duct treatment, integral engine and gearbox noise.

VPFAN - VPFAN predicts the noise of a variable-pitch fan with outlet guide vanes including adjustments for reverse thrust, near-sonic inlet, duct treatment, integral engine, gearbox and jet noise.

VPLFAN - VPLFAN predicts the noise of a variable-pitch lift fan with adjustments for duct treatment, integral engine, gearbox and jet noise.

FPLFAN - FPLFAN predicts the noise of a fixed-pitch lift fan with adjustments for duct treatment, tip turbine drive, integral engine, gearbox and jet noise.

SHTR - SHTR predicts the noise of a helicopter shrouded tail rotor with an adjustment for gearbox noise.

GAAVPF - GAAVPF predicts the geometry and performance of a variable-pitch fan.

GAADES, GAAPFM, GAASEC, GAASIA, GAASIB, GAASIC, GAASID, GAACLK - These subroutines are used by GAAVPF.

GAAFM - Function GAAFM is called by GAASEC and GAAFDS.

GAA123 - GAA123 is used by GAAVPF, GAAFPF and GAAFPM.

VMACH - Function VMACH calculates the Mach number less than one corresponding to a given corrected airflow per unit area.

TREAT - TREAT selects the optimum treatment tuning for minimum sideline PNL for a given amount of treatment and calculates the treated source noise.

GRBOXN - GRBOXN predicts the noise of one or more gearboxes in series. Spur, bevel, planetary (fixed ring gear) and star (fixed cage) configurations are included in the prediction method.

GAAFPF, GAAFDS, GAAFPM - These three subroutines calculate generalized geometry and performance of a fixed-pitch fan.

NOYS - NOYS calculates the NOY value of a given 1/3 octave band SPL.

TONE - Function TONE calculates the tone correction to convert PNL to PNLT.

LOAD - LOAD reads the numerical input data for each case until a card with a 0 in column 1 and -1. in columns 3 to 5 is read.

BESJH - BESJH calculates the regular Bessel function for a given real argument from order 0 to a given integer order.

BIQUAD - BIQUAD interpolates in a one or two-dimensional array.

UNINT - UNINT interpolates in a one or two-dimensional array.

WUNINT - WUNINT provides coefficients for interpolation in an array.

DATEJC - DATEJC is intended to provide the date in a 2A4 format, e.g., 09/10/75. Since it is installation dependent, a dummy subroutine is provided for the general installation.

RTIME - RTIME is intended to provide the time in a 2A4 format, e.g., 13:39:32. Since it is installation dependent, a dummy subroutine is provided for the general installation.

UNBAR - UNBAR interpolates in a one or two-dimensional array.

DESCRIPTION OF USER INPUTS

DATA STORAGE

The data required to describe the system configuration and operating conditions for each case are read and stored into a common block labelled DATAI. Prior to the run this block is initialized to zero. It is not re-zeroed between cases.

DATA INPUT FORMAT

The data cards required for each case are:

1. A comment card, i.e., the case description which is printed. This card must not be blank.

2. A set of cards containing data which are read and interpreted by subroutine LOAD.

3. A card with 0 in column 1 and -1. in columns 3 to 5 follows the last data card for each case.

A blank card follows the 0 -1. card of the last case to signal the end of the run. Therefore, all case description cards preceding the data cards must not be blank in order to avoid stopping the run prematurely.

The data cards follow the format indicated in the sample shown in Figure 2. Card column 1 is punched with a number, 1 to 5, indicating the number of data items on this card. Starting in column 3 the location in common block DATAI of the first data item on the card is punched. The sum of the integer in column 1 and the number starting in column 3 has to be from 2 to 401, inclusive. The order of the data cards for each case is not restricted. However, if two or more cards contain data for the same location, the value from the card which is read last will be used. The 0 -1. card after the data cards signals the end of the data for each case. The individual data items are punched within the columns indicated in floating-point format. If the number uses an exponent, this exponent must be to the right, as illustrated by the input to location 7 in Figure 2.

DEFAULT OPTIONS

For some data items, defaults have been established. That is, if a specific number in the data block is zero after all the data for the case is read, the number is replaced by the default value. Examples are the first three items in the data block, the ambient temperature, relative humidity, and pressure, for which the defaults are 77°F, 70% and 14.696 psia, respectively.

GENERAL DATA INPUT LOCATIONS

With the exception of the data for the gearboxes (to be described later), specific fixed locations are prescribed for each item. These fixed locations

PROGRAM INFO		INPUT DATA					LABEL
n	LOCATION NO.	1	2	3	4	5	
TURBØ PRØP SAMPLE CASE							COMMENT
5	4.	-180.	0.	3.	5.84 E+02	0.	PROP DEF
5	9.	0.	4.	0.	200.	0.	ENG DEF
4	46.	4.	1.	0.	0.		FREE AIR
5	94.	3260.	0.	13.5	4.	-1020.	PROP DATA
1	99.	-180.					GEN ENG
3	145.	3260.	0.	0.			DES COND
3	124.	180.	77.	0.			GEARBOX
5	201.	2.	1.	75.	3.125	3.	
2	206.	50.	4.333				
0	-1.						

FIGURE 2. EXAMPLE OF INPUT DATA FORMAT

are defined by Figures 3 to 13, 16 and 17. Figure 3 shows the general input data block organization and defines the propulsor noise sources for which prediction methods have been programmed.

General Data

The data applicable to all units is loaded into location 1 to 9 and 124 to 126, inclusive, as shown in Figure 4. The ambient atmospheric conditions for the operating condition in locations 1 to 3 and the design condition in locations 125 and 126 have the default values shown. Generally, the default value is supplied by the program if the number in the location is 0. If the number in location 4 is negative it is interpreted as the horizontal speed in knots rather than in ft./sec. Location 6 controls the completeness of the printed output; a 0. provides minimum printing and a 3. provides maximum printing. The shaft angle, location 8, applies to the free-air propeller when used as a tilt rotor and the three fans when used as lift fans, since their axes may be tilted relative to the horizon. The helicopter rotor is assumed to be at 90 degrees. If both the vehicle altitude above the observer (location 7) and the sideline distance to the observer (location 9) are zero the program sets the sideline distance to 200 ft.

Propulsion System Definition

Data locations 10 to 49 listed in Figure 5 define the propulsion system for which the noise is to be estimated. Four data items define each unit. The first, locations 10, 14, 18, etc., define the number of units on the vehicle. The noise of either of the tail rotor types is not calculated if there is no helicopter main rotor. The shrouded tail rotor noise is not calculated if there is a free-air tail rotor. The second item should not be zero if jet noise is to be included. Note that for the free-air propeller and the three helicopter rotors jet noise cannot be included. Jet noise for a variable-pitch fan with inlet guide vanes (IGV) is calculated only if there is an integral engine. The number in the data item headed "PWR.TRANS." defines a data location, as will be discussed in the description of gearbox data. For the fixed-pitch lift fan only (location 32), a negative number indicates that a tip turbine drives the fan. For the core engine, location 48 is associated with gearboxes which are connected to two or more units, each of which may have separate gear trains, and which are connected to a common engine and not to a propulsion unit. The data items under "suppression" indicate whether the unit has noise suppression provided by duct lining.

SPECIFIC DEVICE DATA INPUT REQUIREMENTS

The data items used to describe the design and operating condition of each unit are described below. In several cases the significance of several items is the same for more than one unit and, therefore, is described only for the first unit.

Free-Air Propeller

Data for calculating free-air propeller noise are loaded into locations 10-13, 94-99, 145, 146, 153, 154 and 257 to 276 inclusive (see Figure 6). Location 94 contains the operating propeller horsepower. If this is 0., the operating

LOCATIONS	DESCRIPTION OF DATA BLOCK
1- 9	GENERAL DATA
10- 49	PROPULSION SYSTEM DEFINITION
50- 62	HELICOPTER MAIN ROTOR
63- 76	HELICOPTER FREE-AIR TAIL ROTOR
77- 92	FIXED-PITCH FAN
94- 99	FREE-AIR PROPELLER
100-104	CORE ENGINE COMPRESSOR
105-109	CORE ENGINE COMBUSTOR
110-115	CORE ENGINE TURBINE
116-123	FIXED-PITCH FAN REVERSER
124-126	DESIGN (TAKEOFF) DATA
127-143	VARIABLE-PITCH FAN WITH IGV
144	MAIN & FREE-AIR HELICOPTER ROTOR DESIGN HP
145-146	FREE-AIR PROPELLER DESIGN CONDITIONS
147-150	CORE ENGINE
151	DRIVE FOR VARIABLE-PITCH-FAN WITH IGV
152	FIXED-PITCH FAN NEAR-SONIC INLET
153-154	FREE-AIR PROPELLER ENGINE
155-197	VARIABLE-PITCH FAN WITH OGV
198-199	VARIABLE-PITCH FAN WITH IGV TREATMENT
200-210	SHROUDED TAIL ROTOR
211-236	FIXED PITCH FAN
237-256	VARIABLE-PITCH FAN WITH IGV ENGINE
257-276	FREE-AIR PROPELLER INTEGRAL ENGINE
277-316	VARIABLE-PITCH LIFT FAN
317-351	FIXED-PITCH LIFT FAN
352-400	NOT SPECIFICALLY ALLOCATED , MAY USE FOR GEARBOXES

FIGURE 3. BROAD OUTLINE OF INPUT DATA BLOCK ORGANIZATION

```
1   AMBIENT TEMPERATURE , DEG F (DEFAULT = 77)
2   AMBIENT RELATIVE HUMIDITY , % (DEFAULT = 70)
3   AMBIENT PRESSURE , PSIA (DEFAULT = 14.696)
4   HORIZONTAL SPEED , FPS (KNOTS IF NEGATIVE)
5   VERTICAL SPEED , FPS
6   PRINT CONTROL , 0 MINIMUM TO 3 MAXIMUM PRINTING
    0 PRINT INPUTS, SYSTEM & UNIT DESCRIPTIONS , TOTAL PROPULSOR
       NOISE (SPL,DB(A),PNL,PNLT,PWL&DI)
    1 PLUS SPL FOR EACH UNIT WITH NOISE SUPPRESSION (IF ANY)
    2 PLUS SPL FOR EACH UNIT AND TOTAL WITHOUT NOISE SUPPRESSION
    3 PLUS TONE AND BROADBAND CONTRIBUTIONS TO 1/3-O.B. NOISE
7   VERTICAL HEIGHT ABOVE OBSERVER , FT
8   ANGLE OF SHAFT , 0. FOR HORIZONTAL , 90. FOR VERTICAL
     APPLIES TO FREE-AIR PROPELLER, VARIABLE-PITCH FAN WITH IGV OR
     OGV, FIXED-PITCH FAN AND INTEGRAL CORE ENGINE ONLY
9   SIDELINE DISTANCE , FT, IF 7=9=0. SET TO 200.
124  = DESIGN (TAKE OFF) SPEED , KNOTS
125  = DESIGN (TAKE OFF) AMBIENT TEMPERATURE , DEG F
126  = DESIGN (TAKE OFF) AMBIENT PRESSURE , PSIA , DEFAULT=14.696
```

FIGURE 4. GENERAL DATA READ INTO LOCATIONS 1 TO 9, 124 TO 126

UNIT DESCRIPTION	NO.UNITS	JET	PWR.TRANS.	SUPPRESSION
FREE-AIR PROPELLER	10	11=0.	12	13=0.
VARIABLE-PITCH FAN - IGV	14	15	16	17
VARIABLE-PITCH FAN - OGV	18	19	20	21
FIXED-PITCH FAN	22	23	24	25
VARIABLE-PITCH LIFT FAN	26	27	28	29
FIXED-PITCH LIFT FAN	30	31	32	33
HELICOPTER MAIN ROTOR	34	35=0.	36	37=0.
FREE-AIR TAIL ROTOR	38	39=0.	40	41=0.
SHROUDED TAIL ROTOR	42	43=0.	44	45=0.
CORE ENGINE	46	47	48	49

```
NO. UNITS = 0 IF NONE , OTHERWISE 1,2,3,4 ETC. AS APPROPRIATE
JET = 0 IF NO JET NOISE, =1 IF JET NOISE TO BE INCLUDED
PWR.TRANS. = -1 IF TIP TURBINE, = 0 IF NONE, OTHERWISE NUMBER OF
             FIRST LOCATION DEFINING TRANSMISSION SYSTEM
SUPPRESSION = 0 IF NONE, = 1 IF THERE IS NOISE SUPPRESSION
```

FIGURE 5. PROPULSION SYSTEM DEFINITION, DATA LOCATIONS 10 TO 49

```
94   SHP     PROPELLER HORSEPOWER
95   THRUST  PROPELLER THRUST IF SHP=0. , POUNDS
96   D       PROPELLER DIAMETER , FT
97   BLADN   NUMBER OF BLADES (2 TO 8)
98           PROPELLER TIP SPEED (FPS) IF GT 0. , RPM IF LT 0.
99           BLADE CHORD (FT) AT 80% RADIUS , AF IF LT 0.
145          PROPELLER HORSEPOWER FOR DESIGN (TAKEOFF) CONDITION
146          PROPELLER THRUST FOR DESIGN CONDITION IF HP=0., LB
153          =0. IF SHAFT DRIVE , =1. IF INTEGRAL ENGINE
154          =0. IF USE TYPICAL TURBOSHAFT ENGINE, =1. IF USE:
257  RPMC    COMPRESSOR RPM
258  D       COMPRESSOR DIAMETER , FT
259  FPR     COMPRESSOR FIRST-STAGE PRESSURE RATIO
260  RSS     COMPRESSOR FIRST-STAGE ROTOR-STATOR SPACING IN PERCENT
261  BC      COMPRESSOR FIRST-STAGE NUMBER OF BLADES
262  CK      = 0.
263  P3      COMBUSTOR INLET TOTAL PRESSURE , PSF
264  T3      COMBUSTOR INLET TOTAL TEMPERATURE , DEG R
265  T4      COMBUSTOR EXIT  TOTAL TEMPERATURE , DEG R
266  QMA     COMBUSTOR MASS FLOW RATE , LB/SEC
267  QMT     TURBINE MASS FLOW RATE , LB/SEC
268  VTR     RELATIVE TIP SPEED OF LAST TURBINE ROTOR , FPS
269  CL      SPEED OF SOUND AT TURBINE EXIT , FPS
270  SCC     LAST STAGE STATOR-ROTOR SPACING / STATOR CHORD
271  VK      =0. FOR COPLANAR EXHAUSTS , -10. FOR RECESSED EXHAUST
272  BT      NUMBER OF BLADES IN LAST TURBINE ROTOR
273  RPMT    TURBINE RPM
274          =1. IF JET NOISE , =0. IF NO JET NOISE
275  THRT    JET THRUST , LB
276  AREA    AREA OF JET , SQ FT
```

FIGURE 6. INPUT DATA FOR FREE-AIR PROPELLER

thrust in location 95 is used to define the operating conditions. A negative value for the thrust indicates reverse thrust. After execution, both locations contain positive numbers. The propeller diameter and number of blades are in locations 96 and 97. Location 98 is interpreted as the tip speed if it is positive and as RPM if it is negative. After execution, this location contains tip speed. Location 99 is interpreted as blade chord at a radius of 80% of the tip radius if it is positive and as blade activity factor (typically about 80 to 200) if it is negative. After execution, location 99 contains the blade chord. Locations 145 and 146 contain the propeller horsepower and thrust for the design condition. If the horsepower (location 145) is greater than zero, the corresponding thrust is calculated and put into location 146. If the horsepower is not positive, the thrust defines the design condition and the corresponding horsepower is put into location 145.

Location 153 is 0. if a common engine (data locations 46-49, 100-115, 147-150) provides the power and is not 0. if an integral engine provides the power. An integral engine is defined as being dedicated to one propulsor; thus if 4 propellers with integral engines are specified, the noise from 4 engines will also be calculated. If location 154 is not 1., a generalization of turboshaft engines is used to provide the engine data for noise calculations. On the other hand, if location 154 is 1., the required engine data is taken from locations 257 to 276. Location 274 is used to control inclusion of engine jet noise. The other engine data is discussed later under the heading Common Core Engine.

Variable-Pitch Fan with IGV

Variable-pitch fans with IGV's use data from locations 14-17, 127-143, 151, 198, 199, and 237-256 as indicated in Figure 7. The design-performance generalization program uses locations 127-137 and will change the contents of some of these locations.

Locations 127-130 define the design condition and locations 135 and 136 the operating conditions. The design horsepower (location 128) is used only if the design thrust (location 127) is not greater than 0. The design tip speed, location 129, is used only if it exceeds a minimum value required by the generalization program. The fan design pressure ratio (location 130) is used only if the tip diameter (location 132) is 0. and then must be in the range 1.0 to 1.75.

Locations 131 to 134 define the geometry of the fan. The hub/tip diameter ratio in location 131 is set to .4 if it is .0 and is further changed if it is less than a minimum required by the generalization program. The tip diameter input (location 132) is used only if it is greater than zero. The number of blades (location 133) and IGV's (location 134) must exceed 1. The number in location 137 determines the axial spacing, in feet, between the IGV and rotor blade mid-chord. If it is positive it is this spacing. If it is negative it is minus the dimensionless blade-vane gap, BVGAP, defined as the axial spacing between the IGV trailing edge and the rotor blade leading edge divided by the IGV chord. If it is 0., a BVGAP value of 2.0 is used to establish this spacing.

```
127  = DESIGN (TAKE OFF) NET THRUST , LB, USED IF GT 0.
128  = DESIGN (TAKE OFF) SHP, USED IF 127 LE 0.
129  = DESIGN (TAKE OFF) TIP SPEED (FPS), USED IF GT MINIMUM
130  = DESIGN (TAKE OFF) PRESSURE RATIO, 1.0 TO 1.75, USED IF
       132 = 0.
131  = HUB / TIP DIAMETER RATIO, USE IF GT MINIMUM, MINIMUM OF .4
132  = TIP DIAMETER (FT), USED IF GT 0.
133  = NUMBER OF BLADES
134  = NUMBER OF IGVS
135  = NET THRUST , LB, USED IF GT 0.
136  = SHP, USED IF 135 LE 0.
137  = STACKING LINE DISTANCE , FT, IF GT 0., -BVGAP IF LT 0.,
       IF = 0. BVGAP = 2. USED
138  = STANDARD DEVIATION OF PAM , 0. REPLACED BY 0.5
139  = STANDARD DEVIATION OF PPM , 0. REPLACED BY 0.01
141  = INLET TREATMENT LENGTH , PERCENT OF DIAMETER
142  = EXHAUST TREATMENT LENGTH , PERCENT OF DIAMETER
143  = DCF , 1. OR 2.
151  = 0. IF SHAFT DRIVE , =1. IF INTEGRAL ENGINE
198  = NUMBER OF INLET SPLITTERS
199  = NUMBER OF EXHAUST SPLITTERS
237  = 0. IF USE TYPICAL TURBOSHAFT ENGINE , =1. IF USE:
238  RPMC COMPRESSOR RPM
239  D    COMPRESSOR DIAMETER , FT
240  FPR  COMPRESSOR FIRST-STAGE PRESSURE RATIO
241  RSS  COMPRESSOR FIRST-STAGE ROTOR-STATOR SPACING IN PERCENT
242  BC   COMPRESSOR FIRST-STAGE NUMBER OF BLADES
243  CK   = 0.
244  P3   COMBUSTOR INLET TOTAL PRESSURE , PSF
245  T3   COMBUSTOR INLET TOTAL TEMPERATURE , DEG R
246  T4   COMBUSTOR EXIT  TOTAL TEMPERATURE , DEG R
247  QMA  COMBUSTOR MASS FLOW RATE , LB/SEC
248  QMT  TURBINE MASS FLOW RATE , LB / SEC
249  VTR  RELATIVE TIP SPEED OF LAST TURBINE ROTOR , FT/SEC
250  CL   SPEED OF SOUND AT TURBINE EXIT , FPS
251  SCC  LAST STAGE STATOR-ROTOR SPACING / STATOR CHORD
252  VK   =0. FOR COPLANAR EXHAUSTS , -10. FOR RECESSED EXHAUST
253  BT   NUMBER OF BLADES IN LAST TURBINE ROTOR
254  RPMT TURBINE RPM
255  THRT JET THRUST , LB
256  AREA JET AREA , SQ FT
```

FIGURE 7. INPUT DATA FOR VARIABLE-PITCH FAN WITH IGV

Locations 138 and 139 are the standard deviations of the IGV wake turbulence pulse amplitude modulation and pulse position modulation, respectively, and have default values of 0.5 and 0.01, respectively.

Locations 141-143, 198 and 199 refer to duct treatment and are used only if location 17 is greater than 0. If location 141 is greater than 0. there is treatment in the inlet upstream of the IGV with location 141 interpreted as the length of the wall treatment expressed as a percent of the tip diameter. Location 143 is 1. or 2. to give the degrees of freedom in the suppression. Location 198 is the number of splitters in the inlet treatment; if it is 0. there is only wall treatment. Locations 142, 143 and 199 apply similarly to treatment in the exhaust downstream of the rotor.

Locations 151 and 237 to 256 are used in a similar manner as are locations 153, 154 and 257 to 276 for the free-air propeller.

Variable-Pitch Fan with OGV

Variable-pitch fans with OGV use data from locations 18-21 and 155 to 197 (see Figure 8). With the few exceptions noted below, the interpretation of the input data follows the discussion of the data for a variable-pitch fan with IGV, above, except for the change in data locations referred to. For location 165, BVGAP is the axial spacing between the rotor blade trailing edge and the stator leading edge divided by the rotor blade chord. The default values of the two standard deviations are changed and use of mid-wall treatment between rotor and the OGV's is provided by location 169.

The use of a near-sonic inlet to suppress inlet noise is provided by loading an inlet throat Mach number greater than 0.4 and not greater than 1.0 into location 174.

If the operating net thrust (location 163) is negative, the variable-pitch fan is assumed to operate in a reverse thrust mode. Location 175 determines whether reverse is achieved by changing blade angle through flat pitch or through feather. The former option is available only if the rotor solidity is less than 1.0; the program checks this. The ratio of operating to design tip speed in location 177 must be between 0.75 to 1.0, inclusive, if the fan is reversed.

Fixed-Pitch Fan

Fixed-pitch fans use data from locations 22-25, 77-92, 152 and 211-236, as indicated in Figure 9. Fixed-pitch fan thrust reversers use locations 116-123 (see Figure 10). The interpretation of the data for a near-sonic inlet (location 152), for treatment (locations 211-215) and drive (locations 216-236) follows that described above for variable-pitch fans.

The design tip speed is loaded into location 77 and the ratio of operating to design thrust into location 81. The fan design parameters are loaded into locations 78-80, 82, and 86 to 92. The number of fan stages (location 79) must be 1., 2., or 3. with the corresponding arrays of one, two or three numbers loaded into locations starting at 83, 86 and 89 to define the design of each stage. Location 92 determines whether the first stage has an IGV.

```
155  = DESIGN (TAKEOFF) NET THRUST , LB , USED IF GT 0.
156  = DESIGN (TAKEOFF) SHP, USED IF 155 LE 0.
157  = DESIGN (TAKEOFF) TIP SPEED (FPS), USED IF GT MINIMUM
158  = DESIGN (TAKEOFF) PRESSURE RATIO, 1.0 TO 1.75, USED IF
       160 = 0.
159  = HUB / TIP DIAMETER RATIO, USE IF GT MINIMUM
160  = TIP DIAMETER , FT , USED IF GT 0.
161  = NUMBER OF BLADES
162  = NUMBER OF OGVS
163  = NET THRUST , LB , USED IF NE 0. , REVERSE IF LT 0.
164  = SHP , USED IF 163 EQ 0.
165  = STACKING LINE DISTANCE , FT , IF GT 0., -BVGAP IF LT 0.,
       IF = 0. BVGAP = 2. USED
166  = STANDARD DEVIATION OF PAM , 0. REPLACED BY 1.0
167  = STANDARD DEVIATION OF PPM , 0. REPLACED BY 0.02
168  = INLET TREATMENT LENGTH , PERCENT OF DIAMETER
169  = MID TREATMENT LENGTH , PERCENT OF DIAMETER
170  = EXHAUST TREATMENT LENGTH , PERCENT OF DIAMETER
171  = DOF , 1. OR 2.
172  = INLET SPLITTERS
173  = EXHAUST SPLITTERS
174  = THROAT MACH NUMBER OF NEAR-SONIC INLET (NONE IF LE .4)
175  =0 IF REVERSE THROUGH FLAT PITCH, =1 IF THROUGH FEATHER
176  =0 IF SHAFT DRIVE , =1. IF INTEGRAL ENGINE
177  = REVERSE TIP SPEED / DESIGN TIP SPEED , .75 TO 1.
178  = 0. IF USE TYPICAL TURBOSHAFT ENGINE , =1. IF USE :
179  RPMC COMPRESSOR RPM
180  D    COMPRESSOR DIAMETER , FT
181  FPR  COMPRESSOR FIRST-STAGE PRESSURE RATIO
182  RSS  COMPRESSOR FIRST-STAGE ROTOR-STATOR SPACING IN PERCENT
183  BC   COMPRESSOR FIRST-STAGE NUMBER OF BLADES
184  CK   =0.
185  P3   COMBUSTOR INLET TOTAL PRESSURE , PSF
186  T3   COMBUSTOR INLET TOTAL TEMPERATURE , DEG R
187  T4   COMBUSTOR EXIT  TOTAL TEMPERATURE , DEG R
188  QMA  COMBUSTOR MASS FLOW RATE , LB/SEC
189  QMT  TURBINE MASS FLOW RATE , LB/SEC
190  VTR  RELATIVE TIP SPEED OF LAST TURBINE ROTOR , FPS
191  CL   SPEED OF SOUND AT TURBINE EXIT , FPS
192  SOC  LAST STAGE STATOR-ROTOR SPACING / STATOR CHORD
193  VK   =0. FOR COPLANAR EXHAUSTS , -10. FOR RECESSED EXHAUST
194  BT   NUMBER OF BLADES IN LAST TURBINE ROTOR
195  RPMT TURBINE RPM
196  THRT JET THRUST , LB
197  AREA JET AREA , SQ FT
```

FIGURE 8. INPUT DATA FOR VARIABLE-PITCH FAN (ROTOR+OGV)

77	TSDS	DESIGN TIP SPEED , FPS
78	D	FAN DIAMETER , FT
79	VNSTG	NUMBER OF FAN STAGES , 1. TO 3.
80	VC	=1. FOR SHORT FAN DUCT
		=2. FOR 3/4-LENGTH DUCT
		=3. FOR LONG FAN DUCTS WITH COPLANAR PRIMARY / SECONDARY NOZZLE EXITS
		=4. FOR LONG FAN DUCTS WITH RETRACTED PRIMARY NOZZLE (JT8D)
81	PCTTH	OPERATING THRUST / DESIGN THRUST
82	HOT	HUB / TIP DIAMETER RATIO , DEFAULT = .4
83	PRSTDS	DESIGN PRESSURE RATIO OF FIRST STAGE , 1.1 TO 1.75
84		DESIGN PRESSURE RATIO OF SECOND STAGE (IF 79 = 2 OR 3)
85		DESIGN PRESSURE RATIO OF THIRD STAGE (IF 79 = 3.)
86	TRSS	ROTOR-STATOR SPACING IN PERCENT , STAGE 1
87		ROTOR-STATOR SPACING IN PERCENT , STAGE 2
88		ROTOR-STATOR SPACING IN PERCENT , STAGE 3
89	TB	NUMBER OF BLADES IN STAGE 1
90		NUMBER OF BLADES IN STAGE 2
91		NUMBER OF BLADES IN STAGE 3
92	QIGV	=0. IF NO IGV , =1. IF IGV
152		MACH NUMBER IN NEAR SONIC INLET IF GT.4, LT.1
211		INLET TREATMENT LENGTH , PERCENT OF DIAMETER
212		EXHAUST TREATMENT LENGTH , PERCENT OF DIAMETER
213		DOF , 1. OR 2.
214		NUMBER OF INLET SPLITTERS
215		NUMBER OF EXHAUST SPLITTERS
216		= 0. IF SHAFT DRIVE , =1. IF INTEGRAL ENGINE
217		=0. IF USE TYPICAL TURBOSHAFT ENGINE , =1. IF USE:
218	RPMC	COMPRESSOR RPM
219	D	COMPRESSOR DIAMETER , FT
220	FPR	COMPRESSOR FIRST-STAGE PRESSURE RATIO
221	RSS	COMPRESSOR FIRST-STAGE ROTOR-STATOR SPACING IN PERCENT
222	BC	COMPRESSOR FIRST-STAGE NUMBER OF BLADES
224	P3	COMBUSTOR INLET TOTAL PRESSURE , PSF
225	T3	COMBUSTOR INLET TOTAL TEMPERATURE , DEG R
226	T4	COMBUSTOR EXIT TOTAL TEMPERATURE , DEG R
227	QMA	COMBUSTOR MASS FLOW RATE , LB/SEC
228	QMT	TURBINE MASS FLOW RATE , LB/SEC
229	VTR	RELATIVE TIP SPEED OF LAST TURBINE ROTOR , FPS
230	CL	SPEED OF SOUND AT TURBINE EXIT , FPS
231	SOC	LAST STAGE STATOR-ROTOR SPACING / STATOR CHORD
232	VK	=0. FOR COPLANAR EXHAUSTS , -10. FOR RECESSED EXHAUST
233	BT	NUMBER OF BLADES IN LAST TURBINE ROTOR
234	RPMT	TURBINE RPM
235	THRT	JET THRUST , LB
236	AREA	JET AREA , SQ FT

FIGURE 9. INPUT DATA FOR FIXED-PITCH FAN

A thrust reverser is included if location 116 is not zero, with the configuration determined by its value, as shown in Figure 10. To aid in selecting a value for the fully-expanded jet density, location 120, it should be noted that the standard sea-level density is 0.0023769 lb.-sec^2/ft.^{4}.

The nozzle exit effective diameter, location 121, is $2\sqrt{Area/\pi}$. The area is the nozzle exit area for target reversers and the total port area for cascade reversers. The parameter DH/DE, location 122, is equal to $1/\sqrt{D/H-1}$ for target reversers, where D is the nozzle diameter and H is one-half the nozzle diameter minus one-half the plug diameter. For cascade reversers, DH is computed as $2/\left[(\text{Number of vanes} +1)/\text{length} + \text{length}/\text{area}\right]$, where the length is the axial length of the port and the area is the exit area of one port.

Variable-Pitch Lift Fan

Variable-pitch lift fans use data from locations 26-29 and 277 to 316 (see Figure 11). Since the significance of the input data parallels that of the variable-pitch fan discussed above, it will not be repeated here. Data associated with a near-sonic inlet and thrust reversing are not required for the variable-pitch lift fan.

Fixed-Pitch Lift Fan

As indicated in Figure 12, fixed-pitch lift fans use data from locations 30-33, and 317-351. Since the significance of the input data parallels that of the fixed-pitch fan discussed above it will not be repeated here. The fixed-pitch lift fan is limited to only one stage, unlike the fixed-pitch fan which can have one, two, or three stages, and therefore the amount of data required is reduced.

Helicopter Main Rotor

The helicopter main rotor uses data from locations 34, 36, 50-61 and 144, as defined in Figure 13.

The Lowson-Ollerhead unsteady loading law, $L_n = L_o/n^k$, is used with the exponent k in location 50. Sikorsky Aircraft experience has shown that the value for k of 2.5 estimated by Lowson and Ollerhead is valid for advanced, high performance, low noise rotors and that conventional rotors are represented better by a lower value of k. The correspondence between twist and k shown in Figure 14 has been observed for Sikorsky rotors. This correspondence, expressed in the form of a quadratic function of twist, is provided by the default option for CASE, location 50.

Blade twist also influences the effective radius ratio at which the loading acts, location 51. The Sikorsky correlation with twist shown in Figure 15 is provided as a default option for location 51.

The number of blades, location 52, must exceed 1.

The rotor disk incidence angle is the angle between the tip path plane and the horizon. Typical values are 3 to 5 degrees.

The random airload assumption of Lowson and Ollerhead requires a correlation length to indicate the degree of spatial loading coherence. A default value

```
116   =-2. FOR V-GUTTER TARGET TYPE
      =-1. FOR SEMICYLINDRICAL TARGET TYPE
      = 0. IF NO REVERSER
      = 1. FOR CASCADE TYPE WITH CONSTANT-THICKNESS VANES , NO
             INTERNAL FLOW DEFLECTOR (BLOCKER)
      = 2. FOR CASCADE TYPE WITH CONSTANT-THICKNESS VANES AND
             BLOCKER
      = 3. FOR CASCADE TYPE WITH AIRFOIL-SHAPED VANES , NO BLOCKER
      = 4. FOR CASCADE TYPE WITH AIRFOIL-SHAPED VANES AND BLOCKER
117   = FULLY-EXPANDED JET AREA , SQ FT
118   = TOTAL TEMPERATURE OF JET , DEG R
119   = FULLY-EXPANDED JET VELOCITY , FPS
120   = FULLY-EXPANDED JET DENSITY , LB SEC**2 / FT**4
121   = EFFECTIVE DIAMETER , DE , FT
122   = DH / DE
123   = CASCADE-EXIT-TO-TAILPIPE AREA (AHEAD OF REVERSER) RATIO ,
          FOR CASCADE REVERSERS ONLY
```

FIGURE 10. INPUT DATA FOR FIXED-PITCH FAN REVERSER

```
277  = DESIGN (TAKEOFF) NET LIFT , LB , USED IF GT 0.
278  = DESIGN (TAKEOFF) SHP , USED IF 277 LE 0.
279  = DESIGN (TAKEOFF) TIP SPEED (FPS) , USED IF GT MINIMUM
280  = DESIGN (TAKEOFF) PRESSURE RATIO , 1.0 TO 1.75, USED IF
       282 = 0.
281  = HUB / TIP DIAMETER RATIO , USE IF GT MININUM
282  = TIP DIAMETER , FT , USED IF GT 0.
283  = NUMBER OF BLADES
284  = NUMBER OF OGVS
285  = NET LIFT , LB , USED IF NE 0.
286  = SHP , USED IF 285 = 0.
287  = STACKING LINE DISTANCE , FT , IF GT 0., -BVGAP IF LT 0.,
       IF = 0. BVGAP = 2. USED
288  = STANDARD DEVIATION OF PAM , 0. REPLACED BY 1.
289  = STANDARD DEVIATION OF PPM , 0. REPLACED BY .02
290  = INLET TREATMENT LENGTH , PERCENT OF DIAMETER
291  = MID TREATMENT LENGTH , PERCENT OF DIAMETER
292  = EXHAUST TREATMENT LENGTH , PERCENT OF DIAMETER
293  = DOF , 1. OR 2.
294  = NUMBER OF INLET SPLITTERS
295  = NUMBER OF EXHAUST SPLITTERS
296  = 0. IF SHAFT DRIVE , = 1. IF INTEGRAL ENGINE
297  = 0. IF USE TYPICAL TURBOSHAFT ENGINE , = 1. IF USE:
298  RPMC COMPRESSOR RPM
299  D    COMPRESSOR DIAMETER , FT
300  FPR  COMPRESSOR FIRST-STAGE PRESSURE RATIO
301  RSS  COMPRESSOR FIRST-STAGE ROTOR-STATOR SPACING IN PERCENT
302  BC   COMPRESSOR FIRST-STAGE NUMBER OF BLADES
303  CK   = 0. FOR TURBOSHAFT ENGINE
304  P3   COMBUSTOR INLET TOTAL PRESSURE , PSF
305  T3   COMBUSTOR INLET TOTAL TEMPERATURE , DEG R
306  T4   COMBUSTOR EXIT  TOTAL TEMPERATURE , DEG R
307  QMA  COMBUSTOR MASS FLOW RATE , LB/SEC
308  QMT  TURBINE MASS FLOW RATE , LB/SEC
309  VTR  RELATIVE TIP SPEED OF LAST TURBINE ROTOR , FPS
310  CL   SPEED OF SOUND AT TURBINE EXIT , FPS
311  SOC  LAST STAGE STATOR-ROTOR SPACING / STATOR CHORD
312  VK   =0. FOR COPLANAR EXHAUSTS , -10. FOR RECESSED EXHAUST
313  BT   NUMBER OF BLADES IN LAST TURBINE ROTOR
314  RPMT TURBINE RPM
315  THRT JET THRUST , LB
316  AREA JET AREA , SQ FT
```

FIGURE 11. INPUT DATA FOR VARIABLE-PITCH LIFT FAN

317	TSDS	DESIGN TIP SPEED , FPS
318	C	FAN DIAMETER , FT
319	VC	= 1. FOR SHORT FAN DUCT = 2. FOR 3/4-LENGTH DUCT = 3. FOR LONG FAN DUCTS WITH COPLANAR PRIMARY / SECONDARY NOZZLE EXITS = 4. FOR LONG FAN DUCTS WITH RETRACTED PRIMARY NOZZLE (JT8D)
320	PCTTH	OPERATING THRUST / DESIGN THRUST
321	HOT	HUB / TIP DIAMETER RATIO , DEFAULT = .4
322	FPR	DESIGN PRESSURE RATIO , 1.1 TO 1.75
323	TRSS	ROTOR-STATOR SPACING IN PERCENT
324	TB	NUMBER OF BLADES
325	CIGV	= 0. IF NO IGV , = 1. IF IGV
326		INLET TREATMENT LENGTH , PERCENT OF DIAMETER
327		EXHAUST TREATMENT LENGTH , PERCENT OF DIAMETER
328		DOF , 1. OR 2.
329		NUMBER OF INLET SPLITTERS
330		NUMBER OF EXHAUST SPLITTERS
331		=0. IF SHAFT DRIVE, =1. IF INTEGRAL ENGINE, 32=-1. IF TIP TURBINE (MUST INPUT 342-348,350&351)
332		=0. IF USE TYPICAL TURBOSHAFT ENGINE , =1. IF USE:
333	RPMC	COMPRESSOR RPM
334	D	COMPRESSOR DIAMETER , FT
335	FPR	COMPRESSOR FIRST-STAGE PRESSURE RATIO
336	RSS	COMPRESSOR FIRST-STAGE ROTOR-STATOR SPACING IN PERCENT
337	BC	COMPRESSOR FIRST-STAGE NUMBER OF BLADES
339	P3	COMBUSTOR INLET TOTAL PRESSURE , PSF
340	T3	COMBUSTOR INLET TOTAL TEMPERATURE , DEG R
341	T4	COMBUSTOR EXIT TOTAL TEMPERATURE , DEG R
342	QMA	COMBUSTOR MASS FLOW RATE , LB/SEC
343	CMT	TURBINE MASS FLOW RATE , LB/SEC
344	BTR	RELATIVE TIP SPEED OF LAST TURBINE ROTOR , FPS
345	CL	SPEED OF SOUND AT TURBINE EXIT , FPS
346	SOC	LAST STAGE STATOR-ROTOR SPACING / STATOR CHORD
347	VK	=0. FOR COPLANAR EXHAUSTS , -10. FOR RECESSED EXHAUST
348	BT	NUMBER OF BLADES IN LAST TURBINE ROTOR
349	RPMT	TURBINE RPM
350	THRT	JET THRUST , LB
351	AREA	JET AREA , SQ FT

FIGURE 12. INPUT DATA FOR FIXED-PITCH LIFT FAN

MAIN	TAIL	NAME	MEANING OF PARAMETER
50	63	CASE	ROTOR AIRLOADING K FACTOR , DEFAULT = 1.44 - .0741667*TWIST - .0018056*TWIST**2 LIMITS 1.55.LE.CASE.LE.2.22
51	64	ETA	RADIAL LOADING STATION (.7 .LE. ETA .LE. .9) DEFAULT = 1.+.01667*TWIST
52	65	BIGBR	NUMBER OF ROTOR BLADES
53	66	BIGR	ROTOR RADIUS , FT
54	67	OMEGA	ROTOR ROTATIONAL SPEED , RPM
55	68	SIC	ROTOR DISK INCIDENCE ANGLE , DEG
56	69	CHORDR	ROTOR BLADE CHORD , INCH
57	70	THRUSR	ROTOR THRUST , LB
58	71	TORQUE	ROTOR TORQUE , FT-LB
59	72	BETA	ROTOR CONING ANGLE , DEG
60	73	TWIST	BLADE TWIST , DEG , TYPICALLY NEGATIVE
61	74	CONLC	CORRELATION LENGTH , DEFAULT = .7
	75	TRCCR	NUMBER OF TAIL ROTOR HARMONICS

144 TOTAL DESIGN HP

FIGURE 13. INPUT DATA FOR MAIN AND FREE-AIR TAIL ROTORS

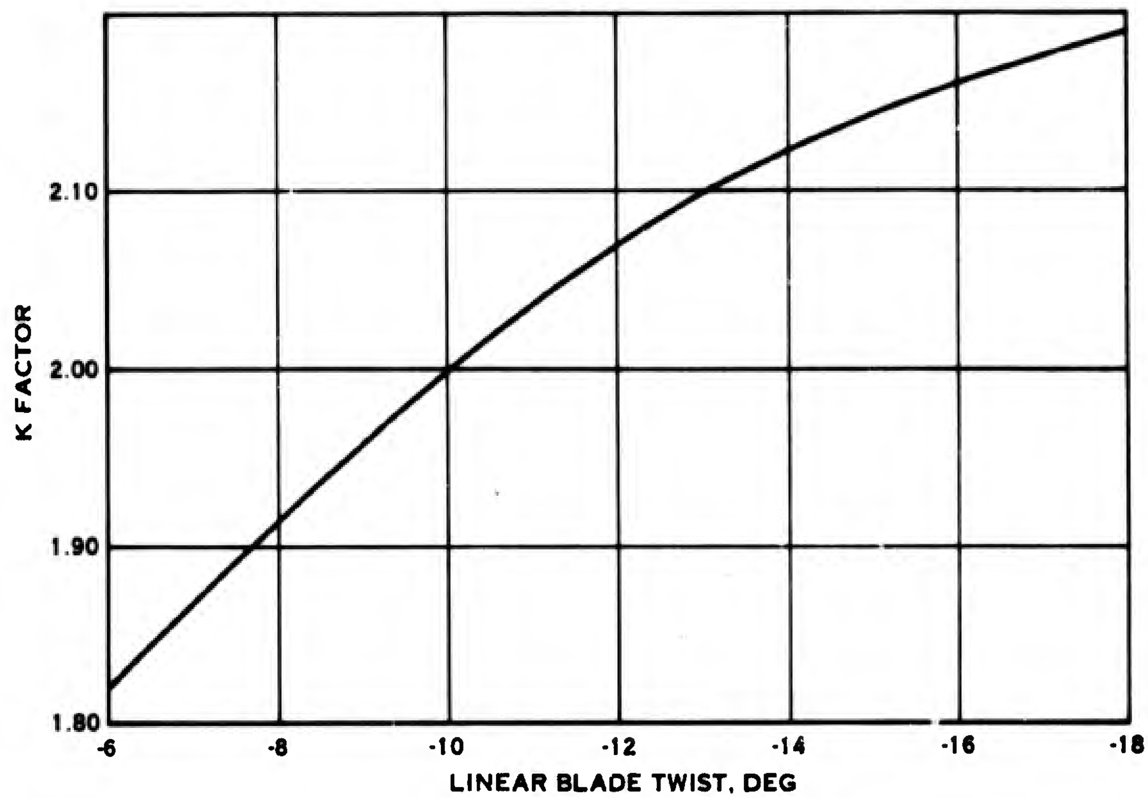

FIGURE 14. EFFECT OF LINEAR BLADE TWIST ON THE HARMONIC LOADING SLOPE

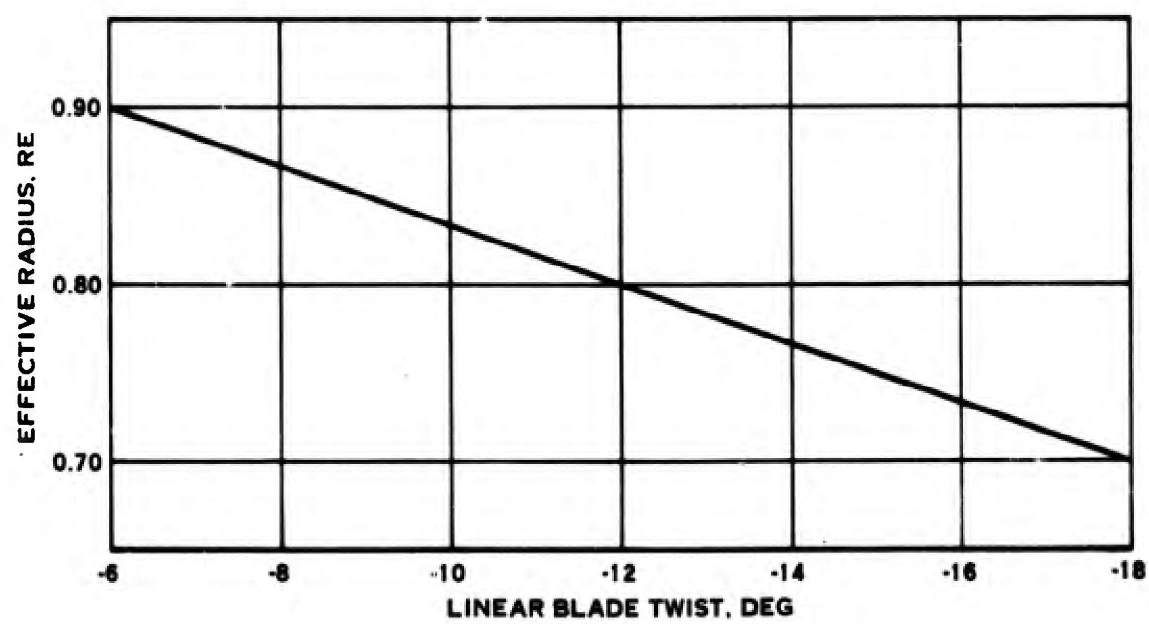

FIGURE 15. EFFECT OF LINEAR BLADE TWIST ON THE EFFECTIVE RADIUS VALUE

of 0.7, suggested by Sikorsky Aircraft, is provided for this variable in location 61.

The rotor RPM and torque for the operating case are loaded into locations 54 and 58, respectively. The computer program prints the corresponding horsepower, (RPM x torque)/5252. For the design case, the sum of the main rotor and free-air tail rotor (if any) horsepowers is read into location 144 for use in designing the common core engine.

Free-Air Tail Rotor

The helicopter free-air tail rotor uses data from locations 38, 40, and 63-75, (see Figure 13).

The significance of the variables and the default options are the same as for the main rotor discussed above. The tail rotor incidence, location 68, is normally zero. An additional input parameter, the number of tail rotor harmonics in location 75 must be 1 to 60, inclusive.

The free-air tail rotor noise is not calculated unless there is a main rotor (location 34) also.

Shrouded Tail Rotor

The helicopter shrouded tail rotor uses data from locations 42, 44, and 200-210,(see Figure 16).

The shrouded tail rotor noise is calculated only if locations 34 and 42 are greater than zero and location 38 is zero.

The significance of the input data is the same as for a variable-pitch fan with IGV discussed above except that for the shrouded tail rotor the design and operating conditions are the same, there is no treatment, and there is no integral engine.

Common Core Engine

The common core engine uses data from locations 46 to 49, 100 to 115, and 147-148, (see Figure 17). Similar data are used for engines which are integral with various propulsion units. Except for the location of the data used, the description of the data for the common core engine here applies to integral engines also.

If location 147 is 0. a generalization of a typical turboshaft engine provides the rest of the data required based on the design and operating horsepowers and the ratio of operating to design power turbine RPM. If location 147 is 1. the data in locations 100 to 115 and 148 to 150 are used.

As a guide to selecting values for these variables, if location 147 is 1., the generalization for a static sea-level power of 10,000 HP is:

```
200   = DESIGN & OPERATING NET THRUST , LB , USED IF GT 0.
201   = DESIGN & OPERATING SHP , USED IF 200 LE 0.
202   = DESIGN & OPERATING TIP SPEED (FPS), USED IF GT MINIMUM
203   = DESIGN & OPERATING PRESSURE RATIO, 1.0 TO 1.75, USED IF
        205 = 0.
204   = HUB / TIP DIAMETER RATIO, USE IF GT MINIMUM
205   = TIP DIAMETER , FT , USED IF GT 0.
206   = NUMBER OF BLADES
207   = NUMBER OF IGVS
208   STACKING LINE DISTANCE ,FT, IF GT 0., -BVGAP IF LT 0., IF =
      0. BVGAP = 2. LSFC
209   STANDARD DEVIATION OF PAM , 0. REPLACED BY .5
210   STANDARD DEVIATION OF PPM , 0. REPLACED BY .01
```

FIGURE 16. INPUT DATA FOR SHROUDED TAIL ROTOR

```
147   = 0. IF USE TYPICAL TURBOSHAFT ENGINE , 1. IF USE FOLLOWING
INPUT DATA FOR CORE ENGINE COMPRESSOR NOISE
100  RPMC COMPRESSOR RPM
101  D    COMPRESSOR DIAMETER , FT
102  FPR  COMPRESSOR FIRST-STAGE PRESSURE RATIO
103  RSS  COMPRESSOR FIRST-STAGE ROTOR-STATOR SPACING IN PERCENT
104  BC   COMPRESSOR FIRST-STAGE NUMBER OF BLADES
INPUT DATA FOR COMBUSTION NOISE
105  CK   =0. FOR TURBOSHAFT ENGINE, =1. FOR TURBOFAN ENGINE
106  P3   COMBUSTOR INLET TOTAL PRESSURE , PSF
107  T3   COMBUSTOR INLET TOTAL TEMPERATURE , DEG R
108  T4   COMBUSTOR EXIT TOTAL TEMPERATURE , DEG R
109  CMA  MASS FLOW RATE , LBM / SEC
INPUT DATA FOR CORE ENGINE TURBINE NOISE
148  QMT  MASS FLOW RATE , LBM / SEC
110  VTR  RELATIVE TIP SPEED OF LAST TURBINE ROTOR , FPS
111  CL   SPEED OF SOUND AT TURBINE EXIT , FPS
112  SCC  LAST STAGE STATOR-ROTOR SPACING / STATOR CHORD
113  VK   =0. FOR CO-PLANAR EXHAUSTS , -10. FOR RECESSED EXHAUST
114  BT   NUMBER OF BLADES IN LAST TURBINE ROTOR
115  RPMT TURBINE RPM
INPUT DATA FOR JET NOISE
149  THRT THRUST OF JET , LB
150  AREA AREA OF JET , SQ. FT
```

FIGURE 17. INPUT DATA FOR CORE ENGINE NOISE

Item	Location	Value	Meaning
Compressor	100	14170.	RPM
	101	1.855	diameter, ft.
	102	1.36	first-stage pressure ratio
	103	10.	first-stage rotor-stator spacing, % of upstream blade chord
	104	29.	first-stage number of blades
Combustor	105	0.	for turboshaft engine
	106	37008.	inlet total pressure, psf
	107	1261.	inlet total temperature, ^{o}R
	108	2686	exit total temperature, ^{o}R
	109	47.2	flow rate, lb./sec.
Turbine	148	56.6	flow rate, lb./sec.
	110	910.	last rotor relative tip speed, fps
	111	1821.	exit speed of sound, fps
	112	.5714	last stage spacing/upstream blade chord
	113	not provided by generalization	
	114	112.	number of last stage rotor
	115	9300.	RPM
Jet	149	1050.	net thrust, lb.
	150	3.11	area, sq. ft.

The flow rates, jet area and jet thrust are proportional to the horsepower. The diameter is proportional to the square root of the horsepower and the RPMs are inversely proportional to the square root of the horsepower.

Gearboxes

The gearbox data may be put into any locations not required otherwise, except 1 to 46 and 124 to 126. However, it is good practice to use locations 352 to 400 since these locations are not used for any other purpose. The location of the first data item for each train of gearboxes in a propulsion unit is loaded into locations 12, 16, 20, 24, 28, 32, 36, 40, 44, and 48, as required. The first data item is the number of gear sets in series (1. or more) for the unit. Following this are the data for each gear set, in order, starting with the gear set nearest to the propulsor. Three data items are required for each gear set:

1. Type of get set:

   spur gear, by loading 1.
   bevel gear, by loading 2.
   planetary (fixed ring gear), by loading 3.
   star (fixed cage), by loading 4.

2. Number of teeth on output gear (ring gear for planetary set).

3. Input RPM/output RPM (Must exceed 2. for planetary gear set).

Thus, the number of data items for each train of gearboxes is 1 plus 3 times the number of gear sets.

For example, if a two-stage gearbox is used with a turboprop, 352 would be put in location 12. Then, 2. would be put in location 352 (indicating two gear sets). Location 353. might be 3., to indicate a planetary gear train driving the propeller; location 354. and 355. would indicate the number of teeth on the ring gear and the reduction ratio, respectively; location 356. would be 1., 2., 3., or 4. to define the second gear stage (whose input is the core engine output shaft); and locations 357. and 358. would define this gear stage number of teeth and reduction ratio.

If two or more trains of gearboxes are joined to a train of gearboxes connected to a common core engine, the first data location for this latter common train is loaded into location 48.

UPDATING THE INPUT DATA FOR THE NEXT CASE

With certain exceptions, data used for one case are also used for the next case unless they are changed by the data read for the next case. For example, if there are two free-air propellers for the first case, data location 10 contains a 2. If there are to be no propellers for the second case the data cards loaded for the second case must put a 0. into data location 10. Otherwise, the second case also will include two propellers.

The exception is certain data describing the design and operating conditions of variable- and fixed-pitch fans and variable- and fixed-pitch lift fans. For these units there is more than one way to describe the condition. For example, one may load either thrust or horsepower. The latter is used only if the thrust in the data array is zero. However, after running the case, both the thrust and horsepower values in the data array are not zero. Generally one value has been changed. For a subsequent case the new values will be used. Thus, if the thrust in the data array was 0. for the first case, the condition for this case would be based on the horsepower, but for the second case the thrust from the first case would be used to provide the horsepower. If one wishes to change the condition for the second case, then the thrust, and perhaps the horsepower, must be changed by loading new data into the data block for the next case.

COMPUTER PROGRAM OUTPUTS

ERROR MESSAGES

General Messages

The free air propeller, variable pitch fan with IGV, variable pitch fan with OGV, fixed pitch fan including thrust reverser, helicopter main rotor, helicopter open tail rotor, helicopter shrouded tail rotor, variable pitch lift fan, fixed pitch lift fan, core engine compressor, core engine combustor, core engine turbine, lift fan tip turbine drive, and gearbox noise estimating modules will check the input data for validity. If an error is detected, i.e. parameter values are outside the allowed ranges, the message: ". . . . Noise Not Calculated Because of Error In Input Data," will be printed where the dots are the appropriate noise source. If this message is printed, then the identified source(s) is not calculated. The corrective action taken by the computer program is to set the corresponding input to the propulsion system definition (location 10 to 49) equal to zero. Thus, that source will not be calculated in subsequent cases unless the system definition location is changed by the data input.

A second general message is: "Bessel Function For IA = ..., M = ... Limited To Order Of ...". This indicates that the Bessel function subroutine was requested to calculate a value for an order too large for the given argument. Since the value of a Bessel function becomes small when the order exceeds the argument, the consequence is probably negligible.

Specific Propulsor Messages

Propellers - The error messages produced by the free-air propeller modules include:

"Error In Interpolation In Table ..., IER = ...". This indicates that end values were reached in interpolating values of blade chord, blade thickness, CT/CP, T/STATIC, etc. The table number identifies the parameter in error, IER is a code for low end, high end, etc. If the end values are used and the calculation continues, the results may be in error.

"Did Not Converge On Propeller Thrust Of ... With SHP = ..." The program could not converge in calculating the aerodynamic performance. The number of propellers is set to zero and propeller noise is not calculated, and will not be calculated in subsequent cases unless subsequent inputs change location 10.

Variable Pitch Fans - Several errors encountered in calculating the aerodynamic performance and noise of variable pitch fans will generate the following messages:

"PR1 Outside Program Range ..." The fan pressure range is printed out. The valid range is 1.0 to 1.75. The noise is not calculated for this case and subsequent cases.

"A Thrust Or SHP Must Be Specified If Diam .GT.0.0 For a Design Case, ..." The value of diameter is printed. The user must input a thrust or SHP if the fan diameter is also input. Noise is not calculated.

"Pressure Ratio Calc. For This Case Out Of Range ..." Occurs for diameter and thrust or SHP input if the calculated pressure ratio is less than 1 or greater than 1.75. Noise is not calculated.

"PR1 Out Of Range For Off-Design Case, ..." Fan pressure ratio is printed. It is outside the valid range of 1.0 to 1.75 and noise will not be calculated for the off-design case.

"A Thrust Or SHP Must Be Specified If Diam .GT.0.0 For An Off-Design Case, ..." Value of diameter is printed if non zero and thrust or SHP is not input for the off-design case. Noise is not calculated.

"Pressure Ratio Calc. For This Case Out Of Range, ..., ... Off Design" Off design case caused calculated pressure ratio to fall outside valid range. Noise is not calculated.

Jet Noise - The error messages printed by the jet noise subroutine include:

"***** Bypass Velocity Greater Than Core Velocity." Input parameter caused the calculated velocity of the bypass flow to exceed the core velocity. The jet noise is then calculated as for a single stream using the bypass parameters. The bypass correction is not calculated.

"***** Core Jet Velocity Out Of Range. Was ..., Set To ... ft/sec." The calculated jet velocity is out of range. The limit of the valid range is printed and used in the calculation.

"***** Off Coaxial Carpet At ... Hz." The end values of the bypass correction table were reached. The calculation proceeds using the table end value.

"***** Off Spectrum Curve At ... Hz" The jet noise frequency spectrum correction table values were reached. The noise calculation proceeds using the end value.

PROPULSION SYSTEM DESCRIPTION

A description of the propulsion system analyzed is printed. This will indicate the type and number of propulsion units for which the noise was calculated, whether jet noise was calculated, what type of transmission, if any noise suppression, and if the calculation includes an integral engine. This list may contain units from previous cases which may not be wanted for the current case. An additional data card setting the number of such units to 0 corrects this error.

The general inputs for design and operating conditions are also printed. These include the ambient conditions, vehicle horizontal and vertical flight speeds, flight angle, and observer location.

AERODYNAMIC PERFORMANCE AND NOISE

A general description of the parameters used to calculate the noise of each source is printed. This information includes the propulsor and core engine design information as well as the actual values, which may be for an off-design condition, used in estimating the noise sources.

With the maximum printing option selected, the computer program prints out the tone and broadband components for each noise source calculated; the combined 1/3 octave band spectra; the total propulsion system noise with and without any noise suppression specified; the total propulsion system 1/3 octave band sound power levels and directivity indices; the sideline A-weighted overall levels, Perceived Noise Levels, and Tone-Corrected Perceived Noise Levels; and the Effective Perceived Noise Level if a non-zero horizontal flight speed is specified.

PRINTING OPTION

A printing option allows the user to select the amount of printout for each case. Location 6 may be loaded with a value of 0, 1, 2, or 3. 0 gives the minimum printing and will print the data inputs, propulsion system description, and total propulsor 1/3 octave band levels, dB(A), PNL, PNLT, 1/3 octave band PWL, directivity indices, and EPNL. 1. increases the printing by printing all of the above plus the 1/3 octave band levels for each unit with noise suppression (if any). 2. further increases the printing by also printing out the 1/3 octave band levels for each unit and the total propulsor without any noise suppression. Finally, 3. in location 6 prints out the tone and broadband components.

Examples will be given in the next section where sample cases are given.

SAMPLE CASES

INTRODUCTION

In this section, representative sample cases are presented to illustrate the input data requirements and the computer program outputs for typical noise and performance calculations of several types of V/STOL rotary propulsors. Sample calculations for a turboprop, fixed-pitch fan, helicopter, and variable-pitch fan will be presented to illustrate the input and output options available to the user.

TURBOPROP SAMPLE CALCULATION

Inputs

This case illustrates a calculation of performance and noise of a typical turboprop propulsion system consisting of four propellers with gearboxes and integral engines. The case is run with SHP input and maximum printing is requested. Also, the core engine parameters are input.

Figure 18 shows the inputs to the computer program used for this calculation. Since this input is for the first case, the default options for ambient temperature, relative humidity, and pressure are exercised by leaving inputs 1, 2, and 3 blank. Location 4 specifies an operating condition of 180 kts (negative input) while location 5 indicates level flight. Location 6 is loaded with 3 to specify maximum printing. Locations 7 and 9 specify a 584 ft. flyover. Location 8 indicates that the propeller shafts are horizontal (i.e. no tilt). Location 10 indicates that the noise from 4 propulsors is to be calculated. Location 12, being greater than zero, indicates that gearbox noise is to be calculated and that the gearbox input data starts at location 360. Location 94 indicates an operating horsepower of 3260. Since location 94 is not zero, the horsepower will be used to calculate the aerodynamic performance. Locations 96 and 97 define the propeller diameter and number of blades. Location 98 is input as a negative number to signify that RPM is input and not tip speed. Location 99 is negative to indicate activity factor. Locations 124 to 126 indicate the design conditions. Location 145 defines the propeller design power which is used to size the core engine.

Location 153 is set to 1. to indicate integral engines while the 1. in location 154 indicates that the engine parameters are to be input. Locations 257 to 261 define the engine compressor design and operating parameters. Locations 263 to 266 are for combustor noise. Locations 267 to 273 define the core engine turbine parameters. Location 275 indicates the core engine net thrust (at 180 kts flight speed), while the engine nozzle area is input in location 276. These and the turbine weight flow (location 267) will be used to calculate the core engine jet noise.

Location 360 (defined in location 12 as the location for the start of the gearbox data) indicates that two gearboxes are to be estimated. Location 361 identifies the first gearbox (closest to the propeller) as a planetary system, while the second stage is identified in location 364 as a spur gear set.

The 0-1. card terminates the input for this case.

PROGRAM INFO		INPUT DATA					LABEL
N	LOCATION NO	1	2	3	4	5	
	TURBOPROP	SAMPLE CASE -	CORE ENGINE	INPUTS,	GEARBOX, MAXIMUM	PRINTING	
5	4.	-180.	0.	3.	584.	0.	
5	9.	0.	4.	0.	360.	0.	
5	94.	3260.	0.	13.5	4.	-1020.	
1	99.	-180.					
3	124.	180.	77.	14.7			
4	145.	3260.	0.	1.	1.		
2	153.	1.	1.				
5	257.	13820.	1.23	1.21	10.	33.	
5	262.	0.	20160.	1069.	2026.	34.	
5	267.	34.	950.	1731.	.3	0.	
5	272.	65.	13820.	1.	376.	1.618	
5	360.	2.	3.	50.	4.333	1.	
2	365.	75.	3.125				
0	-1.						

FIGURE 18. INPUT DATA FOR TURBOPROP SAMPLE CASE

Outputs

The computer program output for the turboprop sample case is shown starting on the next page. The first page defines the design and operating conditions, the flight altitude and sideline distance, and the propulsion system definition. The second page defines the propeller configuration and operating conditions. Note that the propeller thrust has been calculated as 5049.8 lbs. based on the input power of 3260 SHP. The next few pages show the computed propeller broadband and tone noise levels. Then the 1/3 octave band SPL's, dB(A), PNL's, and PNLT's for the total propeller noise (for 4 propellers) is printed out. The next page shows the total calculated gearbox noise. Then the total core engine compressor, combustor, and turbine noise levels (again for 4 units) are printed. The total core engine noise is printed next. Then, the core engine jet noise is printed. The total propulsor noise is printed next. Finally, the total propulsor 1/3 octave band PWL (re 10^{-13} Watts) spectrum and directivity indices and the calculated EPNL for the 584 ft. fly-over are printed.

Note that the propulsor thrust was calculated at 5049.8 lbs. from the propeller and 376 lbs. from the core engine for a total thrust of 5425.8 lbs. per propeller. The input power was 3260 SHP.

FIXED PITCH FAN SAMPLE CALCULATION

Inputs

For this case, the noise and performance of one fixed pitch fan with a generalized integral engine are calculated. A one stage gearbox is also included.

The inputs for this case are shown in Figure 19. The 1. in location 6 specifies intermediate printing. The inputs to locations 7 and 9 specify a 100 ft. sideline at zero altitude above the observer. Since this case was run immediately after the turboprop, location 10 was set to zero to cancel the propellers. Had it been left unchanged, the noise from 4 propellers would also have been included in this case. Location 23 indicates that the fan jet noise is to be calculated, while location 24 indicates that the gearbox information will be input starting at location 360. Locations 77 to 82 define the fan. Location 79 indicates a one-stage fan, so that only locations 83, 86, and 89 are input with design pressure ratio, rotor-stator spacing, and number of blades, respectively. Location 92 specifies no inlet guide vanes (it could have been left blank, since no previous case had an input there). Locations 216 and 217 indicate that a generalized integral engine is to be included in the calculation. The gearbox data is input to location 360 to 363.

Outputs

The computer outputs are shown beginning on the next page. Again the design and operating conditions and propulsion system definition are printed out.

On the next page, the fan design and operating parameters are printed out. The fan thrust was calculated to be 3829 lbs. and the power input to the fan

```
TURBOPRCP SAMPLE CASE - CORE ENGINE INPUTS, GEARBOX, MAXIMUM PRINTING          04/14/76  16:57:01

DESIGN (TAKECFF) CONDITION
TEMPERATURE =  77. DEG F , PRESSURE = 14.70 PSIA , VELOCITY = 180.0 KNCTS
OPERATING (NOISE) CONDITION
TEMPERATURE =  77. DEGF , RELATIVE HUMIDITY =,  70.% , PRESSURE = 14.70 PSIA , PRESSURE ALTITUDE =     0. FT
HORIZONTAL VELOCITY = 180.0 KNOTS = 303.8 FPS , VERTICAL VELOCITY =   0.0 FPS , FLIGHT VELOCITY = 303.8 FPS
FLIGHT ANGLE =   0.0 DEG , VEHICLE ALTITUDE ABOVE OBSERVER = 584. FT , SIDELINE DISTANCE =    0. FT , SLANT DISTANCE =  584. F.

        ROTARY PROPULSION SYSTEM ANALYSED CONSISTS OF :
                          NUMBER     JET       POWER          NOISE       INTEGRAL
   UNIT DESCRIPTION      OF UNITS   NOISE  TRANSMISSION   SUPPRESSION   ENGINE

     FREE-AIR PROPELLER     4.       NO        GEAR BOX        NO          YES
```

FREE-AIR PROPELLER NOISE

TURBOPROP SAMPLE CASE - CORE ENGINE INPUTS, GEARBOX, MAXIMUM PRINTING   04/14/76 16:57:01

PROPELLER CONFIGURATION
DIAMETER = 13.50 FT , SPINNER/TIP DIAMETER RATIO = 0.1394 , 4. BLADES , CHORD AT 80% RADIUS = 1.600 FT , AF = 180.0
BLADE AREA = 9.291 SQ FT , BLADE THICKNESS AT 70% RADIUS = 0.10192 FT
OPERATING CONDITION
SHP = 3260.0 , THRUST = 5050.2 LBS , RPM = 1020.00 , TIP SPEED = 721.00 FPS , TIP MACH NUMBER = 0.635
J = 1.325 , CP = 0.354 , CPE = 0.256 , CT/CP = 1.108 , T/TSTATIC = 0.583
BLADE PASSING FREQUENCY = 68.0 HZ
SHP = 3260.0 AT DESIGN (TAKEOFF) CONDITION , SHAFT ANGLE = 0.

BROADBAND NOISE

1/3-OCTAVE-BAND CENTER FREQ. , HZ	SPL ON A 0.-FOOT SIDELINE , DB AZIMUTH ANGLE , DEG FWD. 20.	30.	40.	50.	60.	70.	80.	90.	100.	110.	120.	130.	140.	150.	REAR 160.
25.0	40.1	42.9	44.5	45.5	46.2	46.6	46.9	47.1	47.3	47.3	47.1	46.6	45.7	43.9	40.9
31.5	42.3	45.1	46.7	47.7	48.4	48.8	49.1	49.3	49.5	49.5	49.3	48.8	47.9	46.1	43.1
40.0	44.6	47.4	49.0	50.0	50.6	51.1	51.4	51.6	51.8	51.8	51.6	51.1	50.1	48.4	45.3
50.0	46.7	49.5	51.1	52.1	52.8	53.2	53.5	53.7	53.9	53.9	53.7	53.2	52.2	50.5	47.4
63.0	48.9	51.7	53.3	54.3	54.9	55.4	55.7	55.9	56.1	56.1	55.9	55.4	54.4	52.6	49.6
80.0	51.1	53.9	55.6	56.6	57.2	57.6	57.9	58.2	58.3	58.4	58.2	57.7	56.7	54.9	51.8
100.0	53.2	56.0	57.7	58.7	59.3	59.8	60.1	60.3	60.4	60.5	60.3	59.8	58.8	57.0	53.9
125.0	55.2	58.1	59.8	60.8	61.4	61.9	62.2	62.4	62.6	62.6	62.4	61.9	60.9	59.1	55.9
160.0	57.5	60.4	62.1	63.1	63.7	64.2	64.5	64.7	64.9	64.9	64.7	64.2	63.2	61.4	58.2
200.0	59.5	62.4	64.1	65.2	65.8	66.3	66.6	66.8	67.0	67.0	66.8	66.3	65.2	63.4	60.2
250.0	61.4	64.4	66.1	67.2	67.8	68.3	68.6	68.8	69.0	69.0	68.8	68.3	67.2	65.4	62.1
315.0	62.3	65.4	67.1	68.2	68.9	69.3	69.6	69.9	70.0	70.0	69.8	69.3	68.2	66.4	63.0
400.0	62.2	65.3	67.1	68.2	68.9	69.4	69.7	69.9	70.1	70.1	69.9	69.3	68.2	66.3	62.9
500.0	60.9	64.2	66.0	67.1	67.8	68.3	68.6	68.9	69.0	69.0	68.8	68.7	67.1	65.2	61.7
630.0	59.0	62.4	64.3	65.5	66.2	66.7	67.0	67.2	67.4	67.4	67.2	66.6	65.4	63.4	59.8
800.0	57.0	60.5	62.5	63.7	64.4	64.9	65.3	65.5	65.6	65.6	65.4	64.8	63.6	61.5	57.7
1000.0	54.9	58.6	60.7	61.9	62.7	63.2	63.6	63.8	64.0	64.0	63.7	63.0	61.8	59.6	55.6
1250.0	52.7	56.6	58.8	60.1	61.0	61.5	61.9	62.1	62.2	62.2	61.9	61.2	59.9	57.6	53.4
1600.0	50.4	54.7	57.0	58.4	59.3	59.9	60.3	60.6	60.7	60.6	60.3	59.6	58.2	55.7	51.1
2000.0	48.2	52.9	55.5	57.0	57.9	58.6	59.0	59.2	59.3	59.3	58.9	58.1	56.6	53.9	48.9
2500.0	45.7	50.9	53.7	55.4	56.4	57.1	57.5	57.8	57.9	57.8	57.4	56.5	54.8	51.9	46.4
3150.0	42.6	48.5	51.6	53.5	54.6	55.4	55.8	56.1	56.2	56.1	55.6	54.6	52.7	49.5	43.3
4000.0	38.6	45.5	49.1	51.2	52.5	53.3	53.9	54.2	54.2	54.1	53.5	52.3	50.2	46.5	39.4
5000.0	36.0	43.4	47.3	49.5	50.9	51.8	52.4	52.7	52.7	52.5	51.9	50.6	48.4	44.4	34.7
6300.0	31.0	39.7	44.2	46.8	48.4	49.4	50.0	50.4	50.4	50.1	49.4	47.9	45.3	40.7	31.7
8000.0	23.5	34.3	39.8	42.9	44.9	46.1	46.8	47.2	47.2	46.8	45.9	44.1	40.9	35.3	24.3
10000.0	12.9	26.7	33.7	37.7	40.1	41.6	42.5	43.0	42.9	42.4	41.1	38.8	34.8	27.7	13.6
12500.0	-0.7	17.2	26.1	31.2	34.3	36.2	37.3	37.8	37.7	36.9	35.2	32.3	27.2	18.2	0.1
16000.0	-22.9	1.7	13.8	20.7	24.9	27.4	28.9	29.5	29.3	28.2	25.9	21.8	14.9	2.7	-22.2
20000.0	-55.1	-20.6	-3.8	5.8	11.6	15.2	17.1	17.9	17.5	15.9	12.6	6.9	-2.6	-19.6	-54.4
DB(A)	65.5	69.0	71.0	72.2	73.0	73.5	73.9	74.1	74.3	74.2	74.0	73.4	72.1	70.0	66.3
PNL	76.0	79.9	82.2	83.5	84.4	85.0	85.3	85.6	85.7	85.7	85.4	84.7	83.3	80.9	76.8
PNLT	76.0	79.9	82.2	83.5	84.4	85.0	85.3	85.6	85.7	85.7	85.4	84.7	83.3	80.9	76.8

```
100 STEADY AND NON-STEADY HARMONICS WITH FUNDAMENTAL FREQUENCY =  68.0 HZ AT AZIMUTH ANGLE OF  20. DEG
   STEADY   29.9 -17.4 -66.1-115.2-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
          -194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
          -194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
          -194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
          -194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
NON-STEADY  63.9  60.2  58.1  56.6  55.4  54.4  53.6  52.9  52.3  51.7  51.2  50.7  50.3  49.9  49.6  49.2  48.9  48.6  48.3  48.0
            47.8  47.5  47.3  47.1  46.9  46.7  46.5  46.3  46.1  45.9  45.7  45.6  45.4  45.2  45.1  44.9  44.8  44.6  44.5  44.4
            44.2  44.1  44.0  43.9  43.8  43.6  43.5  43.4  43.3  43.2  43.1  43.0  42.9  42.8  42.7  42.6  42.5  42.4  42.3  42.2
            42.1  42.1  42.0  41.9  41.8  41.7  41.6  41.6  41.5  41.4  41.3  41.3  41.2  41.1  41.0  41.0  40.9  40.8  40.8  40.7
            40.6  40.6  40.5  40.4  40.4  40.3  40.3  40.2  40.1  40.1  40.0  40.0  39.9  39.9  39.8  39.7  39.7  39.6  39.6  39.5

100 STEADY AND NON-STEADY HARMONICS WITH FUNDAMENTAL FREQUENCY =  68.0 HZ AT AZIMUTH ANGLE OF  30. DEG
   STEADY   29.1  -5.3 -41.1 -77.3-113.9-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
          -194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
          -194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
          -194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
          -194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
NON-STEADY  66.4  62.8  60.6  59.1  57.9  56.9  56.1  55.4  54.8  54.2  53.7  53.3  52.9  52.5  52.1  51.8  51.4  51.1  50.8  50.6
            50.3  50.1  49.8  49.6  49.4  49.2  49.0  48.8  48.6  48.4  48.3  48.1  47.9  47.8  47.6  47.5  47.3  47.2  47.0  46.9
            46.8  46.6  46.5  46.4  46.3  46.2  46.1  45.9  45.8  45.7  45.6  45.5  45.4  45.3  45.2  45.1  45.0  44.9  44.8  44.8
            44.7  44.6  44.5  44.4  44.3  44.3  44.2  44.1  44.0  43.9  43.9  43.8  43.7  43.6  43.6  43.5  43.4  43.4  43.3  43.2
            43.2  43.1  43.0  43.0  42.9  42.9  42.8  42.7  42.7  42.6  42.6  42.5  42.4  42.4  42.3  42.3  42.2  42.2  42.1  42.1

100 STEADY AND NON-STEADY HARMONICS WITH FUNDAMENTAL FREQUENCY =  68.0 HZ AT AZIMUTH ANGLE OF  40. DEG
   STEADY   57.1  31.1   3.7 -24.2 -52.4 -80.7-109.2-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
          -194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
          -194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
          -194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
          -194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
NON-STEADY  67.4  63.7  61.5  60.0  58.8  57.9  57.0  56.3  55.7  55.2  54.6  54.2  53.8  53.4  53.0  52.7  52.3  52.0  51.8  51.5
            51.2  51.0  50.7  50.5  50.3  50.1  49.9  49.7  49.5  49.3  49.2  49.0  48.8  48.7  48.5  48.4  48.2  48.1  47.9  47.8
            47.7  47.6  47.4  47.3  47.2  47.1  47.0  46.8  46.7  46.6  46.5  46.4  46.3  46.2  46.1  46.0  45.9  45.8  45.8  45.7
            45.6  45.5  45.4  45.3  45.2  45.2  45.1  45.0  44.9  44.9  44.8  44.7  44.6  44.6  44.5  44.4  44.3  44.3  44.2  44.1
            44.1  44.0  43.9  43.9  43.8  43.8  43.7  43.6  43.6  43.5  43.5  43.4  43.3  43.3  43.2  43.2  43.1  43.1  43.0  43.0

100 STEADY AND NON-STEADY HARMONICS WITH FUNDAMENTAL FREQUENCY =  68.0 HZ AT AZIMUTH ANGLE OF  50. DEG
   STEADY   72.1  51.8  30.1   7.9 -14.6 -37.3 -60.1 -83.0-105.9-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
          -194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
          -194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
          -194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
          -194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
NON-STEADY  67.3  63.3  61.1  59.6  58.4  57.4  56.6  55.9  55.3  54.7  54.2  53.7  53.3  52.9  52.6  52.2  51.9  51.6  51.3  51.0
            50.8  50.5  50.3  50.1  49.9  49.6  49.4  49.3  49.1  48.9  48.7  48.5  48.4  48.2  48.1  47.9  47.8  47.6  47.5  47.4
            47.2  47.1  47.0  46.9  46.7  46.6  46.5  46.4  46.3  46.2  46.1  46.0  45.9  45.8  45.7  45.6  45.5  45.4  45.3  45.2
            45.1  45.0  45.0  44.9  44.8  44.7  44.6  44.6  44.5  44.4  44.3  44.3  44.2  44.1  44.0  44.0  43.9  43.8  43.8  43.7
            43.6  43.6  43.5  43.4  43.4  43.3  43.3  43.2  43.1  43.1  43.0  43.0  42.9  42.8  42.8  42.7  42.7  42.6  42.6  [illegible]

100 STEADY AND NON-STEADY HARMONICS WITH FUNDAMENTAL FREQUENCY =  68.0 HZ AT AZIMUTH ANGLE OF  60. DEG
   STEADY   81.7  65.3  47.5  29.2  10.5  -8.3 -27.2 -46.2 -65.3 -84.4-103.6-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
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-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
NON-STEADY  67.9  62.3  59.8  58.2  57.0  56.0  55.2  54.5  53.9  53.3  52.8  52.4  51.9  51.5  51.2  50.8  50.5  50.2  49.9  49.6
            49.4  49.1  48.9  48.7  48.5  48.3  48.1  47.9  47.7  47.5  47.3  47.2  47.0  46.8  46.7  46.5  46.4  46.2  46.1  46.0
            45.8  45.7  45.6  45.5  45.4  45.2  45.1  45.0  44.9  44.8  44.7  44.6  44.5  44.4  44.3  44.2  44.1  44.0  43.9  43.8
            43.7  43.7  43.6  43.5  43.4  43.3  43.2  43.2  43.1  43.0  42.9  42.9  42.8  42.7  42.7  42.6  42.5  42.4  42.4  42.3
            42.2  42.2  42.1  42.1  42.0  41.9  41.9  41.8  41.7  41.7  41.6  41.6  41.5  41.5  41.4  41.3  41.3  41.2  41.2  41.1

100 STEADY AND NON-STEADY HARMONICS WITH FUNDAMENTAL FREQUENCY =   68.0 HZ AT AZIMUTH ANGLE OF   70. DEG
    STEADY  88.3  74.4  59.1  43.3  27.2  11.0  -5.4 -21.9 -38.5 -55.1 -71.8 -88.5-105.2-194.0-194.0-194.0-194.0-194.0-194.0-194.0
          -194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
          -194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
          -194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
          -194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
NON-STEADY  70.7  63.7  60.5  58.7  57.4  56.4  55.5  54.8  54.2  53.7  53.1  52.7  52.3  51.9  51.5  51.2  50.8  50.5  50.3  50.0
            49.7  49.5  49.2  49.0  48.8  48.6  48.4  48.2  48.0  47.8  47.7  47.5  47.3  47.2  47.0  46.9  46.7  46.6  46.4  46.3
            46.2  46.1  45.9  45.8  45.7  45.6  45.5  45.3  45.2  45.1  45.0  44.9  44.8  44.7  44.6  44.5  44.4  44.3  44.3  44.2
            44.1  44.0  43.9  43.8  43.7  43.7  43.6  43.5  43.4  43.4  43.3  43.2  43.1  43.1  43.0  42.9  42.8  42.8  42.7  42.6
            42.6  42.5  42.4  42.4  42.3  42.3  42.2  42.1  42.1  42.0  42.0  41.9  41.8  41.8  41.7  41.7  41.6  41.6  41.5  41.5

100 STEADY AND NON-STEADY HARMONICS WITH FUNDAMENTAL FREQUENCY =   68.0 HZ AT AZIMUTH ANGLE OF   80. DEG
    STEADY  92.7  80.2  66.4  52.0  37.4  22.5   7.5  -7.5 -22.7 -37.9 -53.1 -68.4 -83.7 -99.0-194.0-194.0-194.0-194.0-194.0-194.0
          -194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
          -194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
          -194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
          -194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
NON-STEADY  74.0  67.2  63.9  62.1  60.8  59.7  58.9  58.2  57.6  57.0  56.5  56.1  55.7  55.3  54.9  54.6  54.2  53.9  53.6  53.4
            53.1  52.9  52.6  52.4  52.2  52.0  51.8  51.6  51.4  51.2  51.1  50.9  50.7  50.5  50.4  50.3  50.1  50.0  49.8  49.7
            49.6  49.4  49.3  49.2  49.1  49.0  48.9  48.7  48.6  48.5  48.4  48.3  48.2  48.1  48.0  47.9  47.8  47.7  47.6  47.6
            47.5  47.4  47.3  47.2  47.1  47.1  47.0  46.9  46.8  46.7  46.7  46.6  46.5  46.4  46.4  46.3  46.2  46.2  46.1  46.0
            46.0  45.9  45.9  45.8  45.7  45.7  45.6  45.5  45.5  45.4  45.4  45.3  45.2  45.2  45.1  45.1  45.0  45.0  44.9  44.9

100 STEADY AND NON-STEADY HARMONICS WITH FUNDAMENTAL FREQUENCY =   68.0 HZ AT AZIMUTH ANGLE OF   90. DEG
    STEADY  95.4  83.3  70.0  56.0  41.8  27.4  12.9  -1.7 -16.4 -31.1 -45.9 -60.7 -75.5 -90.4-105.3-194.0-194.0-194.0-194.0-194.0
          -194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
          -194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
          -194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
          -194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
NON-STEADY  76.4  70.1  66.9  65.2  63.9  62.8  62.0  61.3  60.7  60.1  59.6  59.2  58.8  58.4  58.0  57.7  57.3  57.0  56.7  56.5
            56.2  56.0  55.7  55.5  55.3  55.1  54.9  54.7  54.5  54.3  54.2  54.0  53.8  53.7  53.5  53.4  53.2  53.1  52.9  52.8
            52.7  52.5  52.4  52.3  52.2  52.1  52.0  51.8  51.7  51.6  51.5  51.4  51.3  51.2  51.1  51.0  50.9  50.8  50.7  50.7
            50.6  50.5  50.4  50.3  50.2  50.2  50.1  50.0  49.9  49.8  49.8  49.7  49.6  49.5  49.5  49.4  49.3  49.3  49.2  49.1
            49.1  49.0  48.9  48.9  48.8  48.8  48.7  48.6  48.6  48.5  48.5  48.4  48.3  48.3  48.2  48.2  48.1  48.1  48.0  48.0

100 STEADY AND NON-STEADY HARMONICS WITH FUNDAMENTAL FREQUENCY =   68.0 HZ AT AZIMUTH ANGLE OF  100. DEG
    STEADY  96.4  83.9  70.1  55.7  41.0  26.2  11.2  -3.9 -19.0 -34.2 -49.4 -64.7 -80.0 -95.3-194.0-194.0-194.0-194.0-194.0-194.0
          -194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
          -194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
          -194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
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            -194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
NON-STEADY    77.8  71.7  68.7  67.0  65.7  64.7  63.9  63.2  62.5  62.0  61.5  61.0  60.6  60.2  59.8  59.5  59.2  58.9  58.6  58.3
              58.1  57.8  57.6  57.3  57.1  56.9  56.7  56.5  56.3  56.2  56.0  55.8  55.7  55.5  55.4  55.2  55.1  54.9  54.8  54.6
              54.5  54.4  54.3  54.1  54.0  53.9  53.8  53.7  53.6  53.5  53.4  53.3  53.2  53.1  53.0  52.9  52.8  52.7  52.6  52.5
              52.4  52.3  52.2  52.2  52.1  52.0  51.9  51.8  51.8  51.7  51.6  51.5  51.5  51.4  51.3  51.2  51.2  51.1  51.0  51.0
              50.9  50.8  50.8  50.7  50.7  50.6  50.5  50.5  50.4  50.4  50.3  50.2  50.2  50.1  50.1  50.0  50.0  49.9  49.8  49.8

100 STEADY AND NON-STEADY HARMONICS WITH FUNDAMENTAL FREQUENCY =   68.0 HZ AT AZIMUTH ANGLE OF 110. DEG
    STEADY    55.9  81.9  66.7  50.9  34.8  18.5   2.1 -14.4 -30.9 -47.5 -64.2 -80.9 -97.6-194.0-194.0-194.0-194.0-194.0-194.0-194.0
            -194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
            -194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
            -194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
            -194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
NON-STEADY    78.1  72.1  69.3  67.6  66.4  65.4  64.5  63.8  63.2  62.7  62.2  61.7  61.4  60.9  60.5  60.2  59.8  59.5  59.3  59.0
              58.7  58.5  58.2  58.0  57.8  57.6  57.4  57.2  57.0  56.8  56.7  56.5  56.3  56.2  56.0  55.9  55.7  55.6  55.4  55.3
              55.2  55.1  54.9  54.8  54.7  54.6  54.5  54.4  54.2  54.1  54.0  53.9  53.8  53.7  53.6  53.5  53.4  53.3  53.3  53.2
              53.1  53.0  52.9  52.8  52.7  52.7  52.6  52.5  52.4  52.4  52.3  52.2  52.1  52.1  52.0  51.9  51.8  51.8  51.7  51.6
              51.5  51.5  51.5  51.4  51.3  51.3  51.2  51.1  51.1  51.0  51.0  50.9  50.8  50.8  50.7  50.7  50.6  50.6  50.5  50.5

100 STEADY AND NON-STEADY HARMONICS WITH FUNDAMENTAL FREQUENCY =   68.0 HZ AT AZIMUTH ANGLE OF 120. DEG
    STEADY    93.6  77.2  59.4  41.1  22.5   3.7 -15.3 -34.3 -53.3 -72.5 -91.7-110.9-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
            -194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
            -194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
            -194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
            -194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
NON-STEADY    77.4  71.6  69.0  67.3  66.1  65.1  64.2  63.5  62.9  62.3  61.8  61.4  61.0  60.6  60.2  59.9  59.5  59.2  58.9  58.7
              58.4  58.2  57.9  57.7  57.5  57.3  57.1  56.9  56.7  56.5  56.4  56.2  56.0  55.9  55.7  55.6  55.4  55.3  55.1  55.0
              54.9  54.7  54.6  54.5  54.4  54.3  54.2  54.0  53.9  53.8  53.7  53.6  53.5  53.4  53.3  53.2  53.1  53.0  53.0  52.9
              52.8  52.7  52.6  52.5  52.4  52.4  52.3  52.2  52.1  52.0  52.0  51.9  51.8  51.8  51.7  51.6  51.5  51.5  51.4  51.3
              51.3  51.2  51.1  51.1  51.0  51.0  50.9  50.8  50.8  50.7  50.7  50.6  50.5  50.5  50.4  50.4  50.3  50.3  50.2  50.2

100 STEADY AND NON-STEADY HARMONICS WITH FUNDAMENTAL FREQUENCY =   68.0 HZ AT AZIMUTH ANGLE OF 130. DEG
    STEADY    89.5  69.1  47.5  25.3   2.8 -19.9 -42.7 -65.6 -88.6-111.6-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
            -194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
            -194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
            -194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
            -194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
NON-STEADY    75.7  70.2  67.7  66.1  64.9  63.9  63.1  62.4  61.8  61.2  60.7  60.2  59.8  59.4  59.1  58.7  58.4  58.1  57.8  57.5
              57.3  57.0  56.8  56.6  56.4  56.1  55.9  55.8  55.6  55.4  55.2  55.0  54.9  54.7  54.6  54.4  54.3  54.1  54.0  53.9
              53.7  53.6  53.5  53.4  53.2  53.1  53.0  52.9  52.8  52.7  52.6  52.5  52.4  52.3  52.2  52.1  52.0  51.9  51.8  51.7
              51.6  51.5  51.5  51.4  51.3  51.2  51.1  51.1  51.0  50.9  50.8  50.8  50.7  50.6  50.5  50.5  50.4  50.3  50.3  50.2
              50.1  50.1  50.0  49.9  49.9  49.8  49.8  49.7  49.6  49.6  49.5  49.5  49.4  49.3  49.3  49.2  49.2  49.1  49.1  49.0

100 STEADY AND NON-STEADY HARMONICS WITH FUNDAMENTAL FREQUENCY =   68.0 HZ AT AZIMUTH ANGLE OF 140. DEG
    STEADY    82.8  56.8  29.4   1.5 -26.7 -55.0 -83.5-112.1-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
            -194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
            -194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
            -194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
            -194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
NON-STEADY    73.1  68.1  65.8  64.2  63.0  62.0  61.7  60.5  59.9  59.3  58.8  58.3  57.9  57.5  57.2  56.8  56.5  56.2  55.9  55.6
              55.4  55.1  54.9  54.7  54.4  54.2  54.0  53.8  53.7  53.5  53.3  53.1  53.0  52.8  52.7  52.5  52.4  52.2  52.1  52.0
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          51.8  51.7  51.6  51.5  51.3  51.2  51.1  51.0  50.9  50.8  50.7  50.6  50.5  50.4  50.3  50.2  50.1  50.0  49.9  49.8
          49.7  49.6  49.6  49.5  49.4  49.3  49.2  49.1  49.1  49.0  48.9  48.8  48.8  48.7  48.6  48.6  48.5  48.4  48.4  48.3
          48.2  48.2  48.1  48.0  48.0  47.9  47.8  47.8  47.7  47.7  47.6  47.5  47.5  47.4  47.4  47.3  47.3  47.2  47.2  47.1

100 STEADY AND NON-STEADY HARMONICS WITH FUNDAMENTAL FREQUENCY =  68.0 HZ AT AZIMUTH ANGLE OF 150. DEG
    STEADY  72.7  38.3   2.6 -33.7 -70.2-107.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
         -194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
         -194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
         -194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
         -194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
NON-STEADY  69.6  65.3  63.0  61.5  60.3  59.3  58.5  57.8  57.1  56.6  56.1  55.6  55.2  54.8  54.4  54.1  53.8  53.5  53.2  52.9
            52.7  52.4  52.2  52.0  51.7  51.5  51.3  51.1  51.0  50.8  50.6  50.4  50.3  50.1  50.0  49.8  49.7  49.5  49.4  49.3
            49.1  49.0  48.9  48.7  48.6  48.5  48.4  48.3  48.2  48.1  48.0  47.9  47.8  47.7  47.6  47.5  47.4  47.3  47.2  47.1
            47.0  46.9  46.8  46.8  46.7  46.6  46.5  46.4  46.4  46.3  46.2  46.1  46.1  46.0  45.9  45.9  45.8  45.7  45.6  45.6
            45.5  45.5  45.4  45.3  45.3  45.2  45.1  45.1  45.0  45.0  44.9  44.8  44.8  44.7  44.7  44.6  44.6  44.5  44.5  44.4

100 STEADY AND NON-STEADY HARMONICS WITH FUNDAMENTAL FREQUENCY =  68.0 HZ AT AZIMUTH ANGLE OF 160. DEG
    STEADY  56.8   9.5 -39.1 -88.3-137.7-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
         -194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
         -194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
         -194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
         -194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0-194.0
NON-STEADY  65.3  61.4  59.2  57.6  56.4  55.5  54.7  54.0  53.3  52.8  52.3  51.8  51.4  51.0  50.6  50.3  50.0  49.7  49.4  49.1
            48.8  48.6  48.4  48.1  47.9  47.7  47.5  47.3  47.1  47.0  46.8  46.6  46.5  46.3  46.1  46.0  45.8  45.7  45.6  45.4
            45.3  45.2  45.0  44.9  44.8  44.7  44.6  44.5  44.4  44.3  44.1  44.0  43.9  43.8  43.7  43.7  43.6  43.5  43.4  43.3
            43.2  43.1  43.0  42.9  42.9  42.8  42.7  42.6  42.5  42.5  42.4  42.3  42.2  42.2  42.1  42.0  42.0  41.9  41.8  41.8
            41.7  41.6  41.6  41.5  41.4  41.4  41.3  41.3  41.2  41.1  41.1  41.0  41.0  40.9  40.9  40.8  40.7  40.7  40.6  40.6
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TOTAL PROPELLER NOISE

SPL ON A C.-FOOT SIDELINE , DB

1/3-OCTAVE-BAND CENTER FREQ. , HZ	FWD. 20.	30.	40.	50.	60.	70.	80.	90.	100.	110.	120.	130.	140.	150.	REAR 160.
	AZIMUTH ANGLE , DEG														
25.0	40.1	42.9	44.5	45.5	46.2	46.6	46.9	47.1	47.3	47.3	47.1	45.6	45.7	43.9	40.9
31.5	42.3	45.1	46.7	47.7	48.4	48.8	49.1	49.3	49.5	49.5	49.3	48.8	47.9	46.1	43.1
40.0	44.6	47.4	49.0	50.0	50.6	51.1	51.4	51.6	51.8	51.8	51.6	51.1	50.1	48.4	45.3
50.0	46.7	49.5	51.1	52.1	52.8	53.2	53.5	53.7	53.9	53.9	53.7	53.2	52.2	50.5	47.4
63.0	63.9	66.4	67.8	73.3	81.8	88.3	92.7	95.4	96.4	95.9	93.7	89.6	83.2	74.4	65.8
80.0	51.1	53.9	55.6	56.6	57.2	57.6	57.9	58.2	58.3	58.4	58.2	57.7	56.7	54.9	51.8
100.0	53.2	56.0	57.7	58.7	59.3	59.8	60.1	60.3	60.4	60.5	60.3	59.8	58.8	57.0	53.9
125.0	61.1	63.8	65.0	65.3	68.0	74.8	80.4	83.4	84.1	82.3	78.2	72.9	68.9	66.0	62.2
160.0	57.5	60.4	62.1	63.1	63.7	64.2	64.5	64.7	64.9	64.9	64.7	64.2	63.2	61.4	58.2
200.0	61.6	64.5	65.9	66.5	66.8	67.8	70.4	72.8	73.4	72.4	71.2	69.9	68.4	66.0	62.5
250.0	62.5	65.4	67.0	67.8	68.3	68.7	69.5	70.5	71.1	71.3	71.0	70.2	68.8	66.7	63.3
315.0	63.0	66.0	67.7	68.6	69.1	69.6	70.1	70.8	71.3	71.5	71.3	70.5	69.3	67.2	63.7
400.0	62.7	65.9	67.5	68.5	69.1	69.5	70.1	70.6	71.1	71.2	71.0	70.3	69.0	67.0	63.5
500.0	61.9	65.1	66.8	67.7	68.2	68.7	69.3	70.1	70.8	71.0	70.8	70.0	68.5	66.3	62.7
630.0	60.0	63.3	65.1	66.1	66.6	67.0	67.7	68.6	69.2	69.5	69.2	68.4	66.9	64.6	60.8
800.0	58.5	61.9	63.7	64.6	65.0	65.5	66.4	67.5	68.3	68.6	68.3	67.4	65.8	63.3	59.3
1000.0	56.5	60.1	62.0	62.9	63.4	63.9	64.8	65.9	66.8	67.1	66.8	65.8	64.1	61.6	57.3
1250.0	54.3	58.7	60.6	61.5	61.9	62.4	63.5	64.9	65.9	66.2	65.9	64.8	63.0	60.2	55.6
1600.0	53.2	57.4	59.5	60.3	60.6	61.2	62.5	64.2	65.4	65.9	65.3	64.2	62.2	59.1	54.1
2000.0	50.9	55.5	57.8	58.8	59.1	59.7	61.1	62.7	63.3	64.2	63.7	62.5	60.4	57.2	51.8
2500.0	49.1	54.2	56.7	57.7	58.0	58.6	60.3	62.1	63.4	63.7	63.2	61.8	59.5	56.0	50.0
3150.0	46.3	52.1	54.9	56.0	56.4	57.1	58.8	60.8	62.1	62.4	61.8	60.3	57.8	53.9	47.2
4000.0	42.7	49.4	52.6	53.9	54.4	55.2	57.1	59.1	60.4	60.7	60.0	58.4	55.6	51.2	43.6
5000.0	40.5	47.8	51.2	52.7	53.2	54.0	56.0	58.2	59.6	59.9	59.1	57.4	54.4	49.7	41.5
6300.0	35.6	44.1	48.2	50.0	50.7	51.6	53.7	55.9	57.3	57.5	56.6	54.7	51.4	46.0	36.5
8000.0	23.5	34.3	39.8	42.9	44.9	46.1	46.8	47.2	47.2	46.8	45.9	44.1	40.9	35.3	24.3
10000.0	12.9	26.7	33.7	37.7	40.1	41.6	42.5	43.0	42.9	42.4	41.1	38.8	34.8	27.7	13.6
12500.0	-0.7	17.2	26.1	31.2	34.3	36.2	37.3	37.8	37.7	36.9	35.2	32.3	27.2	18.2	0.1
16000.0	-22.9	1.7	13.8	20.7	24.9	27.4	28.9	29.5	29.3	28.7	25.9	21.8	14.9	2.7	-22.2
20000.0	-55.1	-20.6	-3.8	5.8	11.6	15.2	17.1	17.9	17.5	15.9	12.6	6.9	-2.6	-19.6	-54.4
CE(A)	66.9	70.4	72.3	73.2	73.7	74.6	76.0	77.5	78.4	78.4	77.6	76.3	74.5	71.8	67.7
PNL	77.8	81.7	83.7	84.9	86.0	89.6	92.4	94.5	95.5	95.2	93.7	91.1	87.0	83.3	78.6
PNLT	78.7	82.6	84.6	85.6	87.0	91.7	95.5	97.8	98.8	98.5	96.4	92.9	88.4	84.4	79.6

GEARBOX NOISE

TURBOPROP SAMPLE CASE - CORE ENGINE INPUTS, GEARBOX, MAXIMUM PRINTING   04/14/76   16:57:01

PLANETARY (FIXED RING) GEARBOX NOISE ,   3260. SHP,   4420. INPUT RPM,   1020. OUTPUT RPM,   50. TEETH ON RING GEAR
TOOTH CONTACT FREQUENCY = 1360. HZ

SPUR-GEAR GEARBOX NOISE ,   3260. SHP,   13811. INPUT RPM,   4420. OUTPUT RPM,   75. TEETH ON OUTPUT GEAR
TOOTH CONTACT FREQUENCY = 5525. HZ

SPL ON A   0.-FOOT SIDELINE , DB
AZIMUTH ANGLE , DEG

1/3-OCTAVE-BAND CENTER FREQ. , HZ	FWD. 20.	30.	40.	50.	60.	70.	80.	90.	100.	110.	120.	130.	140.	150.	REAR 160.
25.0	40.0	43.4	45.5	47.1	48.1	48.9	49.3	49.4	49.3	48.9	48.1	47.1	45.5	43.4	40.0
31.5	40.0	43.3	45.5	47.1	48.1	48.9	49.3	49.4	49.3	48.9	48.1	47.1	45.5	43.3	40.0
40.0	40.0	43.3	45.5	47.1	48.1	48.8	49.3	49.4	49.3	48.8	48.1	47.1	45.5	43.3	40.0
50.0	40.0	43.3	45.5	47.0	48.1	48.8	49.2	49.4	49.2	48.8	48.1	47.0	45.5	43.3	40.0
63.0	39.9	43.3	45.5	47.0	48.1	48.8	49.2	49.4	49.2	48.8	48.1	47.0	45.5	43.3	39.9
80.0	39.9	43.2	45.5	47.0	48.1	48.8	49.2	49.3	49.2	48.8	48.1	47.0	45.5	43.2	39.9
100.0	39.8	43.2	45.4	47.0	48.1	48.8	49.2	49.3	49.2	48.8	48.1	47.0	45.4	43.2	39.8
125.0	39.7	43.1	45.4	46.9	48.0	48.7	49.2	49.3	49.2	48.7	48.0	46.9	45.4	43.1	39.7
160.0	39.6	43.1	45.3	46.9	48.0	48.7	49.1	49.3	49.1	48.7	48.0	46.9	45.3	43.1	39.6
200.0	39.5	43.0	45.3	46.8	47.9	48.7	49.1	49.2	49.1	48.7	47.9	46.8	45.3	43.0	39.5
250.0	39.4	42.9	45.2	46.8	47.9	48.6	49.0	49.2	49.0	48.6	47.9	46.8	45.2	42.9	39.4
315.0	39.2	42.8	45.1	46.7	47.8	48.5	49.0	49.1	49.0	48.5	47.8	46.7	45.1	42.8	39.2
400.0	38.9	42.6	45.0	46.6	47.7	48.4	48.9	49.0	48.9	48.4	47.7	46.6	45.0	42.6	38.9
500.0	39.7	43.5	45.9	47.6	48.7	49.5	49.9	50.0	49.9	49.5	48.7	47.6	45.9	43.5	39.7
630.0	40.7	44.6	47.0	48.7	49.9	50.6	51.1	51.2	51.1	50.6	49.9	48.7	47.0	44.6	40.7
800.0	40.9	44.9	47.5	49.2	50.4	51.2	51.6	51.8	51.6	51.2	50.4	49.2	47.5	44.9	40.9
1000.0	46.3	50.6	53.2	55.0	56.2	57.0	57.5	57.6	57.5	57.0	56.2	55.0	53.2	50.6	46.3
1250.0	58.3	62.8	65.6	67.4	68.7	69.5	70.0	70.1	70.0	69.5	68.7	67.4	65.6	62.8	58.3
1600.0	52.2	57.1	60.0	61.9	63.3	64.1	64.6	64.8	64.6	64.1	63.3	61.9	60.0	57.1	52.2
2000.0	44.2	49.5	52.6	54.7	56.0	56.9	57.5	57.6	57.5	56.9	56.0	54.7	52.6	49.5	44.2
2500.0	54.3	60.1	63.4	65.6	67.1	68.0	68.6	68.8	68.6	68.0	67.1	65.6	63.4	60.1	54.3
3150.0	42.5	48.9	52.6	55.0	56.6	57.6	58.2	58.4	58.2	57.6	56.6	55.0	52.6	48.9	42.5
4000.0	41.9	49.3	53.5	56.1	57.8	59.0	59.6	59.8	59.6	59.0	57.8	56.1	53.5	49.3	41.9
5000.0	48.1	56.0	60.5	63.3	65.1	66.3	66.9	67.1	66.9	66.3	65.1	63.3	60.5	56.0	48.1
6300.0	38.4	47.6	52.7	55.8	57.8	59.1	59.9	60.1	59.9	59.1	57.8	55.8	52.7	47.6	38.4
8000.0	25.3	36.7	42.7	46.4	48.8	50.3	51.1	51.4	51.1	50.3	48.8	46.4	42.7	36.7	25.3
10000.0	26.9	41.4	48.9	53.4	56.3	58.1	59.1	59.4	59.1	58.1	56.3	53.4	48.9	41.4	26.9
12500.0	4.4	22.8	32.3	37.9	41.4	43.6	44.8	45.2	44.8	43.6	41.4	37.9	32.3	22.8	4.4
16000.0	-15.4	9.7	22.4	29.8	34.5	37.3	38.9	39.4	38.9	37.3	34.5	29.8	22.4	9.7	-15.4
20000.0	-45.3	-10.2	7.2	17.3	23.6	27.4	29.5	30.1	29.5	27.4	23.6	17.3	7.2	-10.2	-45.3
DB(A)	61.9	67.1	70.3	72.5	73.9	74.9	75.4	75.6	75.4	74.9	73.9	72.5	70.3	67.1	61.9
PNL	73.1	78.9	82.5	84.8	86.3	87.3	87.8	88.0	87.8	87.3	86.3	84.8	82.5	78.9	73.1
PNLT	76.7	82.6	86.1	88.4	89.9	90.9	91.4	91.6	91.4	90.9	89.9	88.4	86.1	82.6	76.7

CORE-ENGINE COMPRESSOR NOISE

TURBOPROP SAMPLE CASE - CORE ENGINE INPUTS, GEARBOX, MAXIMUM PRINTING 04/14/76 16:57:01

RPM = 13820. , FIRST STAGE DIAMETER = 1.23 FT , 33. BLADES , ROTOR/STATOR SPACING = 10.0 %. STAGE PRESSURE RATIO = 1.2100
BLADE PASSING FREQUENCY = 7601. HZ , CONFIGURATION FROM INPUT DATA READ

SPL ON A 0.-FOOT SIDELINE , DB
AZIMUTH ANGLE , DEG

1/3-OCTAVE-BAND CENTER FREQ. , HZ	FWD. 20.	30.	40.	50.	60.	70.	80.	90.	100.	110.	120.	130.	140.	150.	REAR 160.
25.0	39.4	42.4	44.2	45.2	45.7	43.7	40.5	35.0	28.3	21.4	14.1	12.6	10.8	8.3	4.8
31.5	40.4	43.4	45.2	46.2	46.7	44.7	41.5	36.0	29.3	22.4	15.1	13.6	11.8	9.3	5.7
40.0	41.4	44.4	46.2	47.2	47.7	45.8	42.6	37.1	30.3	23.4	16.2	14.7	12.8	10.3	6.7
50.0	42.4	45.4	47.1	48.2	48.6	46.7	43.5	38.0	31.3	24.3	17.1	15.6	13.7	11.2	7.7
63.0	43.3	46.4	48.1	49.1	49.6	47.7	44.5	39.0	32.3	25.3	18.1	16.6	14.7	12.7	8.7
80.0	44.3	47.4	49.1	50.2	50.7	48.7	45.5	40.0	33.3	26.4	19.1	17.6	15.7	13.2	9.6
100.0	45.3	48.3	50.1	51.1	51.6	49.7	46.5	41.0	34.3	27.3	20.1	18.6	16.7	14.2	10.5
125.0	46.2	49.2	51.0	52.0	52.5	50.6	47.4	41.9	35.2	28.3	21.0	19.5	17.6	15.1	11.5
160.0	47.1	50.2	52.0	53.1	53.6	51.7	48.5	43.0	36.3	29.3	22.1	20.6	18.6	16.1	12.4
200.0	48.0	51.1	53.0	54.0	54.5	52.6	49.4	43.9	37.2	30.2	23.0	21.5	19.5	17.0	13.3
250.0	48.8	52.0	53.9	54.9	55.4	53.5	50.3	44.9	38.1	31.2	23.9	22.4	20.4	17.9	14.1
315.0	49.6	52.9	54.8	55.9	56.4	54.5	51.3	45.8	39.1	32.1	24.9	23.3	21.4	18.8	14.9
400.0	50.4	53.8	55.7	56.8	57.3	55.5	52.3	46.8	40.0	33.1	25.8	24.3	22.3	19.6	15.7
500.0	51.1	54.6	56.5	57.6	58.2	56.3	53.1	47.7	40.9	33.9	26.7	25.1	23.1	20.4	16.4
630.0	51.8	55.3	57.3	58.5	59.1	57.2	54.0	48.6	41.8	34.8	27.6	26.0	23.9	21.2	17.1
800.0	52.3	56.0	58.1	59.3	59.9	58.1	54.9	49.5	42.7	35.7	28.4	26.8	24.7	21.9	17.6
1000.0	52.7	56.6	58.8	60.1	60.7	58.9	55.7	50.3	43.5	36.5	29.2	27.6	25.4	22.5	18.0
1250.0	53.0	57.1	59.4	60.8	61.4	59.6	56.5	51.0	44.3	37.3	29.9	28.2	26.0	23.0	18.3
1600.0	53.0	57.5	60.0	61.4	62.2	60.4	57.3	51.8	45.0	38.0	30.6	28.9	26.6	23.4	18.3
2000.0	52.8	57.7	60.4	61.9	62.7	61.0	57.9	52.4	45.7	38.6	31.2	29.4	27.0	23.6	18.1
2500.0	52.3	57.7	60.6	62.3	63.2	61.5	58.4	53.0	46.2	39.1	31.7	29.8	27.2	23.6	17.6
3150.0	51.3	57.4	60.7	62.5	63.5	61.9	58.9	53.4	46.7	39.5	32.0	30.0	27.3	23.3	16.6
4000.0	49.7	56.7	60.5	62.6	63.7	62.2	59.2	53.8	47.0	39.8	32.2	30.0	27.0	22.6	15.0
5000.0	49.1	56.7	60.7	63.0	64.2	62.7	59.8	54.4	47.6	40.4	32.7	30.4	27.3	22.6	14.4
6300.0	46.6	55.5	60.1	62.7	64.1	62.8	59.9	54.5	47.7	55.7	51.7	49.1	45.5	40.1	30.5
8000.0	42.0	52.9	58.5	61.7	78.8	77.4	74.4	68.9	61.8	40.0	32.0	29.2	25.1	18.8	7.3
10000.0	51.4	65.1	71.8	75.1	61.9	61.1	58.5	53.2	46.2	38.7	30.4	27.1	22.2	14.4	-0.2
12500.0	24.5	42.6	51.6	56.7	59.6	59.2	56.8	51.5	44.6	41.7	35.9	31.9	25.8	15.9	-2.8
16000.0	7.1	31.9	44.1	51.0	55.9	60.0	57.8	52.3	44.9	31.0	21.2	15.7	7.6	-5.7	-31.2
20000.0	-13.4	21.0	37.6	46.5	45.8	46.4	44.2	38.6	35.2	26.3	18.8	11.9	1.3	-15.6	-51.9
SE(A)	63.1	69.7	73.4	75.8	75.2	77.8	74.8	69.3	62.3	56.6	52.0	49.5	46.0	40.8	32.4
PNL	75.9	82.0	86.4	88.5	92.7	91.2	88.2	82.7	75.7	70.8	65.6	63.1	59.8	54.9	46.7
PNLT	78.2	84.4	88.9	91.3	95.3	93.8	90.7	85.2	78.2	73.4	68.8	66.4	63.0	58.1	50.0

CORE-ENGINE COMBUSTION NOISE

TURBOPROP SAMPLE CASE - CORE ENGINE INPUTS, GEARBOX, MAXIMUM PRINTING 04/14/76 16:57:01

INLET TOTAL PRESSURE = 20160. PSF , INLET TOTAL TEMPERATURE = 1069. R , EXIT TOTAL TEMPERATURE = 2026. R
MASS FLOW RATE = 34.0 LB/SEC , TURBOSHAFT ENGINE , CONFIGURATION FROM INPUT DATA READ

SPL ON A 0.-FOOT SIDELINE , DB
AZIMUTH ANGLE , DEG

1/3-OCTAVE-BAND CENTER FREQ. , HZ	FWD. 20.	30.	40.	50.	60.	70.	80.	90.	100.	110.	120.	130.	140.	150.	REAR 160.
25.0	26.2	31.7	36.0	39.5	42.6	45.3	47.7	49.8	51.7	53.3	54.0	51.5	47.0	42.0	35.8
31.5	28.6	34.1	38.4	41.9	45.0	47.7	50.1	52.2	54.1	55.7	56.4	53.9	49.4	44.4	33.2
40.0	31.0	36.5	40.8	44.4	47.5	50.2	52.6	54.7	56.6	58.2	58.8	56.4	51.9	46.8	40.7
50.0	33.3	38.8	43.1	46.7	49.8	52.5	54.9	57.0	58.9	60.5	61.1	58.7	54.2	49.1	42.9
63.0	35.7	41.2	45.5	49.1	52.2	54.9	57.3	59.4	61.3	62.9	63.5	61.1	56.6	51.5	45.3
80.0	38.1	43.7	48.0	51.6	54.7	57.4	59.8	61.9	63.8	65.4	66.0	63.6	59.1	54.0	47.8
100.0	40.4	46.0	50.3	53.9	57.0	59.7	62.1	64.2	66.1	67.7	68.3	65.9	61.4	56.3	50.0
125.0	42.6	48.2	52.6	56.2	59.3	62.0	64.4	66.5	68.4	70.0	70.6	68.2	63.7	58.5	52.3
160.0	45.1	50.7	55.1	58.7	61.8	64.5	66.9	69.0	70.9	72.5	73.1	70.7	66.2	61.0	54.7
200.0	47.3	53.0	57.3	61.0	64.1	66.8	69.2	71.3	73.2	74.8	75.4	73.0	68.4	63.3	56.9
250.0	49.5	55.2	59.6	63.2	66.3	69.1	71.5	73.6	75.5	77.1	77.7	75.2	70.7	65.5	59.1
315.0	50.9	56.6	61.1	64.7	67.8	70.6	73.0	75.1	76.9	78.6	79.2	76.7	72.1	66.9	60.5
400.0	51.6	57.5	62.0	65.6	68.8	71.5	73.9	76.0	77.9	79.5	80.1	77.6	73.0	67.8	61.3
500.0	50.4	56.3	60.8	64.5	67.7	70.4	72.8	75.0	76.8	78.4	79.0	76.5	71.9	66.6	60.0
630.0	48.5	54.6	59.1	62.9	66.1	68.8	71.2	73.4	75.2	76.8	77.4	74.9	70.2	64.9	58.1
800.0	45.5	51.7	56.4	60.2	63.4	66.1	68.6	70.7	72.5	74.1	74.7	72.1	67.5	62.0	55.1
1000.0	42.5	49.0	53.7	57.6	60.8	63.6	66.0	68.1	70.0	71.6	72.1	69.5	64.8	59.3	52.2
1250.0	39.4	46.1	51.0	54.9	58.1	61.0	63.4	65.6	67.4	69.0	69.5	66.9	62.1	56.4	49.1
1600.0	35.8	42.9	47.8	51.8	55.1	58.0	60.5	62.6	64.5	66.0	66.5	63.8	58.9	53.1	45.4
2000.0	32.1	39.6	44.8	48.9	52.3	55.2	57.7	59.8	61.7	63.2	63.6	60.9	55.9	49.9	41.8
2500.0	28.2	36.1	41.6	45.9	49.3	52.3	54.8	57.0	58.9	60.3	60.7	57.8	52.7	46.4	37.8
3150.0	23.6	32.2	38.0	42.5	46.1	49.1	51.6	53.8	55.6	57.1	57.4	54.4	49.1	42.5	33.2
4000.0	18.1	27.7	34.0	38.6	42.4	45.5	48.1	50.3	52.1	53.5	53.7	50.6	45.0	38.0	27.7
5000.0	14.0	24.1	30.7	35.5	39.4	42.5	45.1	47.3	49.1	50.5	50.7	47.5	41.8	34.4	23.6
6300.0	7.5	19.0	26.1	31.3	35.3	38.6	41.3	43.6	45.3	46.6	46.7	43.3	37.2	29.3	17.2
8000.0	-1.5	12.0	20.2	25.9	30.3	33.8	36.6	38.8	40.6	41.8	41.6	37.9	31.2	22.3	8.2
10000.0	-13.6	3.0	12.6	19.2	24.1	27.9	30.8	33.2	34.8	35.9	35.4	31.2	23.7	13.3	-4.0
12500.0	-28.6	-8.0	3.6	11.2	16.8	20.9	24.1	26.5	28.1	29.0	28.1	23.2	14.7	2.3	-18.9
16000.0	-52.4	-25.1	-10.3	-0.8	5.3	10.6	14.2	16.7	18.2	18.5	17.1	11.1	0.8	-14.8	-42.8
20000.0	-86.1	-48.9	-29.3	-17.1	-8.9	-3.1	1.0	3.6	5.0	4.9	2.4	-5.2	-18.2	-38.6	-76.4
DB(A)	54.1	60.2	64.7	68.5	71.7	74.4	76.8	79.0	80.8	82.4	83.0	80.5	75.8	70.5	63.7
PNL	63.5	69.9	74.6	78.5	81.8	84.7	87.2	89.4	91.3	92.9	93.4	90.8	86.0	80.4	73.3
PNLT	63.5	69.9	74.6	78.5	81.8	84.7	87.2	89.4	91.3	92.9	93.4	90.8	86.0	80.4	73.3

CORE-ENGINE TURBINE NOISE

TURBOPROP SAMPLE CASE - CORE ENGINE INPUTS, GEARBOX, MAXIMUM PRINTING 04/14/76 16:57:01

LAST ROTOR STAGE HAS 65. BLADES , STATOR-ROTOR SPACING/STATOR CHORD = 30.0 % , EXHAUST CORRECTION = 0. DB
RPM = 13820. , BLADE PASSING FREQUENCY =14972. HZ , LAST ROTOR RELATIVE TIP SPEED = 950. FPS , EXIT SPEED OF SOUND = 1731. FPS
MASS FLOW RATE = 34.0 LB/SEC , DESIGN (TAKEOFF) HORSEPOWER = 3260. , OPERATING HP = 3260. , CONFIGURATION FROM INPUT DATA READ

SPL ON A 0.-FOOT SIDELINE , DB

1/3-OCTAVE-BAND CENTER FREQ., HZ	FWD. 20.	30.	40.	50.	60.	70.	80.	90.	100.	110.	120.	130.	140.	150.	REAR 160.
	AZIMUTH ANGLE , DEG														
25.0	21.8	28.6	34.2	39.0	43.3	46.2	48.8	51.1	53.2	53.2	50.7	45.2	39.4	31.8	23.2
31.5	22.7	29.6	35.2	40.0	44.3	47.2	49.8	52.1	54.2	54.2	51.7	46.2	40.4	32.8	24.2
40.0	23.7	30.6	36.2	41.1	45.4	48.2	50.8	53.1	55.2	55.3	52.7	47.2	41.4	33.8	25.2
50.0	24.7	31.5	37.2	42.0	46.3	49.2	51.8	54.1	56.2	56.2	53.6	48.2	42.4	34.8	26.2
63.0	25.7	32.6	38.2	43.0	47.3	50.2	52.8	55.1	57.1	57.2	54.6	49.2	43.4	35.8	27.1
80.0	26.6	33.6	39.2	44.0	48.3	51.2	53.8	56.1	58.2	58.2	55.6	50.2	44.4	36.8	28.1
100.0	27.6	34.5	40.1	45.0	49.3	52.2	54.7	57.0	59.1	59.2	56.6	51.1	45.3	37.7	29.0
125.0	28.4	35.4	41.1	45.9	50.2	53.1	55.7	58.0	60.1	60.1	57.5	52.1	46.2	38.6	29.9
160.0	29.4	36.4	42.1	46.9	51.2	54.1	56.7	59.0	61.1	61.1	58.6	53.1	47.2	39.6	30.9
200.0	30.3	37.3	43.0	47.8	52.2	55.1	57.6	59.9	62.0	62.1	59.5	54.0	48.2	40.5	31.7
250.0	31.1	38.2	43.9	48.7	53.1	56.0	58.5	60.9	62.9	63.0	60.4	54.9	49.0	41.4	32.6
315.0	31.9	39.0	44.8	49.7	54.0	56.9	59.5	61.8	63.9	63.9	61.3	55.8	49.9	42.2	33.4
400.0	32.7	39.9	45.7	50.6	54.9	57.8	60.4	62.7	64.8	64.9	62.3	56.8	50.8	43.1	34.1
500.0	33.3	40.7	46.5	51.4	55.8	58.7	61.3	63.6	65.7	65.7	63.1	57.6	51.6	43.9	34.8
630.0	33.9	41.4	47.3	52.2	56.6	59.6	62.2	64.5	66.5	66.6	64.0	58.4	52.4	44.6	35.4
800.0	34.5	42.1	48.0	53.0	57.5	60.4	63.0	65.3	67.4	67.4	64.8	59.2	53.2	45.3	35.9
1000.0	34.8	42.6	48.7	53.7	58.2	61.2	63.8	66.1	68.2	68.2	65.5	59.9	53.8	45.8	36.3
1250.0	35.0	43.0	49.2	54.4	58.8	61.8	64.5	66.8	68.9	68.9	66.2	60.5	54.4	46.2	36.5
1600.0	35.0	43.4	49.7	54.9	59.5	62.5	65.2	67.5	69.5	69.5	66.8	61.1	54.9	46.6	36.4
2000.0	34.6	43.5	50.0	55.3	59.9	63.0	65.7	68.0	70.1	70.0	67.3	61.5	55.2	46.7	36.1
2500.0	34.0	43.3	50.1	55.6	60.3	63.4	66.1	68.4	70.5	70.4	67.6	61.7	55.3	46.5	35.4
3150.0	32.8	42.8	49.9	55.6	60.4	63.6	66.3	68.7	70.7	70.6	67.7	61.8	55.1	46.0	34.2
4000.0	30.8	41.8	49.4	55.3	60.3	63.5	66.3	68.7	70.7	70.6	67.6	61.5	54.5	45.0	32.3
5000.0	30.0	41.5	49.4	55.5	60.5	63.9	66.7	69.1	71.1	70.9	67.8	61.6	54.6	44.7	31.5
6300.0	27.0	39.8	48.2	54.7	59.9	63.4	66.3	68.7	70.7	70.4	67.2	60.8	53.4	43.0	28.4
8000.0	21.5	36.4	45.8	52.8	58.4	62.1	65.0	67.5	69.4	69.1	65.7	59.0	51.0	39.6	23.0
10000.0	12.7	30.6	41.6	49.4	55.5	59.5	62.6	65.1	67.0	66.5	62.8	55.6	46.7	33.8	14.1
12500.0	1.0	22.9	35.8	44.7	51.5	55.8	59.2	61.7	63.6	62.8	58.8	50.9	41.0	26.1	2.5
16000.0	38.0	44.9	50.5	55.3	59.7	63.6	67.2	70.4	73.5	74.8	71.4	63.8	55.8	47.2	37.6
20000.0	-53.3	-14.8	6.1	19.5	29.0	35.0	39.2	42.0	43.6	42.0	36.3	25.7	11.3	-11.6	-51.9
DB(A)	44.9	53.8	60.6	66.2	71.0	74.2	76.9	75.3	81.4	81.3	78.4	72.4	65.8	57.0	46.3
PNL	56.9	66.5	73.7	79.4	84.2	87.4	90.2	92.6	94.6	94.5	91.6	85.6	78.9	69.8	58.4
PNLT	56.9	66.5	73.7	79.4	84.2	87.4	90.2	92.6	94.6	94.5	91.6	85.6	78.9	69.8	58.4

TOTAL CORE ENGINE NOISE

TURBOPROP SAMPLE CASE - CORE ENGINE INPUTS, GEARBOX, MAXIMUM PRINTING 04/14/76 16:57:01

SPL ON A 0.-FOOT SIDELINE , DB
AZIMUTH ANGLE , DEG

1/3-OCTAVE-BAND CENTER FREQ. , HZ	FWD. 20.	30.	40.	50.	60.	70.	80.	90.	100.	110.	120.	130.	140.	150.	REAR 160.
25.0	39.7	42.9	45.1	47.0	48.8	50.0	51.6	53.6	55.5	56.3	55.6	52.4	47.7	42.4	36.0
31.5	40.8	44.1	46.3	48.3	50.2	51.5	53.3	55.2	57.1	58.0	57.6	54.6	50.0	44.7	38.4
40.0	41.9	45.2	47.6	49.7	51.7	53.2	55.0	57.0	59.0	60.0	59.8	56.9	52.3	47.0	40.8
50.0	42.9	46.4	48.9	51.1	53.3	54.9	56.8	58.8	60.7	61.9	61.9	59.1	54.5	49.3	43.0
63.0	44.1	47.7	50.3	52.6	54.9	56.7	58.8	60.8	62.7	63.9	64.1	61.4	56.8	51.6	45.4
80.0	45.3	49.0	51.9	54.4	56.8	58.8	60.9	62.9	64.8	66.1	66.4	63.8	59.2	54.1	47.8
100.0	46.5	50.4	53.4	56.1	58.6	60.7	62.9	65.0	66.9	68.3	68.6	66.0	61.5	56.3	50.1
125.0	47.8	51.9	55.1	57.9	60.5	62.8	65.0	67.1	69.0	70.4	70.8	68.3	63.7	58.6	52.3
160.0	49.3	53.6	57.0	60.0	62.7	65.1	67.4	69.4	71.3	72.8	73.3	70.8	66.2	61.1	54.8
200.0	50.7	55.2	58.8	61.9	64.8	67.2	69.5	71.6	73.5	75.0	75.5	73.0	68.5	63.3	57.0
250.0	52.2	57.0	60.7	64.0	66.9	69.4	71.7	73.8	75.7	77.2	77.8	75.3	70.7	65.5	59.1
315.0	53.3	58.2	62.1	65.4	68.3	70.8	73.2	75.3	77.2	78.7	79.2	76.7	72.2	66.9	60.5
400.0	54.1	59.1	63.0	66.3	69.2	71.8	74.1	76.2	78.1	79.6	80.2	77.6	73.1	67.8	61.3
500.0	53.8	58.6	62.3	65.5	68.4	70.9	73.2	75.3	77.1	78.6	79.1	76.6	72.0	66.6	60.0
630.0	53.5	58.1	61.5	64.5	67.2	69.6	71.8	73.9	75.8	77.2	77.6	75.0	70.3	64.9	58.2
800.0	53.2	57.5	60.6	63.2	65.7	67.7	69.8	71.8	73.7	75.0	75.1	72.4	67.6	62.1	55.2
1000.0	53.2	57.5	60.3	62.6	64.8	66.4	68.3	70.3	72.2	73.2	73.0	70.0	65.1	59.5	52.3
1250.0	53.2	57.6	60.4	62.5	64.5	65.7	67.4	69.3	71.2	71.9	71.1	67.8	62.8	56.8	49.3
1600.0	53.2	57.8	60.6	62.7	64.6	65.5	66.9	68.8	70.7	71.1	69.7	65.7	60.4	54.0	45.9
2000.0	52.9	57.9	60.9	63.0	64.8	65.5	66.9	68.7	70.7	70.8	68.8	64.2	58.6	51.6	42.8
2500.0	52.3	57.9	61.0	63.2	65.1	65.8	67.0	68.8	70.8	70.8	68.4	63.2	57.2	49.5	39.8
3150.0	51.3	57.6	61.0	63.4	65.3	65.9	67.2	68.9	70.9	70.8	68.1	62.5	56.1	47.6	36.8
4000.0	49.7	56.9	60.8	63.3	65.4	66.0	67.2	68.9	70.8	70.6	67.8	61.8	55.0	45.8	33.7
5000.0	49.1	56.3	61.0	63.7	65.8	66.4	67.5	69.2	71.1	70.9	67.9	61.8	54.8	45.2	32.2
6300.0	46.6	55.6	60.4	63.3	65.5	66.1	67.2	68.9	70.7	70.6	67.4	61.2	54.2	44.9	32.7
8000.0	42.0	53.0	58.8	62.2	78.8	77.6	74.9	71.3	70.1	69.1	65.7	59.0	51.0	39.7	23.2
10000.0	51.4	65.1	71.8	75.1	62.8	63.4	64.0	65.4	67.0	66.5	62.8	55.6	46.8	33.9	14.4
12500.0	24.5	42.6	51.7	56.9	60.2	60.8	61.2	62.1	63.6	62.9	58.8	50.9	41.1	26.6	3.6
16000.0	38.0	45.1	51.4	56.7	62.8	65.2	67.6	70.5	73.5	74.8	71.4	63.8	55.8	47.2	37.6
20000.0	-13.4	21.0	37.6	46.6	45.5	46.7	45.4	43.7	44.2	42.1	36.4	25.9	11.7	-10.4	-48.9
DB(A)	63.6	69.8	74.1	77.0	80.4	80.6	81.1	82.4	84.1	84.9	84.3	81.1	76.2	70.7	63.8
PNL	76.5	82.8	87.5	90.5	94.7	94.8	94.7	95.5	97.3	97.7	96.5	93.0	87.7	81.5	73.9
PNLT	78.9	85.3	90.0	92.8	97.1	97.0	96.3	96.2	97.3	97.7	96.5	93.0	87.7	81.5	74.8

***** OFF SPECTRUM CURVE AT 16000.0 HZ
***** OFF SPECTRUM CURVE AT 20000.0 HZ

CORE ENGINE JET NOISE

TURBOFKUP SAMPLE CASE - CORE ENGINE INPUTS, GEARBCX, MAXIMUM PRINTING 04/14/76 16:57:01
JET FLOW RATE = 34.0 LB/SEC , THRUST = 376. LB , AREA = 1.6 SQ.FT

SPL ON A 0.-FOOT SIDELINE , DB

1/3-OCTAVE-BAND CENTER FREQ. , HZ	FWD. 20.	30.	40.	50.	60.	70.	AZIMUTH ANGLE , DEG 80.	90.	100.	110.	120.	130.	140.	150.	REAR 160.
25.0	38.3	42.2	44.8	46.8	48.3	49.5	50.6	51.3	50.4	48.4	46.0	43.1	40.2	35.2	48.0
31.5	40.2	44.1	46.7	48.7	50.3	51.5	52.6	53.3	52.5	50.5	48.1	45.4	47.7	37.5	50.3
40.0	42.1	46.0	48.7	50.7	52.2	53.4	54.5	55.3	54.5	53.0	50.6	48.3	45.7	40.4	53.2
50.0	43.5	47.5	50.2	52.3	53.9	55.1	56.3	57.1	56.2	55.0	52.9	50.9	48.2	43.0	55.8
63.0	44.8	48.8	51.5	53.6	55.3	56.6	57.9	58.7	57.9	56.9	54.8	53.3	50.6	45.3	58.1
80.0	46.0	50.1	52.8	54.5	56.6	57.9	59.2	60.0	59.5	58.6	56.4	55.4	52.5	47.3	60.1
100.0	47.0	51.1	53.8	56.0	57.8	59.1	60.4	61.3	60.9	60.1	57.9	56.9	53.8	48.7	61.5
125.0	47.7	51.8	54.6	56.8	58.6	60.0	61.4	62.3	62.1	61.3	59.1	57.8	54.3	49.2	62.0
160.0	48.2	52.4	55.2	57.5	59.4	60.8	62.2	63.2	63.2	62.3	60.2	58.4	54.2	48.8	61.5
200.0	48.4	52.7	55.6	57.9	59.8	61.3	62.7	63.7	63.9	63.0	60.9	58.4	53.7	47.7	60.4
250.0	48.5	52.8	55.7	58.1	60.0	61.6	63.0	64.1	64.3	63.4	61.2	58.2	52.8	46.0	58.6
315.0	48.3	52.7	55.7	58.1	60.1	61.7	63.2	64.3	64.4	63.5	61.5	57.7	51.7	44.0	56.5
400.0	47.9	52.4	55.4	57.9	59.9	61.6	63.1	64.2	64.5	63.4	61.4	56.9	50.3	41.7	54.1
500.0	47.3	52.0	55.1	57.6	59.7	61.3	62.9	64.0	64.2	63.0	61.1	55.8	48.6	39.4	51.6
630.0	46.5	51.3	54.5	57.1	59.2	60.9	62.5	63.7	63.7	62.4	60.6	54.5	46.7	37.0	49.0
800.0	45.4	50.3	53.6	56.3	58.5	60.2	61.9	63.1	62.9	61.8	59.7	53.0	44.7	34.3	46.0
1000.0	43.9	49.1	52.5	55.3	57.5	59.4	61.1	62.4	61.9	60.6	58.5	51.2	42.3	31.4	42.8
1250.0	42.2	47.6	51.2	54.0	56.4	58.2	60.0	61.3	60.8	59.4	57.0	49.2	39.8	28.3	39.2
1600.0	40.0	45.8	49.5	52.5	54.9	56.8	58.6	59.9	59.3	57.9	55.2	46.8	36.9	24.9	35.2
2000.0	37.7	43.9	47.9	51.0	53.4	55.4	57.2	58.5	57.5	56.0	53.1	44.1	33.6	20.8	30.3
2500.0	34.9	41.6	45.8	49.1	51.7	53.8	55.6	57.0	55.9	53.9	50.7	41.3	30.1	16.6	25.1
3150.0	31.4	38.8	43.4	46.8	49.6	51.7	53.6	55.0	53.6	51.5	48.0	37.9	26.1	11.8	19.1
4000.0	27.0	35.3	40.4	44.1	47.0	49.3	51.2	52.7	50.6	48.7	44.8	34.0	21.3	6.1	11.7
5000.0	23.7	32.6	37.9	41.5	44.5	47.2	49.3	50.7	48.7	45.9	41.7	30.2	16.5	0.2	4.0
6300.0	18.1	28.3	34.3	38.6	41.8	44.2	46.3	47.8	45.7	42.4	38.1	25.9	11.5	-6.0	-4.0
8000.0	9.9	22.2	29.1	34.0	37.5	40.2	42.5	44.0	41.5	37.6	32.8	19.8	4.1	-15.1	-16.4
10000.0	-1.3	14.0	22.3	28.0	32.1	35.1	37.5	39.1	35.6	31.1	25.1	10.8	-6.7	-29.2	-36.2
12500.0	-14.7	4.5	14.7	21.3	25.9	29.2	31.6	33.1	28.2	23.1	15.8	-0.2	-20.1	-46.7	-61.1
16000.0	-36.0	-10.1	3.3	11.6	17.1	20.8	23.4	24.9	19.1	12.3	3.6	-14.7	-37.4	-69.4	-93.9
20000.0	48.7	39.8	34.0	29.6	25.8	22.1	18.4	14.2	6.2	-3.5	-15.5	-38.2	-66.7	-108.6	-151.8
DB(A)	53.4	58.2	61.6	64.4	66.6	68.4	70.1	71.3	70.9	69.6	67.4	61.4	54.2	46.0	58.4
PNL	63.5	68.8	72.5	75.5	78.0	79.9	81.7	83.0	82.2	80.6	78.0	72.2	64.9	56.0	69.2
PNLT	63.5	68.8	72.5	75.5	78.0	79.9	81.7	83.0	82.2	80.6	78.0	72.2	64.9	56.0	69.2

TOTAL PROPULSOR NOISE WITHOUT NOISE SUPPRESSION

TURBOPROP SAMPLE CASE - CORE ENGINE INLETS, GEARBOX, MAXIMUM PRINTING 04/14/76 16:57:01

SPL ON A 0.-FOOT SIDELINE , DB

1/3-OCTAVE-BAND CENTER FREQ. , HZ	FWD. 20.	30.	40.	50.	60.	70.	80.	90.	100.	110.	120.	130.	140.	150.	REAR 160.
							AZIMUTH ANGLE , DEG								
25.0	45.6	48.9	51.1	52.7	54.0	54.9	55.9	57.0	57.8	58.0	57.2	54.7	51.5	48.2	49.5
31.5	47.0	50.2	52.4	54.0	55.4	56.4	57.5	58.6	59.4	59.6	59.0	56.5	53.3	49.9	51.6
40.0	48.5	51.7	53.9	55.6	57.0	58.0	59.2	60.3	61.2	61.5	61.1	58.7	55.4	51.8	54.2
50.0	49.9	53.2	55.4	57.1	58.5	59.6	60.8	62.0	62.9	63.4	63.1	60.8	57.4	53.8	56.6
63.0	64.0	66.6	68.0	73.4	81.8	88.3	92.7	95.4	96.4	95.9	93.7	89.6	83.2	74.4	66.5
80.0	53.3	56.5	58.7	60.4	61.8	63.1	64.4	65.7	66.7	67.5	67.4	65.3	61.8	58.0	50.9
100.0	54.9	58.2	60.3	62.0	63.5	64.8	66.2	67.5	68.6	69.5	69.5	67.4	63.9	60.1	62.5
125.0	61.5	64.4	65.8	66.6	69.1	75.2	80.6	83.6	84.2	82.6	79.0	74.3	70.2	66.8	65.3
160.0	58.6	61.8	63.9	65.6	67.1	68.5	70.0	71.4	72.7	73.8	74.0	71.8	68.2	64.4	63.8
200.0	62.2	65.2	67.0	68.3	69.4	71.1	73.4	75.6	76.7	77.1	77.0	74.9	71.5	67.9	65.3
250.0	63.0	66.2	68.2	69.6	71.0	72.5	74.1	75.8	77.2	78.4	78.7	76.5	72.9	69.2	65.6
315.0	63.6	66.9	68.9	70.5	72.0	73.6	75.2	76.9	78.3	79.6	79.9	77.7	74.0	70.1	66.0
400.0	63.4	66.8	69.1	70.8	72.4	74.1	75.8	77.5	79.0	80.3	80.7	78.4	74.5	70.4	65.8
500.0	62.7	66.2	68.4	70.0	71.6	73.2	75.0	76.7	78.2	79.4	79.8	77.5	73.6	69.5	64.8
630.0	61.1	64.7	67.0	68.7	70.3	71.9	73.6	75.3	76.9	78.0	78.3	75.9	72.0	67.8	62.9
800.0	59.8	63.5	65.8	67.4	68.9	70.2	71.9	73.6	75.1	75.0	76.1	73.6	69.9	65.8	60.9
1000.0	58.6	62.5	64.8	66.5	67.9	69.1	70.7	72.3	73.7	74.4	74.1	71.5	67.8	63.9	58.9
1250.0	60.8	65.1	67.8	69.5	70.8	71.8	72.7	73.7	74.5	74.7	73.9	71.6	68.7	65.4	60.5
1600.0	57.7	62.3	65.0	66.7	68.1	69.0	70.1	71.5	72.8	73.0	71.8	69.0	65.7	62.0	56.7
2000.0	55.4	60.4	63.1	65.0	66.5	67.3	68.6	70.3	71.8	71.9	70.3	66.7	63.0	58.8	53.0
2500.0	57.2	62.8	66.0	68.1	69.6	70.5	71.4	72.4	73.4	73.2	71.5	68.6	65.6	61.8	55.8
3150.0	53.0	59.1	62.5	64.7	66.4	67.1	68.4	70.0	71.7	71.6	69.3	65.0	60.8	55.8	48.8
4000.0	51.1	58.2	62.1	64.5	66.4	67.1	68.3	69.9	71.5	71.3	68.8	64.2	59.6	54.1	46.1
5000.0	52.0	59.8	64.0	66.7	68.6	69.5	70.4	71.6	72.7	72.5	70.1	66.2	62.3	57.2	49.0
6300.0	47.5	56.5	61.3	64.2	66.4	67.1	68.1	69.6	71.2	71.1	68.2	63.0	57.6	51.1	41.2
8000.0	47.1	53.2	58.9	62.4	78.8	77.6	74.9	71.3	70.2	69.2	65.9	59.4	52.0	42.4	29.1
10000.0	51.4	65.2	71.8	75.2	63.7	64.5	65.3	66.4	67.7	67.1	63.7	57.7	51.1	42.2	27.4
12500.0	24.6	42.7	51.8	57.0	60.3	60.9	61.3	62.3	63.7	62.9	58.9	51.2	41.8	28.5	7.8
16000.0	38.0	45.1	51.4	56.7	62.8	65.2	67.6	70.5	73.5	74.8	71.4	63.8	55.8	47.2	37.6
20000.0	48.7	39.8	39.2	46.6	45.9	46.7	45.5	43.9	44.3	42.2	36.5	26.5	13.1	-7.0	-43.3
OE(A)	69.5	74.2	77.4	79.6	82.1	82.6	83.3	84.5	85.8	86.2	85.5	82.8	79.1	75.1	70.2
PNL	82.1	87.5	90.7	92.9	96.7	97.1	97.6	99.3	100.5	100.5	99.0	95.5	91.6	87.0	81.7
PNLT	84.5	90.1	93.3	95.4	99.0	99.1	99.7	101.7	102.8	102.3	100.2	96.2	92.8	88.6	83.5

TOTAL PROPULSOR SOUND POWER AND DIRECTIVITY INDICES

TURBOPROP SAMPLE CASE - CORE ENGINE INPUTS, GEARBOX, MAXIMUM PRINTING   04/14/76   16:57:01

1/3-OCTAVE-BAND CENTER FREQ. , HZ	SOUND POWER LEVEL, DB	DIRECTIVITY INDICES , DB — AZIMUTH ANGLE , DEG														
		FWD. 20.	30.	40.	50.	60.	70.	80.	90.	100.	110.	120.	130.	140.	150.	REAR 160.
25.0	122.5	-1.6	-1.8	-1.9	-1.8	-1.6	-1.3	-0.7	0.4	1.4	2.0	1.9	0.5	-1.1	-2.2	4.0
31.5	124.2	-2.1	-2.2	-2.3	-2.2	-1.9	-1.6	-0.8	0.2	1.3	2.0	2.0	0.7	-0.9	-2.2	4.9
40.0	126.1	-2.5	-2.6	-2.7	-2.6	-2.3	-1.9	-1.1	0.1	1.1	2.0	2.2	1.0	-0.7	-2.1	5.7
50.0	128.0	-2.8	-3.0	-3.1	-2.9	-2.6	-2.1	-1.2	-0.1	1.0	2.0	2.4	1.2	-0.5	-2.0	6.1
63.0	158.1	-18.8	-19.6	-20.4	-16.5	-9.1	-3.4	0.6	3.1	4.3	4.2	2.7	-0.3	-5.2	-11.8	-15.9
80.0	131.9	-3.3	-3.5	-3.6	-3.5	-3.1	-2.5	-1.5	-0.3	0.9	2.1	2.8	1.9	-0.1	-1.7	5.9
100.0	133.7	-3.4	-3.6	-3.7	-3.6	-3.2	-2.6	-1.6	-0.3	1.0	2.3	3.1	2.0	0.0	-1.5	4.9
125.0	145.5	-6.5	-9.0	-9.9	-10.7	-9.2	-3.8	1.1	4.0	4.8	3.6	0.7	-2.9	-5.4	-6.6	-4.7
160.0	137.7	-3.5	-3.7	-3.9	-3.8	-3.3	-2.7	-1.6	-0.3	1.2	2.7	3.6	2.5	0.4	-1.2	1.4
200.0	141.0	-3.1	-3.5	-4.0	-4.3	-4.2	-3.4	-1.4	0.6	1.9	2.7	3.3	2.3	0.5	-0.8	-0.3
250.0	142.2	-3.3	-3.6	-3.9	-4.1	-3.8	-3.1	-1.9	-0.4	1.2	2.8	3.8	2.8	0.8	-0.7	-0.9
315.0	143.4	-3.7	-4.0	-4.3	-4.3	-3.9	-3.1	-1.9	-0.4	1.2	2.9	4.0	2.9	0.7	-0.8	-1.5
400.0	144.1	-4.3	-4.6	-4.7	-4.6	-4.1	-3.2	-1.9	-0.4	1.3	3.0	4.1	3.0	0.7	-1.0	-2.0
500.0	143.4	-4.0	-4.3	-4.5	-4.5	-4.1	-3.2	-1.9	-0.4	1.3	3.0	4.1	2.9	0.7	-1.0	-2.0
630.0	142.1	-3.8	-4.1	-4.3	-4.3	-3.9	-3.1	-1.8	-0.3	1.4	3.0	4.0	2.8	0.6	-1.1	-2.2
800.0	140.4	-2.8	-3.1	-3.5	-3.6	-3.4	-2.9	-1.7	-0.1	1.5	2.9	3.7	2.4	0.4	-1.1	-2.0
1000.0	139.1	-2.0	-2.3	-2.7	-2.9	-2.7	-2.4	-1.4	0.0	1.6	2.8	3.3	1.9	0.0	-1.3	-2.1
1250.0	140.6	-0.6	-0.8	-1.0	-1.1	-1.1	-1.1	-0.6	0.2	1.2	1.8	1.9	0.9	-0.2	-0.8	-1.1
1600.0	138.7	-0.4	-0.8	-1.1	-1.4	-1.4	-1.5	-0.9	0.3	1.7	2.4	2.1	0.6	-0.7	-1.6	-2.0
2000.0	137.7	-0.2	-0.6	-1.0	-1.4	-1.4	-1.7	-1.0	0.5	2.2	2.8	2.0	-0.1	-1.8	-2.9	-3.4
2500.0	140.5	0.1	-0.1	-0.4	-0.6	-0.6	-0.8	-0.5	0.4	1.5	1.9	1.2	-0.3	-1.1	-1.6	-1.8
3150.0	138.7	0.3	-0.1	-0.5	-0.9	-0.9	-1.4	-0.9	0.6	2.4	2.9	1.6	-1.1	-2.9	-4.2	-4.8
4000.0	139.6	0.6	0.2	-0.2	-0.6	-0.6	-1.2	-0.8	0.5	2.4	2.8	1.4	-1.5	-3.5	-4.8	-5.4
5000.0	142.1	0.6	0.3	0.0	-0.3	-0.3	-0.7	-0.5	0.4	1.8	2.2	1.0	-1.1	-2.2	-2.8	-3.1
6300.0	141.5	1.1	0.7	0.3	-0.1	-0.2	-1.0	-0.8	0.4	2.3	2.7	1.1	-2.1	-4.4	-6.0	-6.6
8000.0	153.5	6.9	6.3	5.4	4.2	2.5	-0.3	-3.8	-7.6	-8.5	-8.6	-10.4	-14.4	-17.8	-20.9	-22.4
10000.0	144.4	2.2	1.5	1.4	1.0	0.7	-0.5	-0.9	-0.1	1.5	1.9	0.3	-2.8	-4.9	-6.2	-6.7
12500.0	145.3	3.5	3.0	2.5	1.9	1.5	-0.3	-1.4	-0.9	0.9	1.4	-0.5	-4.7	-8.5	-12.5	-14.9
16000.0	170.6	11.8	-5.6	-10.7	-12.4	-13.4	-13.9	-13.0	-10.5	-7.1	-4.2	-4.7	-7.8	-8.3	-4.2	11.3
20000.0	148.4	5.4	5.0	4.4	3.7	3.0	0.5	-2.4	-4.4	-3.6	-3.3	-5.1	-9.1	-12.4	-15.3	-16.7

FOR SIDELINE DISTANCE OF 0. FT THE EFFECTIVE PERCEIVED NOISE LEVEL = 95.9 EPNDB

PROGRAM INFO		INPUT DATA					LABEL
n	LOCATION NO.	1	2	3	4	5	
	FIXED-PITCH FAN SAMPLE CASE - GEN. ENGINE, GEARBOX, INTERMEDIATE PRINTING						
5	4.	0.	0.	1.	0.	0.	
2	9.	100.	0.				
4	22.	1.	1.	360.	0.		
1	124.	0.					
5	77.	1082.	3.21	1.	2.	1.	
2	82.	.61	1.3				
1	86.	7.1					
1	89.	40.					
1	92.	0.					
2	216.	1.	0.				
4	360.	1.	3.	29.	2.38		
0	-1.						

FIGURE 19. FIXED PITCH FAN SAMPLE CASE INPUT DATA

FIXED-PITCH FAN SAMPLE CASE - GEN. ENGINE, GEARBOX, INTERMEDIATE PRINTING   04/14/76 16:57:34

DESIGN (TAKEOFF) CONDITION
TEMPERATURE = 77. DEG F , PRESSURE = 14.70 PSIA , VELOCITY = 0.0 KNOTS
OPERATING (NOISE) CONDITION
TEMPERATURE = 77. DEGF , RELATIVE HUMIDITY =, 70.% , PRESSURE = 14.70 PSIA , PRESSURE ALTITUDE = 0. FT
HORIZONTAL VELOCITY = 0.0 KNOTS = 0.0 FPS , VERTICAL VELOCITY = 0.0 FPS , FLIGHT VELOCITY = 0.0 FPS
FLIGHT ANGLE = 0.0 DEG , VEHICLE ALTITUDE ABOVE OBSERVER = 0. FT , SIDELINE DISTANCE = 100. FT , SLANT DISTANCE = 100. FT

ROTARY PROPULSION SYSTEM ANALYSED CONSISTS OF :

UNIT DESCRIPTION	NUMBER OF UNITS	JET NOISE	POWER TRANSMISSION	NOISE SUPPRESSION	INTEGRAL ENGINE
FIXED-PITCH FAN	1.	YES	GEAR BOX	NO	YES

FIXED-PITCH FAN NOISE

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FIXED-PITCH FAN SAMPLE CASE - GEN. ENGINE, GEARBOX, INTERMEDIATE PRINTING      04/14/76  16:57:34

DIAMETER =  3.21 FT , HUB/TIP DIAMETER RATIO = 0.610 , FAN DISCHARGE AREA =   3.48 SQ FT , 1 STAGES
3/4-LENGTH FAN DUCTS

DESIGN CONDITIONS
SHP =  2851. , THRUST =  3829. LB , TIP SPEED = 1082. FPS , RPM =  6438. FIRST STAGE INLET MACH NUMBER = 0.500
OPERATING CONDITIONS
SHP =  2853. , THRUST =  3829. LB , TIP SPEED = 1082. FPS , RPM =  6439. FIRST STAGE INLET MACH NUMBER = 0.501
OPERATING THRUST / DESIGN THRUST = 1.00 , OVERALL PRESSURE RATIO =  1.30 , FAN FLOW = 179.8 LB/SEC , BYPASS RATIO = 10.32
SHAFT ANGLE =    0.

STAGE 1 , 40. BLADES , ROTOR/STATOR SPACING =   7.1%, DESIGN STAGE PRESSURE RATIO = 1.3 , OPERATING STAGE PRESSURE RATIO = 1.300
BLADE PASSING FREQUENCY = 4293. HZ
RELATIVE TIP MACH NUMBER = 1.076            CRITICAL STAGE PRESSURE RATIO = 1.2618
  NO INLET GLIDE VANES
COMBINATION-TONE (BUZZ-SAW) NOISE INCLUDED
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CORE-ENGINE COMPRESSOR NOISE

FIXED-PITCH FAN SAMPLE CASE - GEN. ENGINE, GEARBOX, INTERMEDIATE PRINTING 04/14/76 16:57:34

RPM = 26539. , FIRST STAGE DIAMETER = 0.99 FT , 29. PLACES , ROTOR/STATOR SPACING = 10.0 %, STAGE PRESSURE RATIO = 1.3602
BLADE PASSING FREQUENCY = 12827. HZ , CONFIGURATION FROM GENERALIZATION

SPL ON A 100.-FOOT SIDELINE , DB

1/3-OCTAVE-BAND CENTER FREQ. , HZ	FWD. 20.	30.	40.	50.	60.	70.	80.	90.	100.	110.	120.	130.	140.	150.	REAR 160.
	AZIMUTH ANGLE , DEG														
25.0	44.9	48.2	50.4	51.9	52.9	51.7	49.1	44.2	38.1	31.7	24.9	23.9	22.4	20.2	16.9
31.5	45.9	49.2	51.4	52.9	53.9	52.7	50.1	45.2	39.1	32.7	25.9	24.9	23.4	21.2	17.9
40.0	46.9	50.2	52.4	53.9	55.0	53.7	51.1	46.2	40.1	33.7	27.0	25.9	24.4	22.2	18.9
50.0	47.9	51.2	53.4	54.9	56.0	54.7	52.1	47.2	41.1	34.7	28.0	26.9	25.4	23.2	19.9
63.0	48.9	52.2	54.4	55.9	57.0	55.7	53.1	48.2	42.1	35.7	29.0	27.9	26.4	24.2	20.9
80.0	49.9	53.2	55.4	56.9	58.0	56.7	54.1	49.2	43.1	36.7	30.0	28.9	27.4	25.2	21.9
100.0	50.9	54.2	56.4	57.9	59.0	57.7	55.1	50.2	44.1	37.7	31.0	29.9	28.4	26.2	22.9
125.0	51.8	55.1	57.3	58.9	59.9	58.6	56.1	51.2	45.1	38.6	31.9	30.9	29.3	27.1	23.8
160.0	52.9	56.2	58.4	59.9	61.0	59.7	57.1	52.3	46.1	39.7	33.0	31.9	30.4	28.2	24.9
200.0	53.8	57.2	59.4	60.9	62.0	60.7	58.1	53.2	47.1	40.7	34.0	32.9	31.4	29.2	25.8
250.0	54.8	58.1	60.3	61.9	62.9	61.7	59.1	54.2	48.1	41.7	34.9	33.9	32.3	30.1	26.8
315.0	55.8	59.1	61.3	62.9	64.0	62.7	60.1	55.2	49.1	42.7	36.0	34.9	33.3	31.1	27.8
400.0	56.8	60.2	62.4	63.9	65.0	63.7	61.1	56.3	50.1	43.7	37.0	35.9	34.4	32.2	28.8
500.0	57.7	61.1	63.3	64.9	66.0	64.7	62.1	57.2	51.1	44.7	38.0	36.9	35.3	33.1	29.7
630.0	58.7	62.1	64.3	65.9	67.0	65.7	63.1	58.2	52.1	45.7	39.0	37.9	36.3	34.1	30.7
800.0	59.7	63.1	65.4	66.9	68.0	66.7	64.1	59.3	53.1	46.7	40.0	38.9	37.4	35.1	31.7
1000.0	60.6	64.1	66.3	67.9	69.0	67.7	65.1	60.3	54.1	47.7	41.0	39.9	38.3	36.1	32.6
1250.0	61.5	65.0	67.3	68.9	70.0	68.7	66.1	61.2	55.1	48.7	42.0	40.9	39.3	37.0	33.5
1600.0	62.5	66.0	68.3	69.9	71.0	69.8	67.2	62.3	56.2	49.8	43.0	41.9	40.3	38.0	34.5
2000.0	63.3	66.9	69.3	70.9	72.0	70.8	68.2	63.3	57.2	50.8	44.0	42.9	41.3	38.9	35.3
2500.0	64.1	67.9	70.2	71.9	73.0	71.8	69.2	64.3	58.2	51.8	45.0	43.9	42.2	39.9	35.1
3150.0	65.0	68.8	71.3	72.9	74.1	72.8	70.3	65.4	59.3	52.9	46.1	44.9	43.3	40.8	37.0
4000.0	65.8	69.8	72.4	74.1	75.2	74.0	71.5	66.6	60.5	54.0	47.2	46.1	44.4	41.8	37.8
5000.0	66.7	70.3	73.4	75.1	76.3	75.1	72.6	67.7	61.6	55.1	49.3	47.1	45.4	42.8	38.7
6300.0	67.6	71.9	74.6	76.4	77.6	76.4	73.9	69.0	62.9	56.4	49.6	48.4	46.6	43.9	39.6
8000.0	68.4	73.0	75.9	77.8	79.1	77.9	75.4	70.5	64.4	57.9	51.1	49.8	47.9	45.0	40.4
10000.0	69.0	74.2	77.3	79.3	80.7	79.6	77.1	72.3	66.1	59.6	52.7	51.3	49.3	46.2	41.0
12500.0	86.0	91.7	94.8	96.6	97.1	96.1	93.6	88.8	82.6	76.1	73.0	71.5	69.3	65.9	60.0
16000.0	69.7	76.7	80.7	83.3	84.9	84.0	81.6	76.8	70.6	64.0	56.9	55.3	52.7	48.7	41.7
20000.0	69.2	77.9	82.7	85.7	87.6	86.9	84.6	79.8	73.6	66.9	59.6	57.7	54.7	49.9	41.2
DB(A)	82.9	88.3	91.4	93.2	93.9	92.8	90.4	85.5	79.4	72.8	69.2	67.7	65.5	62.1	56.4
PNL	89.4	93.4	95.9	97.7	98.9	97.7	95.1	90.2	84.0	77.6	70.8	69.6	67.8	65.2	61.0
PNLT	89.4	93.4	95.9	97.7	98.9	97.7	95.1	90.2	84.0	77.6	70.8	69.6	67.8	65.2	61.0

CORE-ENGINE COMBUSTION NOISE

FIXED-PITCH FAN SAMPLE CASE - GEN. ENGINE, GEARBOX, INTERMEDIATE PRINTING 04/14/76 16:57:34

INLET TOTAL PRESSURE = 37021. PSF , INLET TOTAL TEMPERATURE = 1261. R , EXIT TOTAL TEMPERATURE = 2685. R
MASS FLOW RATE = 13.4 LB/SEC , TURBOSHAFT ENGINE , CONFIGURATION FROM GENERALIZATION

SPL ON A 100.-FOOT SIDELINE , DB
AZIMUTH ANGLE , DEG

1/3-OCTAVE-BAND CENTER FREQ. , HZ	FWD. 20.	30.	40.	50.	60.	70.	80.	90.	100.	110.	120.	130.	140.	150.	REAR 160.
25.0	32.7	38.4	43.0	47.0	50.4	53.5	56.3	58.9	61.1	63.1	64.1	62.0	57.7	52.8	46.8
31.5	35.2	40.9	45.4	49.4	52.8	55.9	58.7	61.3	63.5	65.5	66.5	64.4	60.1	55.3	49.3
40.0	37.6	43.3	47.9	51.9	55.3	58.4	61.2	63.8	66.0	68.0	69.0	66.9	62.6	57.7	51.7
50.0	40.0	45.7	50.2	54.2	57.6	60.8	63.6	66.1	68.4	70.4	71.3	69.2	64.9	60.1	54.1
63.0	42.4	48.1	52.7	56.6	60.0	63.2	66.0	68.5	70.8	72.8	73.7	71.6	67.4	62.5	56.5
80.0	44.8	50.6	55.1	59.1	62.5	65.6	68.5	71.0	73.3	75.2	76.2	74.1	69.8	65.0	58.9
100.0	47.2	52.9	57.5	61.4	64.9	68.0	70.8	73.3	75.6	77.6	78.5	76.4	72.2	67.3	61.3
125.0	49.5	55.2	59.8	63.7	67.2	70.3	73.1	75.6	77.9	79.9	80.9	78.7	74.5	69.6	63.6
160.0	52.0	57.7	62.3	66.3	69.7	72.9	75.7	78.2	80.5	82.5	83.4	81.3	77.0	72.1	66.1
200.0	54.3	60.1	64.7	68.6	72.1	75.2	78.0	80.5	82.8	84.8	85.7	83.6	79.4	74.5	68.4
250.0	56.6	62.4	67.0	70.9	74.4	77.5	80.3	82.8	85.1	87.1	88.1	85.9	81.7	76.8	70.7
315.0	59.0	64.8	69.4	73.3	76.8	79.9	82.7	85.2	87.5	89.5	90.5	88.3	84.1	79.2	73.1
400.0	61.2	67.0	71.6	75.5	79.0	82.1	84.9	87.5	89.7	91.7	92.7	90.5	86.3	81.4	75.3
500.0	62.1	67.9	72.5	76.5	79.9	83.1	85.9	88.4	90.7	92.7	93.6	91.5	87.2	82.3	76.2
630.0	62.0	67.9	72.5	76.4	79.9	83.0	85.8	88.4	90.6	92.6	93.6	91.4	87.2	82.3	76.1
800.0	60.9	66.8	71.4	75.4	78.8	82.0	84.6	87.3	89.6	91.6	92.5	90.4	86.1	81.2	75.0
1000.0	58.6	64.5	69.2	73.1	76.6	79.7	82.6	85.1	87.4	89.3	90.3	88.1	83.9	78.9	72.7
1250.0	56.2	62.1	66.8	70.7	74.2	77.4	80.2	82.7	85.0	87.0	87.9	85.7	81.5	76.5	70.3
1600.0	53.4	59.4	64.1	68.1	71.6	74.7	77.5	80.1	82.3	84.3	85.3	83.1	78.8	73.8	67.5
2000.0	50.9	56.9	61.6	65.7	69.2	72.3	75.1	77.7	79.9	81.9	82.9	80.7	76.3	71.3	65.0
2500.0	48.3	54.4	59.2	63.2	66.7	69.9	72.7	75.3	77.5	79.5	80.4	78.2	73.9	68.8	62.4
3150.0	45.5	51.7	56.6	60.6	64.2	67.3	70.2	72.7	75.0	76.9	77.9	75.6	71.3	66.1	59.6
4000.0	42.5	48.9	53.8	57.9	61.5	64.7	67.5	70.1	72.3	74.3	75.2	72.9	68.5	63.3	56.6
5000.0	39.8	46.3	51.3	55.4	59.0	62.2	65.1	67.6	69.9	71.8	72.7	70.4	66.0	60.7	53.9
6300.0	36.7	43.5	48.5	52.7	56.4	59.6	62.4	65.0	67.2	69.2	70.0	67.7	63.2	57.9	50.8
8000.0	33.1	40.2	45.4	49.7	53.4	56.7	59.6	62.1	64.4	66.3	67.1	64.7	60.1	54.6	47.2
10000.0	29.1	36.7	42.2	46.7	50.4	53.7	56.6	59.2	61.4	63.3	64.1	61.7	56.9	51.1	43.2
12500.0	24.6	32.9	38.7	43.4	47.3	50.6	53.6	56.1	58.4	60.2	60.9	58.4	53.4	47.3	38.7
16000.0	18.4	27.9	34.2	39.2	43.2	46.7	49.7	52.3	54.5	56.3	56.9	54.2	48.9	42.3	32.5
20000.0	10.7	21.9	29.1	34.5	38.8	42.4	45.5	48.2	50.3	52.0	52.5	49.5	43.8	36.3	24.8
DB(A)	67.3	73.1	77.8	81.7	85.2	88.4	91.2	93.7	96.0	98.0	98.9	96.7	92.5	87.5	81.4
PNL	76.6	82.6	87.4	91.5	95.0	98.2	101.1	103.6	105.9	107.9	108.9	106.7	102.3	97.3	91.0
PNLT	76.6	82.6	87.4	91.5	95.0	98.2	101.1	103.6	105.9	107.9	108.9	105.7	102.3	97.3	91.0

CORE-ENGINE TURBINE NOISE

FIXED-PITCH FAN SAMPLE CASE - GEN. ENGINE, GEARBOX, INTERMEDIATE PRINTING 04/14/76 16:57:34

LAST ROTOR STAGE HAS 112. BLADES , STATOR-ROTOR SPACING/STATOR CHORD = 57.1 % , EXHAUST CORRECTION = 0. DB
RPM = 17425. , BLADE PASSING FREQUENCY =32527. HZ , LAST ROTOR RELATIVE TIP SPEED = 910. FPS , EXIT SPEED OF SOUND = 1821. FPS
MASS FLOW RATE = 16.1 LB/SEC , DESIGN (TAKEOFF) HORSEPOWER = 2851. , OPERATING HP = 2853. , CONFIGURATION FROM GENERALIZATION

SPL ON A 100.-FOOT SIDELINE , DB

1/3-OCTAVE-BAND CENTER FREQ. , HZ	FWD. 20.	30.	40.	50.	60.	70.	80.	90.	100.	110.	120.	130.	140.	150.	REAR 160.
							AZIMUTH ANGLE , DEG								
25.0	18.3	25.6	31.8	37.3	42.3	46.1	49.5	52.6	55.5	56.3	54.3	49.5	44.2	37.0	28.7
31.5	19.3	26.6	32.8	38.3	43.4	47.1	50.5	53.6	56.5	57.3	55.4	50.5	45.2	38.0	29.7
40.0	20.3	27.6	33.9	39.3	44.4	48.1	51.5	54.6	57.5	58.3	56.4	51.5	46.2	39.0	30.7
50.0	21.3	28.6	34.8	40.3	45.4	49.1	52.5	55.6	58.5	59.3	57.4	52.5	47.2	40.0	31.7
63.0	22.3	29.6	35.8	41.3	46.4	50.1	53.5	56.6	59.5	60.3	58.4	53.5	48.2	41.0	32.7
80.0	23.3	30.6	36.8	42.3	47.4	51.1	54.5	57.6	60.5	61.3	59.4	54.5	49.2	42.0	33.7
100.0	24.3	31.5	37.8	43.3	48.4	52.1	55.5	58.5	61.5	62.3	60.4	55.5	50.2	43.0	34.7
125.0	25.2	32.5	38.7	44.2	49.3	53.0	56.4	59.6	62.4	63.2	61.3	56.4	51.1	43.9	35.6
160.0	26.3	33.6	39.8	45.3	50.4	54.1	57.5	60.6	63.5	64.3	62.4	57.5	52.2	45.0	36.7
200.0	27.2	34.5	40.7	46.3	51.3	55.1	58.5	61.6	64.5	65.3	63.3	58.5	53.1	45.9	37.6
250.0	28.2	35.5	41.7	47.2	52.3	56.0	59.4	62.6	65.4	66.2	64.3	59.4	54.1	46.9	38.6
315.0	29.1	36.5	42.7	48.2	53.3	57.0	60.4	63.6	66.4	67.2	65.3	60.4	55.1	47.9	39.5
400.0	30.1	37.5	43.7	49.2	54.3	58.0	61.4	64.6	67.4	68.2	66.3	61.4	56.1	48.9	40.5
500.0	31.0	38.4	44.6	50.2	55.3	59.0	62.4	65.5	68.4	69.2	67.3	62.4	57.0	49.3	41.4
630.0	32.0	39.4	45.6	51.2	56.2	60.0	63.4	66.5	69.4	70.2	68.2	63.4	58.0	50.8	42.4
800.0	32.9	40.4	46.6	52.2	57.2	61.0	64.4	67.5	70.4	71.2	69.2	64.4	59.0	51.8	43.3
1000.0	33.8	41.2	47.5	53.1	58.2	61.9	65.3	68.4	71.3	72.1	70.2	65.3	59.9	52.6	44.2
1250.0	34.6	42.1	48.4	54.0	59.1	62.8	66.2	69.4	72.2	73.0	71.1	66.2	60.8	53.5	45.0
1600.0	35.5	43.1	49.4	55.0	60.1	63.8	67.2	70.4	73.2	74.0	72.1	67.2	61.8	54.5	45.9
2000.0	36.3	43.9	50.2	55.8	61.0	64.7	68.1	71.3	74.1	74.9	73.0	68.0	62.6	55.3	46.7
2500.0	36.9	44.7	51.0	56.7	61.8	65.6	69.0	72.1	75.0	75.8	73.8	68.9	63.4	56.1	47.3
3150.0	37.6	45.4	51.9	57.5	62.7	66.4	69.9	73.0	75.9	76.6	74.7	69.7	64.3	56.8	48.0
4000.0	38.1	46.1	52.6	58.3	63.5	67.3	70.7	73.9	76.7	77.5	75.5	70.5	65.0	57.5	48.5
5000.0	38.8	46.9	53.4	59.2	64.4	68.1	71.6	74.7	77.6	78.3	76.4	71.4	65.8	58.3	49.2
6300.0	39.1	47.4	54.1	59.9	65.1	68.9	72.4	75.5	78.4	79.1	77.1	72.1	66.5	58.8	49.5
8000.0	39.0	47.7	54.5	60.4	65.7	69.5	73.0	76.2	79.0	79.7	77.7	72.6	66.9	59.1	49.4
10000.0	38.3	47.5	54.6	60.6	66.0	69.9	73.4	76.6	79.4	80.1	78.0	72.3	67.0	58.9	48.7
12500.0	37.1	47.0	54.4	60.6	66.1	70.1	73.6	76.8	79.6	80.3	78.1	72.8	66.9	58.4	47.5
16000.0	34.5	45.6	53.5	60.1	65.7	69.8	73.4	76.6	79.4	80.0	77.7	72.3	65.9	57.0	44.9
20000.0	30.1	42.9	51.6	58.6	64.6	68.8	72.5	75.8	78.5	79.0	76.5	70.8	64.0	54.3	40.5
DB(A)	48.5	56.6	63.2	69.0	74.3	78.1	81.6	84.7	87.6	88.3	86.3	81.2	75.6	68.0	58.9
PNL	61.3	69.5	76.0	81.7	86.9	90.7	94.2	97.4	100.2	101.0	99.0	94.0	88.5	81.0	71.9
PNLT	61.3	69.5	76.0	81.7	86.9	90.7	94.2	97.4	100.2	101.0	99.0	94.0	86.5	81.0	71.9

***** OFF SPECTRUM CURVE AT 25.0 HZ
***** OFF SPECTRUM CURVE AT 31.5 HZ

CORE ENGINE JET NOISE

FIXED-PITCH FAN SAMPLE CASE - GEN. ENGINE, GEARBOX, INTERMEDIATE PRINTING 04/14/76 16:57:34
JET FLO. RATE = 16.1 LB/SEC , THRUST = 626. LB , AREA = 0.4 SQ.FT

SPL ON A 100.-FOOT SIDELINE , DB

1/3-OCTAVE-BAND CENTER FREQ. , HZ	AZIMUTH ANGLE , DEG FWD. 20.	30.	40.	50.	60.	70.	80.	90.	100.	110.	120.	130.	140.	150.	REAR 160.
25.0	58.4	52.6	65.7	64.2	70.1	71.8	73.5	75.3	75.1	74.8	75.6	77.7	80.0	80.4	77.6
31.5	54.7	56.8	62.0	64.4	65.4	68.1	69.8	71.5	71.3	71.0	71.8	73.9	76.3	76.7	73.8
40.0	54.5	58.6	61.3	64.2	55.2	67.9	69.6	71.4	71.5	71.5	72.2	74.1	76.8	76.8	74.0
50.0	55.6	59.8	62.9	65.4	67.4	69.0	70.8	72.5	73.1	73.6	74.6	76.3	79.3	79.2	76.4
63.0	56.4	60.5	63.7	66.1	68.1	69.8	71.5	73.3	74.0	74.8	75.8	77.7	80.9	80.9	78.1
80.0	57.3	61.5	64.6	67.1	69.1	70.7	72.5	74.2	75.2	76.4	77.8	79.6	82.8	83.2	80.4
100.0	58.5	62.7	65.9	68.3	70.3	72.0	73.7	75.4	76.6	77.9	79.4	81.4	85.0	85.4	82.6
125.0	59.2	63.3	66.5	68.9	70.9	72.6	74.3	76.1	77.5	79.0	80.7	83.0	86.5	87.0	84.1
160.0	60.2	64.4	67.6	70.0	72.0	73.7	75.4	77.2	78.4	80.3	82.2	84.8	88.3	88.8	86.0
200.0	61.4	65.6	68.7	71.2	73.2	74.9	76.6	78.4	79.4	81.6	83.5	86.5	89.9	90.3	87.5
250.0	61.9	66.1	69.3	71.7	73.7	75.4	77.1	78.9	80.3	82.4	84.2	87.7	90.9	91.4	88.5
315.0	62.5	66.7	69.9	72.4	74.4	76.0	77.8	79.5	81.2	83.4	85.0	88.5	91.4	92.0	89.1
400.0	63.3	67.5	70.7	73.2	75.2	76.9	78.6	80.4	82.0	84.3	86.0	89.1	91.4	91.8	88.9
500.0	63.6	67.8	71.0	73.4	75.4	77.1	78.8	80.6	82.5	84.6	86.5	88.8	90.6	90.5	87.6
630.0	63.6	67.8	71.0	73.5	75.5	77.2	78.9	80.7	82.6	84.8	86.4	88.4	89.3	88.5	85.6
800.0	63.4	67.6	70.8	73.3	75.3	77.0	78.7	80.5	82.5	84.5	86.3	87.4	87.7	86.0	83.0
1000.0	62.9	67.2	70.5	72.9	75.0	76.6	78.4	80.2	82.1	84.1	86.0	86.2	86.0	83.4	80.4
1250.0	62.5	66.3	70.1	72.6	74.6	76.3	78.0	79.8	81.3	83.7	85.5	85.1	84.3	81.0	77.9
1600.0	61.9	66.3	69.6	72.1	74.1	75.8	77.6	79.4	81.3	83.0	84.9	83.8	82.3	78.4	75.3
2000.0	51.2	65.6	69.0	71.5	73.5	75.2	77.0	78.7	80.6	82.2	84.1	82.2	80.3	75.8	72.6
2500.0	60.2	64.8	68.1	70.7	72.7	74.4	76.2	78.0	79.6	81.1	83.0	80.5	78.1	73.3	70.0
3150.0	59.1	63.8	67.2	69.8	71.9	73.6	75.3	77.1	78.4	80.0	81.7	78.7	75.8	70.5	67.1
4000.0	57.4	62.3	65.8	68.4	70.5	72.2	74.0	75.8	76.9	78.5	79.9	76.4	73.1	67.3	63.8
5000.0	55.8	60.8	64.3	67.0	69.1	70.9	72.6	74.4	75.6	77.0	78.1	74.1	70.5	64.5	60.8
6300.0	53.7	58.3	62.5	65.2	67.3	69.1	70.9	72.7	73.4	75.2	76.1	71.8	67.6	61.2	57.4
8000.0	50.9	56.4	60.3	63.1	65.3	67.1	68.9	70.7	71.4	72.6	73.4	68.8	64.1	57.4	53.1
10000.0	47.5	53.5	57.6	60.5	62.8	64.7	66.5	68.3	69.1	70.1	70.7	65.4	60.3	53.2	48.4
12500.0	43.3	50.0	54.4	57.6	60.0	61.9	63.7	65.6	65.7	67.1	67.5	61.8	56.2	48.5	43.1
16000.0	37.4	45.2	50.2	53.6	56.2	58.3	60.2	62.0	62.3	63.1	63.3	57.1	50.9	42.4	35.8
20000.0	29.8	35.4	45.2	49.1	51.9	54.1	56.1	58.0	58.4	58.7	58.9	52.1	45.1	35.7	27.4
DB(A)	72.4	76.8	80.1	82.6	84.7	86.4	88.1	89.5	91.7	93.5	95.2	95.4	95.9	94.9	91.9
PNL	84.9	85.6	93.0	95.6	97.7	99.4	101.2	103.0	104.5	106.2	107.9	107.0	107.5	106.3	103.3
PNLT	84.9	89.6	93.0	95.6	97.7	99.4	101.2	103.0	104.5	106.2	107.9	107.0	107.5	106.3	103.3

GEARBOX NOISE

FIXED-PITCH FAN SAMPLE CASE - GEN. ENGINE, GEARBOX, INTERMEDIATE PRINTING 04/14/76 16:57:34

PLANETARY (FIXED RING) GEARBOX NOISE , 2853. SHP, 15326. INPUT RPM, 6439. OUTPUT RPM, 29. TEETH ON RING GEAR
TOOTH CONTACT FREQUENCY = 7623. HZ

SPL ON A 100.-FOOT SIDELINE , DB
AZIMUTH ANGLE , DEG

1/3-OCTAVE-BAND CENTER FREQ. , HZ	FWD. 20.	30.	40.	50.	60.	70.	80.	90.	100.	110.	120.	130.	140.	150.	REAR 160.
25.0	51.4	54.7	56.9	58.4	59.4	60.2	60.6	60.7	60.5	60.2	59.4	58.4	56.9	54.7	51.4
31.5	51.4	54.7	56.9	58.4	59.4	60.2	60.6	60.7	60.6	60.2	59.4	58.4	56.9	54.7	51.4
40.0	51.4	54.7	56.9	58.4	59.4	60.2	60.6	60.7	60.5	60.2	59.4	58.4	56.9	54.7	51.4
50.0	51.4	54.7	56.8	58.4	59.4	60.2	60.6	60.7	60.6	60.2	59.4	58.4	56.8	54.7	51.4
63.0	51.3	54.7	56.8	58.4	59.4	60.1	60.6	60.7	60.5	60.1	59.4	58.4	56.8	54.7	51.3
80.0	51.3	54.7	56.8	58.4	59.4	60.1	60.6	60.7	60.6	60.1	59.4	58.4	56.8	54.7	51.3
100.0	51.3	54.6	56.8	58.4	59.4	60.1	60.5	60.7	60.5	60.1	59.4	58.4	56.8	54.6	51.3
125.0	51.3	54.5	[illegible]	58.4	59.4	60.1	60.5	60.7	60.5	60.1	59.4	58.4	56.8	54.6	[illegible]
160.0	51.3	54.6	[illegible]	58.3	59.4	60.1	60.5	60.7	60.5	60.1	59.4	58.3	56.8	54.5	51.3
200.0	51.3	54.6	56.8	58.3	59.4	60.1	60.5	60.7	60.5	60.1	59.4	58.3	56.8	54.6	51.3
250.0	51.3	54.6	56.8	58.3	59.4	60.1	60.5	60.7	60.5	60.1	59.4	58.3	56.8	54.5	51.3
315.0	51.2	54.5	56.8	58.3	59.4	60.1	60.5	60.6	60.5	60.1	59.4	58.3	56.8	54.6	51.2
400.0	51.2	54.5	56.8	58.3	59.4	60.1	60.5	60.6	60.5	60.1	59.4	58.3	56.8	54.5	51.2
500.0	51.1	54.5	56.7	58.3	59.3	60.1	60.5	60.6	60.5	60.1	59.3	58.3	56.7	54.5	51.1
630.0	51.1	54.5	56.7	58.2	59.3	60.0	60.5	60.6	60.5	60.0	59.3	58.2	56.7	54.5	51.1
800.0	51.0	54.4	56.6	58.2	59.3	60.0	60.4	60.6	60.4	60.0	59.3	58.2	56.6	54.4	51.0
1000.0	50.9	54.3	56.6	58.2	59.2	60.0	60.4	60.5	60.4	60.0	59.2	58.2	56.6	54.3	50.9
1250.0	50.7	54.2	56.5	58.1	59.2	59.9	60.3	60.5	60.3	59.9	59.2	58.1	56.5	54.2	50.7
1600.0	50.5	54.1	56.4	58.0	59.1	59.9	60.3	60.4	60.3	59.9	59.1	58.0	56.4	54.1	50.5
2000.0	50.3	54.0	56.3	57.9	59.0	59.8	60.2	60.3	60.2	59.8	59.0	57.9	56.3	54.0	50.3
2500.0	50.0	53.8	56.1	57.8	58.9	59.7	60.1	60.2	60.1	59.7	58.9	57.8	56.1	53.8	50.0
3150.0	51.7	55.5	57.9	59.6	60.8	61.5	62.0	62.1	62.0	61.5	60.8	59.6	57.9	55.5	51.7
4000.0	53.2	57.2	59.7	61.4	62.6	63.3	63.8	63.9	63.8	63.3	62.6	61.4	59.7	57.2	53.2
5000.0	53.8	57.9	60.5	62.3	63.4	64.2	64.7	64.8	64.7	64.2	63.4	62.3	60.5	57.9	53.8
6300.0	60.2	64.5	67.1	68.9	70.2	71.0	71.4	71.6	71.4	71.0	70.2	68.9	67.1	64.5	60.2
8000.0	72.0	76.7	79.5	81.4	82.7	83.6	84.1	84.2	84.1	83.6	82.7	81.4	79.5	76.7	72.0
10000.0	65.4	70.6	73.7	75.7	77.1	78.0	78.5	78.6	78.5	78.0	77.1	75.7	73.7	70.6	65.4
12500.0	56.2	62.1	65.5	67.7	69.2	70.2	70.7	70.9	70.7	70.2	69.2	67.7	65.5	62.1	56.2
16000.0	64.5	71.6	75.6	78.1	79.8	80.9	81.5	81.7	81.5	80.9	79.8	78.1	75.6	71.6	64.5
20000.0	49.2	57.9	62.7	65.7	67.7	68.9	69.6	69.8	69.6	68.9	67.7	65.7	62.7	57.9	49.2
DB(A)	72.5	77.3	80.2	82.1	83.5	84.3	84.8	85.0	84.8	84.3	83.5	82.1	80.2	77.3	72.5
PNL	85.5	89.9	92.6	94.4	95.7	96.5	97.0	97.1	97.0	96.5	95.7	94.4	92.6	89.9	85.5
PNLT	86.9	91.3	94.0	95.8	97.0	97.9	98.3	98.5	98.3	97.9	97.0	95.8	94.0	91.3	86.9

TOTAL PROPULSOR NOISE WITHOUT NOISE SUPPRESSION

FIXED-PITCH FAN SAMPLE CASE - GEN. ENGINE, GEARBOX, INTERMEDIATE PRINTING 04/14/76 16:57:34

SPL ON A 100.-FOOT SIDELINE , DB

1/3-OCTAVE-BAND CENTER FREQ. , HZ	FWD. 20.	30.	40.	50.	60.	70.	80.	90.	100.	110.	120.	130.	140.	150.	REAR 160.
	AZIMUTH ANGLE , DEG														
25.0	62.0	65.7	68.4	70.5	72.3	73.6	75.0	76.6	75.6	76.7	77.0	78.2	80.2	80.5	77.6
31.5	61.4	64.9	67.3	69.3	71.1	72.1	73.2	74.6	74.9	75.3	75.4	75.4	76.7	76.8	73.9
40.0	62.1	65.6	68.0	69.9	71.7	72.7	73.7	75.2	75.7	76.3	76.3	76.0	77.3	77.0	74.0
50.0	63.0	66.5	68.9	70.9	72.7	73.7	74.8	76.3	77.1	77.8	78.1	77.9	79.7	79.4	76.4
63.0	63.9	67.4	69.9	71.8	73.6	74.7	75.8	77.3	78.3	79.2	79.6	79.4	81.3	81.1	78.1
80.0	64.9	68.4	70.9	72.8	74.7	75.8	77.0	78.5	79.7	80.8	81.4	81.3	83.2	83.3	80.4
100.0	65.9	69.4	71.9	73.5	75.0	77.0	78.2	79.9	81.1	82.3	83.1	83.1	85.3	85.6	82.6
125.0	66.8	70.3	72.8	74.5	76.8	78.1	79.4	81.1	82.5	83.9	84.7	84.8	86.9	87.1	84.2
160.0	67.9	71.4	74.0	76.1	78.1	79.4	80.8	82.6	84.1	85.7	86.6	86.7	88.7	89.0	86.0
200.0	68.9	72.5	75.1	77.3	79.3	80.8	82.3	84.2	85.7	87.4	88.4	88.6	90.4	90.5	87.5
250.0	69.8	73.4	76.1	78.4	80.5	82.1	83.8	85.7	87.4	89.1	90.1	90.1	91.5	91.6	88.6
315.0	70.8	74.5	77.3	79.7	81.9	83.7	85.4	87.4	89.2	91.1	92.0	91.6	92.2	92.3	89.2
400.0	71.9	75.7	78.6	81.3	83.5	85.4	87.2	89.2	91.1	92.9	93.9	93.1	92.7	92.2	89.1
500.0	72.8	76.7	79.8	82.7	84.8	86.5	88.2	90.1	92.0	93.8	94.7	93.6	92.4	91.2	88.0
630.0	73.6	77.5	80.6	83.6	85.6	87.2	88.6	90.3	92.1	93.9	94.8	93.4	91.6	89.5	86.1
800.0	74.4	78.4	81.7	85.0	86.7	88.0	88.8	90.0	91.6	93.3	94.1	92.6	90.3	87.4	83.7
1000.0	75.4	79.7	83.4	87.3	88.7	89.6	89.6	89.5	90.7	92.2	92.8	91.1	88.7	85.1	81.2
1250.0	76.1	80.2	83.8	87.5	88.9	89.7	89.5	89.2	90.2	91.4	91.8	89.9	87.2	83.1	78.9
1600.0	76.9	81.1	84.6	88.3	89.7	90.4	90.1	89.5	90.3	91.2	91.3	88.9	85.9	81.4	76.6
2000.0	77.9	82.3	86.1	90.1	91.5	92.2	91.6	90.2	90.7	91.4	91.2	88.5	85.2	80.2	74.6
2500.0	78.5	82.7	86.2	89.8	91.2	92.0	91.5	90.8	91.3	91.9	91.5	88.5	85.1	79.8	73.2
3150.0	79.1	83.1	86.1	89.0	90.5	91.3	91.3	91.5	92.1	92.7	92.1	89.0	85.4	79.9	72.3
4000.0	93.7	97.5	99.8	101.2	102.3	102.3	102.5	103.4	104.9	105.4	104.6	102.4	97.7	92.2	84.3
5000.0	80.6	84.8	87.4	89.6	91.4	92.1	92.5	93.5	94.1	94.7	93.9	90.7	86.9	81.3	72.6
6300.0	81.5	85.8	88.5	90.6	92.5	93.2	93.7	94.8	95.4	95.9	95.1	91.8	88.0	82.4	73.3
8000.0	90.8	95.3	97.9	99.6	100.8	101.0	101.3	102.3	103.6	104.0	103.2	100.7	96.1	90.3	81.8
10000.0	81.1	86.3	89.4	91.6	93.6	94.4	94.9	96.0	96.6	97.1	96.2	92.8	88.8	82.8	73.2
12500.0	89.5	95.2	98.4	100.2	101.3	101.2	100.9	101.2	102.3	102.7	101.7	99.0	94.0	87.6	77.7
16000.0	83.4	90.3	94.0	96.4	98.0	98.5	98.9	99.8	101.0	101.4	100.3	97.4	92.1	85.2	74.3
20000.0	79.3	87.9	92.5	95.3	97.3	97.8	98.2	99.1	100.3	100.5	99.3	96.0	90.3	82.5	69.6
OB(A)	97.1	101.3	103.9	105.8	107.1	107.4	107.5	108.2	109.5	110.0	109.4	107.1	103.2	98.9	93.6
PNL	111.3	115.2	117.8	119.8	121.1	121.5	121.8	122.6	123.8	124.5	124.1	121.9	118.5	114.2	107.9
PNLT	115.9	115.8	122.1	123.8	124.9	125.0	125.3	126.2	127.8	128.4	127.9	126.1	122.3	118.0	111.8

TOTAL PROPULSOR SOUND POWER AND DIRECTIVITY INDICES

FIXED-PITCH FAN SAMPLE CASE - GEN. ENGINE, GEARBOX, INTERMEDIATE PRINTING 04/14/76 16:57:34

1/3-OCTAVE-BAND CENTER FREQ. , HZ	SOUND POWER LEVEL ,DB	DIRECTIVITY INDICES , DB AZIMUTH ANGLE , DEG FWD. 20.	30.	40.	50.	60.	70.	80.	90.	100.	110.	120.	130.	140.	150.	REAR 160.
25.0	129.7	-7.9	-7.5	-7.0	-6.4	-5.6	-5.0	-4.1	-2.6	-2.5	-2.0	-0.9	1.3	4.8	7.3	7.7
31.5	127.0	-5.7	-5.5	-5.3	-4.9	-4.1	-3.8	-3.1	-1.8	-1.4	-0.6	0.2	1.3	4.1	6.4	6.8
40.0	127.5	-5.6	-5.4	-5.2	-4.8	-4.0	-3.7	-3.1	-1.8	-1.1	-0.2	0.6	1.3	4.2	6.0	6.4
50.0	129.4	-6.5	-6.3	-6.1	-5.7	-4.9	-4.6	-3.9	-2.6	-1.6	-0.5	0.5	1.4	4.6	6.5	6.9
63.0	130.8	-7.1	-6.9	-6.6	-6.2	-5.5	-5.1	-4.4	-3.0	-1.9	-0.6	0.5	1.4	4.8	6.8	7.1
80.0	132.7	-8.0	-7.8	-7.5	-7.1	-6.3	-5.8	-5.1	-3.7	-2.4	-0.9	0.4	1.4	4.8	7.2	7.6
100.0	134.6	-8.9	-8.7	-8.4	-7.9	-7.1	-6.6	-5.8	-4.3	-2.9	-1.2	0.2	1.3	5.1	7.5	7.9
125.0	136.1	-9.5	-9.3	-8.9	-8.4	-7.6	-7.0	-6.1	-4.6	-3.0	-1.2	0.3	1.5	5.1	7.5	7.9
160.0	138.0	-10.2	-10.0	-9.6	-9.0	-8.1	-7.5	-6.5	-4.8	-3.2	-1.2	0.4	1.6	5.2	7.6	8.0
200.0	139.6	-10.8	-10.5	-10.1	-9.4	-8.5	-7.7	-6.6	-4.9	-3.2	-1.1	0.6	1.9	5.2	7.5	7.9
250.0	140.9	-11.1	-10.8	-10.3	-9.6	-8.5	-7.7	-6.4	-4.6	-2.8	-0.7	1.0	2.1	5.0	7.3	7.7
315.0	142.0	-11.2	-10.9	-10.3	-9.4	-8.3	-7.3	-5.9	-4.1	-2.1	0.1	1.7	2.5	4.5	6.9	7.2
400.0	143.0	-11.1	-10.6	-9.9	-8.8	-7.6	-6.5	-5.1	-3.2	-1.2	1.1	2.7	3.0	4.1	5.9	6.1
500.0	143.2	-10.4	-9.8	-9.0	-7.6	-6.6	-5.6	-4.3	-2.6	-0.5	1.7	3.4	3.3	3.7	4.7	4.8
630.0	142.9	-9.2	-8.7	-7.8	-6.3	-5.4	-4.6	-3.6	-2.0	-0.0	2.2	3.7	3.5	3.2	3.3	3.3
800.0	142.3	-7.6	-7.0	-6.0	-4.3	-3.6	-3.1	-2.7	-1.6	0.2	2.2	3.8	3.3	2.6	2.0	1.7
1000.0	141.6	-5.9	-5.1	-3.6	-1.3	-1.0	-0.7	-1.2	-1.5	-0.1	1.8	3.1	2.5	1.7	0.4	-0.0
1250.0	141.1	-4.5	-3.9	-2.6	-0.5	-0.1	-0.0	-0.6	-1.1	0.0	1.7	2.8	1.9	0.9	-1.0	-1.7
1600.0	141.1	-3.5	-2.5	-1.7	0.4	0.7	0.7	-0.1	-0.8	0.1	1.4	2.3	1.1	-0.4	-2.6	-3.8
2000.0	142.0	-3.2	-2.4	-1.0	1.4	1.7	1.7	0.6	-0.9	-0.3	0.9	1.5	-0.2	-1.8	-4.5	-6.5
2500.0	142.2	-2.5	-2.0	-0.9	1.0	1.3	1.3	0.5	-0.4	0.2	1.3	1.6	-0.2	-2.1	-4.9	-7.8
3150.0	142.5	-1.9	-1.6	-1.1	0.1	0.5	0.5	0.0	0.1	0.9	1.9	2.1	0.1	-1.8	-4.8	-8.6
4000.0	155.1	0.6	0.4	0.2	-0.1	-0.2	-1.0	-1.2	-0.5	1.1	2.1	2.1	1.0	-1.9	-4.9	-8.8
5000.0	144.3	-1.3	-1.3	-1.2	-0.8	-0.2	-0.3	-0.3	0.5	1.3	2.3	2.3	0.3	-1.7	-4.7	-9.4
6300.0	145.8	-1.2	-1.2	-1.2	-0.9	-0.3	-0.4	-0.3	0.6	1.4	2.3	2.3	0.3	-1.7	-4.7	-9.4
8000.0	154.5	0.4	0.2	-0.0	-0.2	-0.3	-0.9	-1.1	-0.3	1.2	2.1	2.1	0.9	-1.8	-4.7	-8.6
10000.0	148.0	-1.1	-1.1	-1.1	-0.9	-0.3	-0.4	-0.4	0.6	1.4	2.3	2.3	0.3	-1.7	-4.5	-9.0
12500.0	155.5	2.0	1.8	1.5	1.2	0.8	-0.3	-1.2	-1.0	0.3	1.2	1.2	-0.0	-2.8	-5.8	-9.8
16000.0	154.6	0.4	0.3	0.1	-0.2	-0.1	-0.8	-1.0	-0.3	1.1	2.1	2.1	0.8	-1.9	-4.8	-8.6
20000.0	155.8	0.5	0.4	0.2	-0.0	0.0	-0.7	-1.0	-0.3	1.1	2.0	2.0	0.7	-2.0	-5.0	-9.2

was calculated to be 2854 SHP. Since the maximum printing was not specified, the fan noise components were not printed. Since the fan operating and design cases were specified in the input to be the same, the generalized engine parameters were scaled to a core engine designed for 2854 SHP. The calculated core engine parameter and noise are printed in the next several pages. The core engine jet noise which is printed includes the fan jet bypass correction, since it was specified in location 23. The core engine jet thrust was calculated to be 627 lbs. The gearbox information is printed next.

Finally the total propulsor noise levels are printed on the last two pages. The total propulsor thrust was calculated to be 4456 lbs. (i.e. 3829 + 627) with an input power of 2854 SHP.

HELICOPTER SAMPLE CALCULATION

Inputs

In this sample case, the inputs for calculating the noise of a conventional helicopter are shown in Figure 20.

Locations 1 to 3 define the ambient condition. Locations 4 and 5 indicate level flight at 70 kts. The maximum printing is requested in location 6. Location 7 and 9 specify a 200 ft. flyover altitude with the observer location on a 200 ft. sideline. The ambient conditions for the design condition are input to location 124 to 126.

Since this case was run by itself, only locations 34 and 38 are needed to specify one main rotor and one free-air tail rotor. Location 46 specifies two core engines. Locations 47 and 48 are left zero so that jet and transmission noise will not be calculated.

For the main rotor, locations 50 and 51 are left blank to use the default options for K factor and radial loading station. Locations 52 to 60 define the main rotor design and operating parameters. The default value of 0.7 for the correlation length is used in location 61. For the free-air tail rotor, locations 63 and 64 are also left blank to use default values. Locations 65 to 74 are input with the tail rotor design and operating parameters and the value of 0.7 for the correlation length. Location 75 specifies that 20 harmonics of tail rotor noise are to be calculated.

Location 144 specifies a total design power of 2100 SHP, i.e. two 1050 SHP engines. A zero was input to location 147 to insure that generalized engine parameters will be used for estimating core engine noise.

The 0-1. card terminates the input for this case.

Outputs

The computer output for this case is shown in the next few pages. The propulsion system is defined on the first page. The next six pages define the main rotor design and operating conditions used in calculating the noise, the harmonic levels and broadband 1/3 octave band levels at each azimuth, and the combined 1/3 octave band SPL's, dB(A), PNL, and PNLT along the specified

PROGRAM INFO		INPUT DATA					LABEL
n	LOCATION NO.	1	2	3	4	5	
	HELICOPTER SAMPLE CASE - GENERALIZED ENGINE, MAXIMUM PRINTING						
5	1.	66.	60.	14.7	-70.	0.	
4	6.	3.	200.	0.	200.		
3	124.	0.	59.	14.7			
1	34.	1.					
1	38.	1.					
1	46.	2.					
5	52.	5.	31.	203.	5.	18.23	
5	57.	16350.	18475.	6.	-8.	.7	
5	65.	5.	5.	1243.	0.	7.32	
5	70.	507.	532.	0.	0.	.7	
1	75.	20.					
1	144.	2100.					
1	147.	0.					
0	-1.						

FIGURE 20. INPUT DATA FOR HELICOPTER SAMPLE CASE

HELICOPTER SAMPLE CASE - GENERALIZED ENGINE, MAXIMUM PRINTING 04/14/76 16:57:48

DESIGN (TAKEOFF) CONDITION
TEMPERATURE = 59. DEG F , PRESSURE = 14.70 PSIA , VELOCITY = 0.0 KNOTS
OPERATING (NOISE) CONDITION
TEMPERATURE = 66. DEGF , RELATIVE HUMIDITY =, 60.% , PRESSURE = 14.70 PSIA , PRESSURE ALTITUDE = -7. FT
HORIZONTAL VELOCITY = 70.0 KNOTS = 118.1 FPS , VERTICAL VELOCITY = 0.0 FPS , FLIGHT VELOCITY = 118.1 FPS
FLIGHT ANGLE = 0.0 DEG , VEHICLE ALTITUDE ABOVE OBSERVER = 200. FT , SIDELINE DISTANCE = 200. FT , SLANT DISTANCE = 283. FT

ROTARY PROPULSION SYSTEM ANALYSED CONSISTS OF :

UNIT DESCRIPTION	NUMBER OF UNITS	JET NOISE	POWER TRANSMISSION	NOISE SUPPRESSION	INTEGRAL ENGINE
HELICOPTER MAIN ROTOR	1.	NO	NONE	NO	NO
FREE-AIR TAIL ROTOR	1.	NO	NONE	NO	NO
CORE ENGINE	2.	NO	NONE	NO	NO

HELICOPTER MAIN ROTOR NOISE

HELICOPTER SAMPLE CASE - GENERALIZED ENGINE, MAXIMUM PRINTING   04/14/76   16:57:48

AIRLOADING K FACTOR =	1.92	ROTOR RADIUS , FT =	31.00	THRUST , LB =	16350.
RADIAL LOADING STATION =	0.87	BLADE CHORD , IN. =	18.23	TORQUE , FT-LB =	18475.
NUMBER OF ROTOR BLADES =	5.	ROTATIONAL SPEED , RPM =	203.0	HORSEPOWER =	714.1
NUMBER OF GEARBOXES =	0.	DISK INCIDENCE ANGLE =	5.0	TWIST , DEG =	-8.000
NUMBER OF ROTORS =	1.	CONING ANGLE , DEG =	6.0	CORLCM =	0.700

ROTOR HARMONICS 1-60 WITHOUT ATMOSPHERIC ATTENUATION FOR ANGLE OF 20.0 AND BLADE PASSING FREQUENCY OF 16.9 HZ ARE

75.7 68.1 63.1 60.3 58.4 56.8 55.6 54.5 53.6 52.7 52.0 51.3 50.6 50.0 49.5 49.0 48.5 48.0 47.6 47.2
46.8 46.4 46.1 45.7 45.4 45.1 44.8 44.5 44.2 44.0 43.7 43.4 43.2 43.0 42.7 42.5 42.3 42.1 41.9 41.7
41.5 41.3 41.1 40.9 40.7 40.5 40.4 40.2 40.0 39.9 39.7 39.6 39.4 39.3 39.1 39.0 38.8 38.7 38.6 38.4 DB

HELICOPTER ROTOR ROTATIONAL AND BROADBAND NOISE IN 1/3-OCTAVE BANDS AT AZIMUTH ANGLE OF 20. DEG

FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND
25.0	63.0	47.5	31.5	61.7	48.6	40.0	68.0	50.2	50.0	61.1	51.4
63.0	61.2	52.6	80.0	61.1	54.0	100.0	59.8	55.4	125.0	58.6	56.4
160.0	57.9	57.6	200.0	56.8	59.2	250.0	55.7	60.3	315.0	54.8	59.1
400.0	53.9	57.1	500.0	52.9	55.9	630.0	51.8	55.6	800.0	50.7	55.2
1000.0	49.6	54.7	1250.0	48.6	52.8	1600.0	47.5	50.9	2000.0	46.0	48.6
2500.0	44.2	47.5	3150.0	42.0	45.7	4000.0	39.2	43.5	5000.0	37.1	40.9
6300.0	33.0	36.3	8000.0	26.9	29.7	10000.0	18.2	20.5	12500.0	6.5	8.3
16000.0	-10.3	-9.5	20000.0	-35.8	-35.0						

ROTOR HARMONICS 1-60 WITHOUT ATMOSPHERIC ATTENUATION FOR ANGLE OF 30.0 AND BLADE PASSING FREQUENCY OF 16.9 HZ ARE

81.4 74.1 69.6 67.0 65.1 63.6 62.4 61.3 60.4 59.5 58.8 58.1 57.4 56.8 56.3 55.8 55.3 54.8 54.4 54.0
53.6 53.2 52.9 52.5 52.2 51.9 51.6 51.3 51.0 50.8 50.5 50.2 50.0 49.8 49.5 49.3 49.1 48.9 48.7 48.5
48.3 48.1 47.9 47.7 47.5 47.4 47.2 47.0 46.9 46.7 46.5 46.4 46.2 46.1 45.9 45.8 45.6 45.5 45.4 45.2 DB

HELICOPTER ROTOR ROTATIONAL AND BROADBAND NOISE IN 1/3-OCTAVE BANDS AT AZIMUTH ANGLE OF 30. DEG

FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND
25.0	68.4	52.1	31.5	68.1	53.2	40.0	73.7	54.8	50.0	67.7	56.1
63.0	67.5	57.3	80.0	67.6	58.6	100.0	66.5	60.0	125.0	65.3	61.1
160.0	64.6	62.3	200.0	63.6	63.9	250.0	62.6	65.0	315.0	61.8	63.8
400.0	60.8	61.9	500.0	59.9	60.7	630.0	58.9	60.5	800.0	58.5	60.1
1000.0	57.3	59.7	1250.0	55.9	58.0	1600.0	54.4	56.2	2000.0	53.1	54.2
2500.0	51.6	53.3	3150.0	49.9	52.0	4000.0	47.7	50.4	5000.0	46.0	48.2
6300.0	42.9	44.6	8000.0	38.5	39.7	10000.0	32.3	33.1	12500.0	24.1	24.3
16000.0	12.1	11.8	20000.0	-5.1	-5.8						

ROTOR HARMONICS 1-60 WITHOUT ATMOSPHERIC ATTENUATION FOR ANGLE OF 40.0 AND BLADE PASSING FREQUENCY OF 16.9 HZ ARE

84.9 77.7 73.6 71.1 69.2 67.8 66.5 65.4 64.5 63.7 62.9 62.2 61.6 61.0 60.4 59.9 59.4 59.0 58.5 58.1
57.7 57.4 57.0 56.7 56.4 56.0 55.7 55.5 55.2 54.9 54.6 54.4 54.1 53.9 53.7 53.5 53.2 53.0 52.8 52.6
52.4 52.2 52.0 51.9 51.7 51.5 51.3 51.2 51.0 50.8 50.7 50.5 50.4 50.2 50.1 49.9 49.8 49.7 49.5 49.4 DB

HELICOPTER ROTOR ROTATIONAL AND BROADBAND NOISE IN 1/3-OCTAVE BANDS AT AZIMUTH ANGLE OF 40. DEG

FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND
25.0	71.4	55.7	31.5	72.2	56.8	40.0	76.8	58.4	50.0	72.0	59.7
63.0	71.3	60.9	80.0	71.4	62.3	100.0	70.4	63.7	125.0	69.3	64.7

160.0	68.6	65.9	200.0	67.6	67.6	250.0	66.8	68.7	315.0	66.0	67.5
400.0	65.0	65.6	500.0	64.1	64.5	630.0	63.2	64.3	800.0	62.2	63.9
1000.0	61.3	63.6	1250.0	60.5	61.9	1600.0	59.7	60.2	2000.0	58.5	58.3
2500.0	57.3	57.5	3150.0	55.8	56.4	4000.0	53.9	55.1	5000.0	52.4	53.1
6300.0	49.8	50.0	8000.0	46.2	46.0	10000.0	41.3	40.6	12500.0	34.8	33.5
16000.0	25.4	23.6	20000.0	11.9	9.7						

ROTOR HARMONICS 1-60 WITHOUT ATMOSPHERIC ATTENUATION FOR ANGLE OF 50.0 AND BLADE PASSING FREQUENCY OF 16.9 HZ ARE

87.0 79.9 76.1 73.7 71.8 70.4 69.1 68.1 67.1 66.3 65.5 64.8 64.2 63.6 63.0 62.5 62.0 61.6 61.2 60.8
60.4 60.0 59.6 59.3 59.0 58.7 58.4 58.1 57.8 57.5 57.3 57.0 56.8 56.5 56.3 56.1 55.8 55.6 55.4 55.2
55.0 54.8 54.7 54.5 54.3 54.1 53.9 53.8 53.6 53.4 53.3 53.1 53.0 52.8 52.7 52.5 52.4 52.3 52.1 52.0 DB

HELICOPTER ROTOR ROTATIONAL AND BROADBAND NOISE IN 1/3-OCTAVE BANDS AT AZIMUTH ANGLE OF 50. DEG

FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND
25.0	72.9	58.6	31.5	75.1	59.7	40.0	78.4	61.3	50.0	75.0	62.6
63.0	73.5	63.8	80.0	73.6	65.1	100.0	72.9	66.5	125.0	71.8	67.6
160.0	71.0	68.8	200.0	70.2	70.5	250.0	69.4	71.5	315.0	68.5	70.4
400.0	67.6	68.5	500.0	66.8	67.4	630.0	65.9	67.2	800.0	64.8	66.9
1000.0	63.7	66.6	1250.0	62.6	64.9	1600.0	61.5	63.3	2000.0	60.4	61.4
2500.0	59.2	60.7	3150.0	57.8	59.7	4000.0	56.1	58.6	5000.0	54.7	56.7
6300.0	52.5	53.9	8000.0	49.3	50.4	10000.0	45.1	45.6	12500.0	39.6	39.6
16000.0	31.6	31.1	20000.0	20.3	19.4						

ROTOR HARMONICS 1-60 WITHOUT ATMOSPHERIC ATTENUATION FOR ANGLE OF 60.0 AND BLADE PASSING FREQUENCY OF 16.9 HZ ARE

88.1 81.3 77.7 75.3 73.5 72.0 70.7 69.7 68.7 67.9 67.1 66.4 65.8 65.2 64.7 64.1 63.7 63.2 62.8 62.4
62.0 61.6 61.3 60.9 60.6 60.3 60.0 59.7 59.4 59.1 58.9 58.6 58.4 58.1 57.9 57.7 57.5 57.3 57.0 56.8
56.6 56.5 56.3 56.1 55.9 55.7 55.6 55.4 55.2 55.1 54.9 54.8 54.6 54.5 54.3 54.2 54.0 53.9 53.7 53.6 DB

HELICOPTER ROTOR ROTATIONAL AND BROADBAND NOISE IN 1/3-OCTAVE BANDS AT AZIMUTH ANGLE OF 60. DEG

FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND
25.0	73.3	60.8	31.5	77.2	61.9	40.0	79.0	63.5	50.0	77.2	64.8
63.0	74.9	65.0	80.0	74.9	67.3	100.0	74.5	68.7	125.0	73.3	69.8
160.0	72.5	71.0	200.0	71.8	72.7	250.0	71.1	73.9	315.0	70.1	72.6
400.0	69.2	70.8	500.0	68.4	69.6	630.0	67.5	69.4	800.0	66.5	69.1
1000.0	65.7	68.8	1250.0	64.6	67.2	1600.0	63.8	65.6	2000.0	62.8	63.8
2500.0	61.7	63.1	3150.0	60.4	62.2	4000.0	58.8	61.2	5000.0	57.4	59.4
6300.0	55.3	56.8	8000.0	52.5	53.5	10000.0	48.7	49.2	12500.0	43.8	43.7
16000.0	36.7	36.2	20000.0	26.8	25.8						

ROTOR HARMONICS 1-60 WITHOUT ATMOSPHERIC ATTENUATION FOR ANGLE OF 70.0 AND BLADE PASSING FREQUENCY OF 16.9 HZ ARE

88.6 82.0 78.5 76.2 74.4 72.9 71.7 70.6 69.7 68.8 68.1 67.4 66.7 66.1 65.6 65.1 64.6 64.1 63.7 63.3
62.9 62.5 62.2 61.8 61.5 61.2 60.9 60.6 60.3 60.1 59.8 59.5 59.3 59.1 58.8 58.6 58.4 58.2 58.0 57.8
57.6 57.4 57.2 57.0 56.8 56.7 56.5 56.3 56.1 56.0 55.8 55.7 55.5 55.4 55.2 55.1 54.9 54.8 54.7 54.5 DB

HELICOPTER ROTOR ROTATIONAL AND BROADBAND NOISE IN 1/3-OCTAVE BANDS AT AZIMUTH ANGLE OF 70. DEG

FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND
25.0	73.2	62.4	31.5	78.9	63.5	40.0	78.9	65.1	50.0	78.8	66.4
63.0	75.3	67.6	80.0	75.7	69.0	100.0	75.4	70.4	125.0	74.2	71.4
160.0	73.3	72.6	200.0	72.8	74.3	250.0	71.9	75.4	315.0	71.0	74.2
400.0	70.1	72.4	500.0	69.3	71.3	630.0	68.3	71.1	800.0	67.8	70.8
1000.0	67.0	70.5	1250.0	66.0	68.9	1600.0	64.6	67.3	2000.0	63.5	45.5
2500.0	62.4	64.9	3150.0	61.1	64.0	4000.0	59.6	63.1	5000.0	58.3	61.3

6300.0	56.4	58.8	8000.0	53.8	55.7	10000.0	50.3	51.7	12500.0	45.7	46.6
16000.0	39.3	39.7	20000.0	30.2	30.1						

ROTOR HARMONICS 1-60 WITHOUT ATMOSPHERIC ATTENUATION FOR ANGLE OF 80.0 AND BLADE PASSING FREQUENCY OF 16.9 HZ ARE
88.7 82.3 78.9 76.6 74.8 73.3 72.1 71.0 70.1 69.2 68.5 67.8 67.1 66.5 66.0 65.5 65.0 64.5 64.1 63.7
63.3 62.9 62.6 62.2 61.9 61.6 61.3 61.0 60.7 60.5 60.2 60.0 59.7 59.5 59.2 59.0 58.8 58.6 58.4 58.2
58.0 57.8 57.6 57.4 57.2 57.1 56.9 56.7 56.6 56.4 56.2 56.1 55.9 55.8 55.6 55.5 55.4 55.2 55.1 54.9 DB

HELICOPTER ROTOR ROTATIONAL AND BROADBAND NOISE IN 1/3-OCTAVE BANDS AT AZIMUTH ANGLE OF 80. DEG

FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND
25.0	72.8	63.5	31.5	80.2	64.6	40.0	78.3	66.2	50.0	79.1	67.5
63.0	76.4	68.7	80.0	76.1	70.0	100.0	75.0	71.4	125.0	74.7	72.5
160.0	73.3	73.7	200.0	73.1	75.4	250.0	72.2	75.5	315.0	71.4	75.3
400.0	70.4	73.5	500.0	69.6	72.4	630.0	68.7	72.2	800.0	68.2	71.9
1000.0	67.0	71.6	1250.0	66.2	70.0	1600.0	65.1	69.4	2000.0	63.7	66.6
2500.0	62.8	66.1	3150.0	61.3	65.2	4000.0	60.0	64.3	5000.0	58.8	62.6
6300.0	56.8	60.1	8000.0	54.3	57.2	10000.0	51.0	53.3	12500.0	46.7	48.5
16000.0	40.6	41.9	20000.0	32.0	32.9						

ROTOR HARMONICS 1-60 WITHOUT ATMOSPHERIC ATTENUATION FOR ANGLE OF 90.0 AND BLADE PASSING FREQUENCY OF 16.9 HZ ARE
88.5 82.3 78.9 76.6 74.8 73.3 72.1 71.0 70.1 69.2 68.5 67.8 67.1 66.6 66.0 65.5 65.0 64.5 64.1 63.7
63.3 62.9 62.6 62.3 61.9 61.6 61.3 61.0 60.7 60.5 60.2 60.0 59.7 59.5 59.2 59.0 58.8 58.6 58.4 58.2
58.0 57.8 57.6 57.4 57.2 57.1 56.9 56.7 56.6 56.4 56.2 56.1 55.9 55.8 55.6 55.5 55.4 55.2 55.1 55.0 DB

HELICOPTER ROTOR ROTATIONAL AND BROADBAND NOISE IN 1/3-OCTAVE BANDS AT AZIMUTH ANGLE OF 90. DEG

FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND
25.0	72.2	64.0	31.5	81.2	65.1	40.0	77.4	65.7	50.0	79.1	68.0
63.0	76.8	69.2	80.0	76.4	70.6	100.0	75.4	72.0	125.0	74.8	73.1
160.0	74.0	74.3	200.0	73.1	76.0	250.0	72.1	77.0	315.0	71.3	75.9
400.0	70.5	74.1	500.0	69.6	72.9	630.0	68.7	72.8	800.0	67.5	72.5
1000.0	66.6	72.2	1250.0	65.9	70.6	1600.0	64.8	69.0	2000.0	64.0	67.2
2500.0	62.9	66.7	3150.0	61.6	65.9	4000.0	60.3	65.0	5000.0	59.0	63.2
6300.0	57.1	60.8	8000.0	54.7	57.9	10000.0	51.4	54.7	12500.0	47.2	49.4
16000.0	41.2	43.0	20000.0	32.9	34.2						

ROTOR HARMONICS 1-60 WITHOUT ATMOSPHERIC ATTENUATION FOR ANGLE OF 100.0 AND BLADE PASSING FREQUENCY OF 16.9 HZ ARE
88.1 81.0 78.6 76.2 74.4 73.0 71.7 70.7 69.7 68.9 68.1 67.4 66.8 66.2 65.7 65.1 64.7 64.2 63.8 63.4
63.0 62.6 62.3 61.9 61.6 61.3 61.0 60.7 60.4 60.1 59.9 59.6 59.4 59.1 58.9 58.7 58.5 58.2 58.0 57.8
57.6 57.5 57.3 57.1 56.9 56.7 56.6 56.4 56.2 56.1 55.9 55.7 55.6 55.4 55.3 55.2 55.0 54.9 54.7 54.6 DB

HELICOPTER ROTOR ROTATIONAL AND BROADBAND NOISE IN 1/3-OCTAVE BANDS AT AZIMUTH ANGLE OF 100. DEG

FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND
25.0	71.6	64.1	31.5	81.8	65.2	40.0	76.3	66.8	50.0	78.8	68.1
63.0	77.1	69.3	80.0	76.0	70.7	100.0	74.9	72.1	125.0	74.8	73.2
160.0	73.7	74.3	200.0	72.6	76.0	250.0	71.9	77.1	315.0	70.9	76.0
400.0	70.0	74.1	500.0	69.2	73.0	630.0	68.3	72.8	800.0	67.2	72.6
1000.0	66.4	72.3	1250.0	65.8	70.6	1600.0	64.9	69.1	2000.0	64.0	67.3
2500.0	63.0	66.7	3150.0	61.6	65.9	4000.0	60.3	65.0	5000.0	59.0	63.3
6300.0	57.2	60.9	8000.0	54.7	58.0	10000.0	51.4	54.2	12500.0	47.2	49.5
16000.0	41.3	43.1	20000.0	33.0	34.4						

ROTOR HARMONICS 1-60 WITHOUT ATMOSPHERIC ATTENUATION FOR ANGLE OF 110.0 AND BLADE PASSING FREQUENCY OF 16.9 HZ ARE

67.4	81.2	77.9	75.5	73.7	72.3	71.0	70.0	69.0	68.2	67.4	66.7	66.1	65.5	65.0	64.5	64.0	63.5	63.1	62.7
62.3	61.9	61.6	61.2	60.9	60.6	60.3	60.0	59.7	59.4	59.2	58.9	58.7	58.4	58.2	58.0	57.8	57.6	57.4	57.1
57.0	56.8	56.6	56.4	56.2	56.0	55.9	55.7	55.5	55.4	55.2	55.1	54.9	54.8	54.6	54.5	54.3	54.2	54.1	53.9 DB

HELICOPTER ROTOR ROTATIONAL AND BROADBAND NOISE IN 1/3-OCTAVE BANDS AT AZIMUTH ANGLE OF 110. DEG

FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND
25.0	71.0	63.5	31.5	81.2	64.7	40.0	75.0	66.3	50.0	78.1	67.6
63.0	76.3	63.8	80.0	75.1	70.2	100.0	74.2	71.6	125.0	73.8	72.7
160.0	72.7	73.8	200.0	71.8	75.5	250.0	71.0	76.6	315.0	70.2	75.5
400.0	69.2	73.6	500.0	68.4	72.5	630.0	67.2	72.3	800.0	67.0	72.0
1000.0	66.2	71.3	1250.0	65.1	70.1	1600.0	63.9	68.6	2000.0	63.1	66.8
2500.0	67.0	66.7	3150.0	60.7	65.4	4000.0	59.3	64.5	5000.0	58.1	62.7
6300.0	56.2	60.3	8000.0	53.7	57.3	10000.0	50.4	53.5	12500.0	46.1	48.7
16000.0	40.1	42.1	20000.0	31.6	33.2						

ROTOR HARMONICS 1-60 WITHOUT ATMOSPHERIC ATTENUATION FOR ANGLE OF 120.0 AND BLADE PASSING FREQUENCY OF 16.9 HZ ARE

86.3	80.1	76.8	74.4	72.6	71.2	70.0	68.9	67.9	67.1	66.3	65.7	65.0	64.4	63.9	63.4	62.9	62.4	62.0	61.6
61.2	60.8	60.5	60.1	59.8	59.5	59.2	58.9	58.6	58.4	58.1	57.8	57.6	57.4	57.1	56.9	56.7	56.5	56.3	56.1
55.9	55.7	55.5	55.3	55.1	54.9	54.8	54.6	54.4	54.3	54.1	54.0	53.8	53.7	53.5	53.4	53.2	53.1	53.0	52.8 DB

HELICOPTER ROTOR ROTATIONAL AND BROADBAND NOISE IN 1/3-OCTAVE BANDS AT AZIMUTH ANGLE OF 120. DEG

FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND
25.0	70.3	62.5	31.5	80.1	63.6	40.0	73.6	65.2	50.0	77.0	66.5
63.0	75.1	67.7	80.0	73.9	69.1	100.0	73.2	70.5	125.0	72.4	71.6
160.0	71.4	72.7	200.0	70.7	74.4	250.0	69.3	75.5	315.0	69.0	74.4
400.0	68.1	72.5	500.0	67.2	71.4	630.0	66.4	71.2	800.0	65.4	70.9
1000.0	64.1	70.6	1250.0	62.9	69.0	1600.0	61.9	67.4	2000.0	60.8	65.6
2500.0	59.6	65.0	3150.0	58.3	64.2	4000.0	56.8	63.2	5000.0	55.4	61.5
6300.0	53.4	59.0	8000.0	50.8	55.9	10000.0	47.2	51.9	12500.0	42.7	46.8
16000.0	36.3	39.9	20000.0	27.3	30.5						

ROTOR HARMONICS 1-60 WITHOUT ATMOSPHERIC ATTENUATION FOR ANGLE OF 130.0 AND BLADE PASSING FREQUENCY OF 16.9 HZ ARE

84.8	78.5	75.2	72.8	71.0	69.6	68.3	67.3	66.3	65.5	64.7	64.0	63.4	62.8	62.3	61.8	61.3	60.8	60.4	60.0
59.6	59.2	58.9	58.5	58.2	57.9	57.6	57.3	57.0	56.7	56.5	56.2	56.0	55.7	55.5	55.3	55.1	54.9	54.7	54.5
54.3	54.1	53.9	53.7	53.5	53.3	53.2	53.0	52.8	52.7	52.5	52.4	52.2	52.1	51.9	51.8	51.6	51.5	51.4	51.2 DB

HELICOPTER ROTOR ROTATIONAL AND BROADBAND NOISE IN 1/3-OCTAVE BANDS AT AZIMUTH ANGLE OF 130. DEG

FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND
25.0	69.2	60.7	31.5	78.5	61.8	40.0	71.8	63.4	50.0	75.4	64.7
63.0	73.5	65.9	80.0	72.3	67.3	100.0	71.7	68.7	125.0	70.6	69.8
160.0	69.7	71.0	200.0	69.0	72.6	250.0	68.1	73.7	315.0	67.3	72.6
400.0	66.4	70.7	500.0	65.5	69.6	630.0	64.0	69.4	800.0	63.0	69.1
1000.0	61.8	64.8	1250.0	60.5	67.2	1600.0	59.6	65.6	2000.0	58.5	63.7
2500.0	57.4	63.1	3150.0	56.1	62.2	4000.0	54.5	61.2	5000.0	53.2	59.4
6300.0	51.2	56.7	8000.0	48.3	53.5	10000.0	44.5	49.2	12500.0	39.5	43.7
16000.0	32.5	36.2	20000.0	22.5	25.7						

ROTOR HARMONICS 1-60 WITHOUT ATMOSPHERIC ATTENUATION FOR ANGLE OF 140.0 AND BLADE PASSING FREQUENCY OF 16.9 HZ ARE

87.7	76.3	72.9	70.5	68.7	67.3	66.0	65.0	64.0	63.2	62.4	61.7	61.1	60.5	59.9	59.4	58.9	58.5	58.1	57.7
57.3	56.9	56.5	56.2	55.9	55.6	55.3	55.0	54.7	54.4	54.2	53.9	53.7	53.4	53.2	53.0	52.7	52.5	52.3	52.1
51.9	51.7	51.5	51.4	51.2	51.0	50.8	50.7	50.5	50.3	50.2	50.0	49.9	49.7	49.6	49.4	49.3	49.2	49.0	48.9 DB

HELICOPTER ROTOR ROTATIONAL AND BROADBAND NOISE IN 1/3-OCTAVE BANDS AT AZIMUTH ANGLE OF 140. DEG

FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND
25.0	67.4	58.2	31.5	76.3	59.3	40.0	69.6	69.9	50.0	73.2	62.1
63.0	71.2	63.3	80.0	70.0	64.7	100.0	69.5	66.1	125.0	68.1	67.2
160.0	67.4	68.4	200.0	66.7	70.0	250.0	65.9	71.1	315.0	64.9	70.0
400.0	64.0	68.1	500.0	63.1	67.0	630.0	62.3	66.8	800.0	61.6	66.5
1000.0	60.4	66.1	1250.0	59.2	64.5	1600.0	57.9	62.8	2000.0	56.6	61.0
2500.0	55.4	60.3	3150.0	54.0	59.3	4000.0	52.3	58.1	5000.0	50.9	56.2
6300.0	48.7	53.4	8000.0	45.5	[illegible]	10000.0	41.1	44.9	12500.0	35.5	38.7
16000.0	27.3	30.1	20000.0	15.7	18.1						

ROTOR HARMONICS 1-60 WITHOUT ATMOSPHERIC ATTENUATION FOR ANGLE OF 150.0 AND BLADE PASSING FREQUENCY OF 16.9 HZ ARE

79.0 72.9 69.5 67.1 65.3 63.9 62.6 61.6 60.6 59.8 59.0 58.3 57.7 57.1 56.5 56.0 55.5 55.1 54.7 54.2
53.9 53.5 53.1 52.8 52.5 52.2 51.9 51.6 51.3 51.0 50.8 50.5 50.3 50.0 49.8 49.6 49.3 49.1 48.9 48.7
48.5 48.3 48.1 48.0 47.8 47.6 47.4 47.3 47.1 46.9 46.8 46.6 46.5 46.3 46.2 46.0 45.9 45.8 45.6 45.5 DB

HELICOPTER ROTOR ROTATIONAL AND BROADBAND NOISE IN 1/3-OCTAVE BANDS AT AZIMUTH ANGLE OF 150. DEG

FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND
25.0	64.6	54.6	31.5	72.9	55.7	40.0	66.3	57.3	50.0	69.5	58.6
63.0	67.8	59.8	80.0	66.6	61.1	100.0	66.1	62.5	125.0	64.6	63.6
160.0	64.0	64.8	200.0	63.2	66.4	250.0	62.3	67.5	315.0	61.4	66.4
400.0	60.5	64.5	500.0	59.6	63.3	630.0	58.1	63.1	800.0	57.4	62.8
1000.0	56.4	62.4	1250.0	55.1	60.7	1600.0	53.8	59.0	2000.0	52.6	57.0
2500.0	51.2	56.2	3150.0	49.6	55.1	4000.0	47.7	53.7	5000.0	46.1	51.6
6300.0	43.4	43.4	8000.0	39.7	44.1	10000.0	34.3	38.4	12500.0	27.4	30.9
16000.0	17.2	20.2	20000.0	2.7	5.3						

ROTOR HARMONICS 1-60 WITHOUT ATMOSPHERIC ATTENUATION FOR ANGLE OF 160.0 AND BLADE PASSING FREQUENCY OF 16.9 HZ ARE

74.8 67.9 64.3 61.9 60.1 58.7 57.4 56.3 55.4 54.6 53.8 53.1 52.5 51.9 51.3 50.8 50.3 49.9 49.5 49.0
48.7 48.3 47.9 47.6 47.3 47.0 46.6 46.4 46.1 45.8 45.5 45.3 45.0 44.8 44.6 44.4 44.1 43.9 43.7 43.5
43.3 43.1 42.9 42.8 42.6 42.4 42.2 42.1 41.9 41.7 41.6 41.4 41.3 41.1 41.0 40.8 40.7 40.6 40.4 40.3 DB

HELICOPTER ROTOR ROTATIONAL AND BROADBAND NOISE IN 1/3-OCTAVE BANDS AT AZIMUTH ANGLE OF 160. DEG

FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND
25.0	59.9	49.7	31.5	67.8	50.8	40.0	61.3	52.4	50.0	63.9	53.7
63.0	62.6	54.9	80.0	61.4	56.3	100.0	60.7	57.7	125.0	59.4	58.7
160.0	58.8	59.9	200.0	57.8	61.5	250.0	56.9	62.6	315.0	56.0	61.4
400.0	55.1	59.5	500.0	54.1	58.3	630.0	52.6	58.0	800.0	51.9	57.6
1000.0	50.8	57.2	1250.0	49.6	55.4	1600.0	48.2	53.5	2000.0	46.8	51.4
2500.0	45.3	50.4	3150.0	43.3	48.9	4000.0	40.9	47.1	5000.0	38.9	44.7
6300.0	35.3	40.6	8000.0	30.2	35.0	10000.0	22.9	27.2	12500.0	13.2	16.9
16000.0	-1.2	2.1	20000.0	-21.9	-19.0						

HELICOPTER MAIN ROTOR NOISE

SPL ON A 200.-FOOT SIDELINE , DB

1/3-OCTAVE-BAND CENTER FREQ. , HZ	FWD. 20.	30.	40.	50.	60.	70.	80.	90.	100.	110.	120.	130.	140.	150.	REAR 160.
	AZIMUTH ANGLE , DEG														
25.0	63.2	68.5	71.5	73.0	73.6	73.6	73.3	72.8	72.3	71.7	71.0	69.8	67.9	65.0	60.3
31.5	62.0	68.3	72.4	75.2	77.4	79.0	80.3	81.3	82.0	81.3	80.2	78.7	76.4	73.1	68.0

40.0	68.2	73.8	76.9	78.5	79.1	79.1	78.6	77.8	76.8	75.6	74.2	72.4	70.1	66.9	61.9
50.0	61.6	68.1	72.3	75.3	77.5	79.1	79.4	79.5	79.1	78.5	77.4	75.8	73.5	69.8	64.3
63.0	61.8	68.0	71.7	74.0	75.5	76.4	77.1	77.5	77.8	77.1	75.9	74.2	71.9	68.5	63.3
80.0	62.0	68.2	72.0	74.3	75.7	76.6	77.1	77.5	77.1	76.4	75.2	73.5	71.2	67.8	62.7
100.0	61.3	67.5	71.4	73.9	75.5	76.7	77.0	77.1	76.8	76.1	75.1	73.5	71.2	67.7	62.6
125.0	60.8	66.8	70.7	73.3	75.0	76.1	76.8	77.1	77.1	76.4	75.1	73.3	70.8	67.3	62.7
160.0	61.0	66.8	70.6	73.2	74.9	76.1	76.8	77.2	77.1	76.4	75.2	73.5	71.0	67.6	62.6
200.0	61.5	67.0	70.8	73.5	75.4	76.7	77.5	77.9	77.7	77.2	76.0	74.3	71.8	68.3	63.3
250.0	61.9	67.2	71.0	73.8	75.8	77.1	78.0	78.4	78.3	77.8	76.7	74.9	72.4	68.9	63.9
315.0	60.9	66.2	70.1	72.8	74.7	76.1	77.0	77.3	77.3	76.7	75.6	73.9	71.3	67.8	62.9
400.0	59.4	64.8	68.6	71.4	73.3	74.6	75.4	75.8	75.7	75.2	74.1	72.3	69.8	66.3	61.3
500.0	58.4	63.8	67.7	70.4	72.3	73.6	74.4	74.8	74.7	74.1	73.0	71.3	68.8	65.2	60.3
630.0	58.0	63.4	67.2	70.0	71.9	73.3	74.1	74.5	74.4	73.8	72.8	70.9	68.5	64.8	59.9
800.0	57.6	63.2	66.8	69.5	71.5	73.0	73.8	74.1	74.0	73.6	72.4	70.5	68.2	64.5	59.6
1000.0	57.3	62.7	66.4	69.0	71.1	72.6	73.4	73.7	73.7	73.3	72.0	70.1	67.8	64.2	59.3
1250.0	56.0	61.3	65.2	67.7	69.8	71.3	72.1	72.4	72.4	71.9	70.6	69.7	66.4	62.8	57.9
1600.0	54.9	60.0	64.2	66.5	68.7	70.0	70.8	71.1	71.2	70.6	69.3	67.4	65.1	61.5	56.6
2000.0	53.5	58.7	63.0	65.2	67.5	68.6	69.4	69.8	69.9	69.3	67.9	66.0	63.6	60.0	55.2
2500.0	53.0	58.2	62.4	64.7	66.9	68.2	69.0	69.4	69.4	68.8	67.4	65.6	63.2	59.6	54.7
3150.0	52.5	57.6	61.9	64.1	66.4	67.6	68.4	68.8	68.9	68.3	66.9	65.1	62.7	59.1	54.2
4000.0	52.0	57.1	61.3	63.6	65.8	67.1	68.0	68.4	68.5	67.9	66.5	64.7	62.3	58.7	53.8
5000.0	50.8	56.0	60.2	62.5	64.7	66.0	66.8	67.2	67.3	66.7	65.3	63.5	61.1	57.5	52.6
6300.0	49.6	54.8	59.1	61.3	63.5	64.8	65.5	66.0	66.0	65.4	64.0	62.2	59.8	56.2	51.3
8000.0	48.4	53.7	58.0	60.2	62.4	63.7	64.4	64.8	64.9	64.3	62.8	61.0	58.7	55.0	50.1
10000.0	47.3	52.6	56.9	59.1	61.3	62.6	63.3	63.7	63.7	63.1	61.6	59.8	57.5	53.9	48.9
12500.0	46.1	51.4	55.8	58.0	60.2	61.4	62.1	62.5	62.5	61.9	60.3	58.6	56.3	52.6	47.7
16000.0	45.0	50.4	54.6	56.9	59.1	60.3	61.0	61.4	61.4	60.8	59.2	57.4	55.1	51.5	46.5
20000.0	43.9	49.3	53.8	55.9	58.1	59.2	59.9	60.3	60.3	59.7	58.0	56.2	54.0	50.3	45.4
DB(A)	66.9	72.3	76.2	78.7	80.8	82.1	82.9	83.3	83.3	82.7	81.5	79.7	77.3	73.7	68.8
PNL	80.1	85.7	89.9	92.4	94.5	95.8	96.6	97.0	97.0	96.4	95.1	93.2	90.7	87.0	82.0
PNLT	80.1	85.7	89.9	92.4	94.5	95.8	96.6	97.0	97.0	96.4	95.1	93.2	90.7	87.0	82.0

HELICOPTER FREE-AIR TAIL ROTOR NOISE

HELICOPTER SAMPLE CASE - GENERALIZED ENGINE, MAXIMUM PRINTING 04/14/76 16:57:48

AIRLOADING K FACTOR =	1.55	ROTOR RADIUS , FT =	5.00	THRUST , LB =	507.
RADIAL LOADING STATION =	0.90	BLADE CHORD , IN. =	7.32	TORQUE , FT-LB =	532.
NUMBER OF ROTOR BLADES =	5.	ROTATIONAL SPEED , RPM =	1243.0	HORSEPOWER =	125.9
NUMBER OF GEARBOXES =	0.	DISK INCIDENCE ANGLE =	0.0	TWIST , DEG =	0.0
NUMBER OF ROTORS =	1.	CONING ANGLE , DEG =	0.0	CORLCM =	0.700
NUMBER OF HARMONICS =	20.				

ROTOR HARMONICS 1-60 WITHOUT ATMOSPHERIC ATTENUATION FOR ANGLE OF 20.0 AND BLADE PASSING FREQUENCY OF 103.6 HZ ARE

59.0 53.1 50.2 48.6 47.5 46.6 45.8 45.2 44.6 44.1 43.7 43.3 42.9 42.5 42.2 41.9 41.6 41.3 41.1 40.8
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 DB

HELICOPTER ROTOR ROTATIONAL AND BROADBAND NOISE IN 1/3-OCTAVE BANDS AT AZIMUTH ANGLE OF 20. DEG

FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND
25.0	-25.6	29.2	31.5	-12.2	30.5	40.0	1.5	31.5	50.0	14.4	33.1
63.0	27.8	34.5	80.0	41.5	35.6	100.0	54.4	37.2	125.0	57.7	38.4
160.0	44.0	39.6	200.0	48.4	40.9	250.0	51.7	42.7	315.0	48.6	43.2
400.0	47.3	44.3	500.0	48.3	45.9	630.0	47.9	46.8	800.0	47.3	45.4
1000.0	47.2	43.3	1250.0	46.6	41.9	1600.0	46.1	41.2	2000.0	45.0	40.4
2500.0	39.0	39.3	3150.0	24.4	36.5	4000.0	9.6	33.2	5000.0	7.6	30.3
6300.0	4.4	25.7	8000.0	-1.1	21.1	10000.0	-9.4	12.9	12500.0	-20.4	0.8
16000.0	-36.5	-17.1	20000.0	-61.3	-42.6						

ROTOR HARMONICS 1-60 WITHOUT ATMOSPHERIC ATTENUATION FOR ANGLE OF 30.0 AND BLADE PASSING FREQUENCY OF 103.6 HZ ARE

63.2 59.7 57.7 56.3 55.3 54.4 53.7 53.0 52.5 52.0 51.5 51.1 50.7 50.4 50.0 49.7 49.4 49.2 48.9 48.7
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 DB

HELICOPTER ROTOR ROTATIONAL AND BROADBAND NOISE IN 1/3-OCTAVE BANDS AT AZIMUTH ANGLE OF 30. DEG

FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND
25.0	-20.9	33.5	31.5	-7.6	35.3	40.0	6.2	36.4	50.0	19.1	37.9
63.0	32.4	39.3	80.0	46.2	40.4	100.0	59.1	42.0	125.0	61.6	43.2
160.0	48.5	44.4	200.0	55.5	45.8	250.0	58.0	47.1	315.0	56.5	48.1
400.0	55.1	49.3	500.0	56.1	50.9	630.0	56.0	51.8	800.0	55.5	50.6
1000.0	55.4	48.6	1250.0	55.0	47.2	1600.0	54.7	46.7	2000.0	53.7	46.1
2500.0	47.7	45.3	3150.0	33.4	42.9	4000.0	18.5	40.2	5000.0	17.5	37.7
6300.0	14.6	35.2	8000.0	11.2	31.3	10000.0	5.7	25.6	12500.0	-2.0	17.0
16000.0	-13.2	4.4	20000.0	-29.9	-13.3						

ROTOR HARMONICS 1-60 WITHOUT ATMOSPHERIC ATTENUATION FOR ANGLE OF 40.0 AND BLADE PASSING FREQUENCY OF 103.6 HZ ARE

68.2 65.0 63.1 61.7 60.6 59.7 59.0 58.4 57.8 57.3 56.8 56.4 56.0 55.7 55.4 55.0 54.8 54.5 54.2 54.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 DB

HELICOPTER ROTOR ROTATIONAL AND BROADBAND NOISE IN 1/3-OCTAVE BANDS AT AZIMUTH ANGLE OF 40. DEG

FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND
25.0	-15.4	37.5	31.5	-2.0	38.9	40.0	11.8	40.0	50.0	24.7	41.5

FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND
63.0	38.0	42.9	80.0	51.8	44.0	100.0	64.7	45.5	125.0	66.1	46.8
160.0	53.4	48.0	200.0	61.4	49.4	250.0	62.9	50.7	315.0	62.4	51.8
400.0	60.6	52.9	500.0	61.4	54.5	630.0	61.5	55.5	800.0	61.0	54.3
1000.0	60.9	52.4	1250.0	60.6	51.1	1600.0	60.3	50.7	2000.0	59.5	50.2
2500.0	53.0	49.5	3150.0	39.0	47.3	4000.0	24.3	44.9	5000.0	23.5	42.6
6300.0	21.8	40.6	8000.0	18.5	37.5	10000.0	14.3	33.0	12500.0	8.3	26.1
16000.0	-0.2	16.1	20000.0	-13.0	2.2						

ROTOR HARMONICS 1-60 WITHOUT ATMOSPHERIC ATTENUATION FOR ANGLE OF 50.0 AND BLADE PASSING FREQUENCY OF 103.6 HZ ARE

71.8 68.4 66.5 65.1 64.0 63.1 62.4 61.8 61.2 60.7 60.3 59.8 59.5 59.1 58.8 58.5 58.2 57.9 57.6 57.4
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 DB

HELICOPTER ROTOR ROTATIONAL AND BROADBAND NOISE IN 1/3-OCTAVE BANDS AT AZIMUTH ANGLE OF 50. DEG

FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND
25.0	-11.1	40.2	31.5	2.2	41.6	40.0	16.0	42.7	50.0	28.9	44.2
63.0	42.2	45.6	80.0	56.0	46.7	100.0	68.9	48.3	125.0	68.9	49.6
160.0	56.8	50.8	200.0	65.5	52.1	250.0	65.8	53.5	315.0	66.5	54.6
400.0	64.2	55.7	500.0	64.7	57.4	630.0	65.2	58.4	800.0	64.6	57.2
1000.0	64.3	55.2	1250.0	64.3	54.0	1600.0	63.9	53.5	2000.0	63.2	53.2
2500.0	56.1	52.6	3150.0	42.2	50.5	4000.0	27.6	48.3	5000.0	26.3	46.1
6300.0	24.5	44.4	8000.0	22.1	41.7	10000.0	18.5	38.0	12500.0	13.6	32.0
16000.0	6.4	23.5	20000.0	-4.1	11.8						

ROTOR HARMONICS 1-60 WITHOUT ATMOSPHERIC ATTENUATION FOR ANGLE OF 60.0 AND BLADE PASSING FREQUENCY OF 103.6 HZ ARE

74.0 70.7 68.7 67.3 66.2 65.4 64.6 64.0 63.4 62.9 62.5 62.0 61.7 61.3 61.0 60.7 60.4 60.1 59.8 59.6
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 DB

HELICOPTER ROTOR ROTATIONAL AND BROADBAND NOISE IN 1/3-OCTAVE BANDS AT AZIMUTH ANGLE OF 60. DEG

FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND
25.0	-8.1	42.3	31.5	5.3	43.7	40.0	19.1	44.3	50.0	32.0	46.3
63.0	45.3	47.7	80.0	59.1	48.8	100.0	72.0	50.4	125.0	70.4	51.7
160.0	58.9	52.9	200.0	68.6	54.2	250.0	67.3	55.6	315.0	68.7	56.7
400.0	66.7	57.8	500.0	67.0	59.5	630.0	67.2	60.5	800.0	67.0	59.3
1000.0	66.6	57.4	1250.0	66.6	56.2	1600.0	66.2	55.9	2000.0	65.4	55.4
2500.0	57.7	54.9	3150.0	43.9	52.9	4000.0	29.4	50.8	5000.0	29.1	48.7
6300.0	28.3	47.2	8000.0	25.8	44.8	10000.0	22.6	41.5	12500.0	18.5	36.1
16000.0	12.0	28.5	20000.0	3.0	18.1						

ROTOR HARMONICS 1-60 WITHOUT ATMOSPHERIC ATTENUATION FOR ANGLE OF 70.0 AND BLADE PASSING FREQUENCY OF 103.6 HZ ARE

75.4 72.0 70.0 68.7 67.6 66.7 66.0 65.3 64.8 64.3 63.8 63.4 63.0 62.7 62.3 62.0 61.7 61.5 61.2 61.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 DB

HELICOPTER ROTOR ROTATIONAL AND BROADBAND NOISE IN 1/3-OCTAVE BANDS AT AZIMUTH ANGLE OF 70. DEG

FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND
25.0	-5.8	43.9	31.5	7.6	45.3	40.0	21.4	46.4	50.0	34.3	47.9
63.0	47.6	49.2	80.0	61.4	50.3	100.0	74.3	51.9	125.0	70.8	53.2
160.0	60.3	54.4	200.0	70.9	55.8	250.0	67.9	57.2	315.0	70.1	58.2
400.0	68.6	59.4	500.0	68.5	61.0	630.0	68.5	62.1	800.0	68.7	60.9
1000.0	68.2	59.0	1250.0	68.0	57.8	1600.0	67.7	57.5	2000.0	66.7	57.1

2500.0	58.3	56.6	3150.0	44.5	54.6	4000.0	30.0	52.6	5000.0	29.3	50.5
6300.0	28.6	49.1	8000.0	26.5	46.9	10000.0	23.3	43.9	12500.0	20.1	38.9
16000.0	14.2	31.9	20000.0	5.5	22.3						

ROTOR HARMONICS 1-60 WITHOUT ATMOSPHERIC ATTENUATION FOR ANGLE OF 80.0 AND BLADE PASSING FREQUENCY OF 103.6 HZ ARE

76.1 72.7 70.8 69.4 68.3 67.4 66.7 66.1 65.5 65.0 64.5 64.1 63.7 63.4 63.0 62.7 67.4 67.2 61.9 61.7
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 DB

HELICOPTER ROTOR ROTATIONAL AND BROADBAND NOISE IN 1/3-OCTAVE BANDS AT AZIMUTH ANGLE OF 80. DEG

FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND
25.0	-4.0	44.9	31.5	9.3	46.3	40.0	23.1	47.4	50.0	36.0	48.9
63.0	49.3	50.3	80.0	63.1	51.4	100.0	76.0	52.9	125.0	70.6	54.2
160.0	61.3	55.4	200.0	72.6	56.8	250.0	67.9	58.2	315.0	70.8	59.3
400.0	69.9	60.4	500.0	69.6	62.1	630.0	69.1	63.1	800.0	69.6	61.9
1000.0	69.1	60.0	1250.0	68.8	58.8	1600.0	68.5	58.5	2000.0	67.3	58.1
2500.0	58.1	57.7	3150.0	44.3	55.7	4000.0	43.2	53.7	5000.0	42.5	51.7
6300.0	41.4	50.4	8000.0	39.5	48.3	10000.0	36.7	45.4	12500.0	33.0	40.7
16000.0	27.6	34.0	20000.0	15.8	25.0						

ROTOR HARMONICS 1-60 WITHOUT ATMOSPHERIC ATTENUATION FOR ANGLE OF 90.0 AND BLADE PASSING FREQUENCY OF 103.6 HZ ARE

76.3 72.9 70.9 69.5 68.5 67.6 66.9 66.2 65.7 65.2 64.7 64.3 63.9 63.6 63.2 62.9 62.6 62.4 62.1 61.8
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 DB

HELICOPTER ROTOR ROTATIONAL AND BROADBAND NOISE IN 1/3-OCTAVE BANDS AT AZIMUTH ANGLE OF 90. DEG

FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND
25.0	-2.8	45.4	31.5	10.5	46.8	40.0	24.3	47.9	50.0	37.2	49.4
63.0	50.5	50.3	80.0	64.3	51.9	100.0	76.2	53.5	125.0	69.7	54.8
160.0	62.0	56.0	200.0	72.8	57.3	250.0	67.4	58.7	315.0	71.0	59.8
400.0	70.1	61.0	500.0	69.7	62.6	630.0	69.3	63.6	800.0	69.5	62.5
1000.0	69.4	60.6	1250.0	68.9	59.4	1600.0	68.6	59.1	2000.0	67.7	58.7
2500.0	57.2	58.2	3150.0	43.5	56.3	4000.0	42.9	54.3	5000.0	43.1	52.3
6300.0	42.0	51.0	8000.0	40.4	49.0	10000.0	38.1	46.2	12500.0	34.8	41.6
16000.0	29.7	35.1	20000.0	22.2	26.3						

ROTOR HARMONICS 1-60 WITHOUT ATMOSPHERIC ATTENUATION FOR ANGLE OF 100.0 AND BLADE PASSING FREQUENCY OF 103.6 HZ ARE

75.9 72.5 70.6 69.2 68.1 67.3 66.5 65.9 65.3 64.8 64.4 64.0 63.6 63.2 62.9 62.6 62.3 62.0 61.8 61.5
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 DB

HELICOPTER ROTOR ROTATIONAL AND BROADBAND NOISE IN 1/3-OCTAVE BANDS AT AZIMUTH ANGLE OF 100. DEG

FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND
25.0	-2.1	45.5	31.5	11.2	46.9	40.0	25.0	48.0	50.0	37.9	49.5
63.0	51.3	50.8	80.0	65.1	51.9	100.0	75.9	53.5	125.0	68.3	54.8
160.0	62.3	56.0	200.0	72.5	57.4	250.0	66.7	58.8	315.0	70.7	59.8
400.0	69.7	61.0	500.0	69.3	62.7	630.0	69.0	63.7	800.0	68.9	62.5
1000.0	68.8	60.6	1250.0	68.6	59.4	1600.0	68.2	59.1	2000.0	66.4	58.8
2500.0	55.8	58.3	3150.0	42.1	56.4	4000.0	41.5	54.4	5000.0	41.2	52.4
6300.0	40.2	51.1	8000.0	38.5	49.1	10000.0	36.0	46.3	12500.0	32.4	41.7
16000.0	27.2	35.2	20000.0	19.7	26.4						

ROTOR HARMONICS 1-60 WITHOUT ATMOSPHERIC ATTENUATION FOR ANGLE OF 110.0 AND BLADE PASSING FREQUENCY OF 103.6 HZ ARE

75.1	71.7	69.7	68.4	67.3	66.4	65.7	65.0	64.5	64.0	63.5	63.1	62.7	62.4	62.0	61.7	61.4	61.2	60.9	60.7
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0 DB

HELICOPTER ROTOR ROTATIONAL AND BROADBAND NOISE IN 1/3-OCTAVE BANDS AT AZIMUTH ANGLE OF 110. DEG

FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND
25.0	-1.9	45.0	31.5	11.4	46.4	40.0	25.2	47.5	50.0	38.1	49.0
63.0	51.5	50.4	80.0	65.3	51.5	100.0	75.0	53.1	125.0	66.4	54.4
160.0	62.3	55.5	200.0	71.6	56.9	250.0	65.6	58.3	315.0	69.9	59.4
400.0	68.8	60.5	500.0	68.3	62.2	630.0	68.3	63.2	800.0	67.9	62.0
1000.0	67.8	60.2	1250.0	67.7	58.9	1600.0	67.4	58.7	2000.0	65.1	58.3
2500.0	53.9	57.8	3150.0	40.1	55.9	4000.0	38.9	53.9	5000.0	38.6	51.8
6300.0	37.8	50.5	8000.0	35.8	48.4	10000.0	33.4	45.6	12500.0	29.9	40.9
16000.0	24.8	34.2	20000.0	17.2	25.3						

ROTOR HARMONICS 1-60 WITHOUT ATMOSPHERIC ATTENUATION FOR ANGLE OF 120.0 AND BLADE PASSING FREQUENCY OF 103.6 HZ ARE

73.6	70.2	68.3	66.9	65.8	65.0	64.2	63.6	63.0	62.5	62.1	61.6	61.3	60.9	60.6	60.3	60.0	59.7	59.4	59.2
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0 DB

HELICOPTER ROTOR ROTATIONAL AND BROADBAND NOISE IN 1/3-OCTAVE BANDS AT AZIMUTH ANGLE OF 120. DEG

FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND
25.0	-2.4	44.0	31.5	11.0	45.4	40.0	24.8	46.5	50.0	37.6	48.0
63.0	51.0	49.4	80.0	64.8	50.5	100.0	73.6	52.0	125.0	63.9	53.3
160.0	61.7	54.5	200.0	70.2	55.9	250.0	64.2	57.3	315.0	68.5	58.3
400.0	67.4	59.5	500.0	66.9	61.1	630.0	67.1	62.2	800.0	66.4	61.0
1000.0	66.3	59.1	1250.0	66.2	57.9	1600.0	65.8	57.6	2000.0	63.2	57.2
2500.0	51.4	56.7	3150.0	37.6	54.7	4000.0	36.9	52.7	5000.0	36.1	50.6
6300.0	34.9	49.2	8000.0	32.8	47.1	10000.0	30.0	44.1	12500.0	26.0	39.1
16000.0	20.4	32.1	20000.0	12.0	22.6						

ROTOR HARMONICS 1-60 WITHOUT ATMOSPHERIC ATTENUATION FOR ANGLE OF 130.0 AND BLADE PASSING FREQUENCY OF 103.6 HZ ARE

71.3	68.0	66.0	64.7	63.6	62.7	62.0	61.3	60.8	60.3	59.8	59.4	59.0	58.7	58.3	58.0	57.7	57.5	57.2	57.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0 DB

HELICOPTER ROTOR ROTATIONAL AND BROADBAND NOISE IN 1/3-OCTAVE BANDS AT AZIMUTH ANGLE OF 130. DEG

FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND
25.0	-3.7	42.3	31.5	9.6	43.7	40.0	23.4	44.8	50.0	36.3	46.3
63.0	49.6	47.7	80.0	63.4	48.8	100.0	71.3	50.4	125.0	60.8	51.7
160.0	60.2	52.8	200.0	67.9	54.2	250.0	62.2	55.6	315.0	65.8	56.7
400.0	65.2	57.8	500.0	64.7	59.4	630.0	64.8	60.5	800.0	64.2	59.3
1000.0	64.1	57.4	1250.0	64.0	56.1	1600.0	63.4	55.8	2000.0	60.3	55.4
2500.0	48.0	54.9	3150.0	34.2	52.9	4000.0	32.9	50.7	5000.0	32.5	48.6
6300.0	31.2	47.1	8000.0	29.1	44.7	10000.0	26.0	41.4	12500.0	22.0	36.1
16000.0	15.8	28.4	20000.0	6.6	18.0						

ROTOR HARMONICS 1-60 WITHOUT ATMOSPHERIC ATTENUATION FOR ANGLE OF 140.0 AND BLADE PASSING FREQUENCY OF 103.6 HZ ARE

68.0	64.7	62.7	61.4	60.3	59.4	58.7	58.0	57.5	57.0	56.5	56.1	55.7	55.4	55.0	54.7	54.4	54.2	53.9	53.7
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0 DB

HELICOPTER ROTOR ROTATIONAL AND BROADBAND NOISE IN 1/3-OCTAVE BANDS AT AZIMUTH ANGLE OF 140. DEG

FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND
25.0	-6.3	39.9	31.5	7.1	41.2	40.0	20.9	42.3	50.0	33.8	43.8
63.0	47.1	45.2	80.0	60.9	46.3	100.0	67.7	47.9	125.0	56.7	49.2
160.0	57.7	50.4	200.0	64.6	51.7	250.0	59.2	53.1	315.0	61.9	54.2
400.0	61.9	55.3	500.0	61.5	56.9	630.0	61.5	58.0	800.0	61.0	56.8
1000.0	60.8	54.8	1250.0	60.5	53.6	1600.0	59.9	53.2	2000.0	56.3	52.7
2500.0	43.7	52.2	3150.0	29.8	50.1	4000.0	29.4	47.8	5000.0	29.0	45.6
6300.0	27.4	43.9	8000.0	25.0	41.1	10000.0	21.4	37.3	12500.0	16.5	31.2
16000.0	9.1	22.5	20000.0	-1.7	10.5						

ROTOR HARMONICS 1-60 WITHOUT ATMOSPHERIC ATTENUATION FOR ANGLE OF 150.0 AND BLADE PASSING FREQUENCY OF 103.6 HZ ARE

63.1	59.7	57.8	56.4	55.4	54.5	53.8	53.1	52.6	52.1	51.6	51.2	50.8	50.5	50.1	49.8	49.5	49.3	49.0	48.7
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0 DB

HELICOPTER ROTOR ROTATIONAL AND BROADBAND NOISE IN 1/3-OCTAVE BANDS AT AZIMUTH ANGLE OF 150. DEG

FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND
25.0	-10.5	36.4	31.5	2.8	37.8	40.0	16.6	38.9	50.0	29.5	40.4
63.0	42.8	41.8	80.0	56.6	42.8	100.0	63.0	44.4	125.0	51.2	45.7
160.0	53.3	46.9	200.0	59.6	48.3	250.0	54.6	49.6	315.0	56.4	50.7
400.0	57.0	51.8	500.0	56.6	53.4	630.0	56.3	54.4	800.0	56.2	53.2
1000.0	55.7	51.2	1250.0	55.4	49.9	1600.0	54.8	49.5	2000.0	50.7	48.9
2500.0	37.6	48.2	3150.0	23.6	46.0	4000.0	22.0	43.5	5000.0	20.9	41.2
6300.0	19.2	39.0	8000.0	15.5	35.6	10000.0	11.1	30.9	12500.0	5.0	23.5
16000.0	-4.6	12.8	20000.0	-18.3	-2.2						

ROTOR HARMONICS 1-60 WITHOUT ATMOSPHERIC ATTENUATION FOR ANGLE OF 160.0 AND BLADE PASSING FREQUENCY OF 103.6 HZ ARE

56.4	52.3	50.3	48.9	47.8	47.0	46.2	45.6	45.0	44.5	44.1	43.7	43.3	42.9	42.6	42.3	42.0	41.7	41.5	41.2
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0 DB

HELICOPTER ROTOR ROTATIONAL AND BROADBAND NOISE IN 1/3-OCTAVE BANDS AT AZIMUTH ANGLE OF 160. DEG

FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND	FREQUENCY	ROTATIONAL	BROADBAND
25.0	-16.7	31.5	31.5	-3.3	32.9	40.0	10.4	34.0	50.0	23.3	35.5
63.0	36.7	36.9	80.0	50.4	38.0	100.0	56.3	39.5	125.0	44.0	40.8
160.0	46.3	42.0	200.0	52.1	43.3	250.0	47.3	44.7	315.0	48.5	45.7
400.0	49.4	46.8	500.0	49.0	48.4	630.0	48.4	49.3	800.0	48.4	48.0
1000.0	47.8	46.0	1250.0	47.3	44.5	1600.0	46.6	44.0	2000.0	42.1	43.3
2500.0	28.7	42.4	3150.0	14.7	39.8	4000.0	13.0	36.8	5000.0	11.6	34.1
6300.0	8.8	31.2	8000.0	4.7	26.5	10000.0	-2.1	19.7	12500.0	-11.0	9.5
16000.0	-24.6	-5.4	20000.0	-44.5	-26.5						

HELICOPTER TAIL ROTOR NOISE

SPL ON A 200.-FOOT SIDELINE , DB

AZIMUTH ANGLE , DEG

1/3-OCTAVE-BAND CENTER FREQ. , HZ	FWD. 20.	30.	40.	50.	60.	70.	80.	90.	100.	110.	120.	130.	140.	150.	REAR 160.
25.0	29.2	33.9	37.5	40.3	42.4	43.9	44.9	45.4	45.5	45.0	44.0	42.3	39.9	36.4	31.6

31.5	30.6	35.3	38.9	41.7	43.8	45.3	46.3	46.8	46.9	46.4	45.4	43.7	41.3	37.8	33.0
40.0	31.7	36.5	40.0	42.8	44.9	46.4	47.4	47.9	48.0	47.5	46.5	44.9	42.4	38.9	34.1
50.0	33.3	38.0	41.6	44.4	46.5	48.1	49.1	49.7	49.8	49.4	48.4	46.7	44.3	40.8	35.8
63.0	35.4	40.2	44.1	47.3	49.7	51.5	52.9	53.7	54.1	54.0	53.3	51.8	49.3	45.4	39.9
80.0	42.6	47.3	52.5	56.5	59.5	61.8	63.4	64.6	65.3	65.5	65.0	63.6	61.1	56.9	50.8
100.0	54.6	59.2	64.8	69.0	72.1	74.4	76.1	76.3	76.0	75.1	73.6	71.4	68.0	63.1	56.5
125.0	57.9	61.8	66.2	69.0	70.5	71.0	70.7	69.9	68.5	65.7	64.4	61.4	57.5	52.4	45.8
160.0	45.6	50.1	54.7	57.8	60.0	61.4	62.4	63.0	63.3	63.2	62.5	61.1	58.5	54.3	47.9
200.0	49.4	56.1	61.8	65.5	68.8	71.1	72.8	73.0	72.7	71.9	70.4	68.2	64.9	60.1	52.9
250.0	52.5	58.6	63.4	66.2	67.7	68.4	68.4	68.1	67.4	66.5	65.1	63.2	60.3	56.0	49.5
315.0	50.1	57.4	63.0	67.0	69.2	70.5	71.3	71.5	71.2	70.4	69.0	66.5	62.8	57.7	50.7
400.0	49.7	56.5	61.5	65.0	67.4	69.2	70.6	70.8	70.4	69.6	68.2	66.1	63.0	58.5	51.8
500.0	51.0	57.7	62.6	65.8	67.9	69.5	70.6	70.7	70.3	69.5	68.2	66.1	63.1	58.7	52.3
630.0	51.3	58.0	63.0	66.4	68.4	69.7	70.4	70.6	70.4	69.8	68.6	66.5	63.5	59.0	52.6
800.0	50.6	57.5	62.4	65.8	68.1	69.7	70.7	70.6	70.1	69.3	67.9	65.9	62.9	58.6	52.2
1000.0	50.1	57.2	62.2	65.5	67.7	69.1	70.1	70.4	69.9	68.9	67.5	65.5	62.4	57.9	51.2
1250.0	49.7	56.9	62.0	65.4	67.7	69.0	69.8	69.9	69.7	68.8	67.4	65.3	62.1	57.5	50.7
1600.0	49.7	56.9	62.0	65.3	67.5	68.9	69.7	69.8	69.4	68.7	67.3	65.0	61.8	57.2	50.5
2000.0	49.3	56.5	61.5	64.9	67.0	68.1	68.8	68.7	68.0	66.9	65.2	62.7	59.2	54.6	48.2
2500.0	46.0	52.3	56.6	59.4	61.0	61.8	62.1	62.0	61.4	60.5	59.1	57.1	54.4	50.8	45.7
3150.0	42.0	46.9	50.6	53.4	55.4	56.8	57.7	58.1	58.1	57.6	56.6	54.9	52.4	48.9	44.1
4000.0	40.3	45.1	48.7	51.4	53.5	55.0	56.4	56.8	56.8	56.3	55.2	53.5	51.0	47.5	42.7
5000.0	38.7	43.5	47.1	49.8	51.9	53.4	54.9	55.4	55.3	54.7	53.6	51.9	49.5	46.0	41.1
6300.0	38.4	43.2	46.8	49.5	51.6	53.1	54.6	55.1	55.0	54.4	53.3	51.6	49.2	45.7	40.8
8000.0	38.0	42.8	46.4	49.1	51.2	52.7	54.2	54.8	54.6	54.0	53.0	51.2	48.8	45.3	40.4
10000.0	37.7	42.5	46.1	48.8	50.9	52.4	53.9	54.6	54.4	53.8	52.7	50.9	48.5	45.0	40.1
12500.0	36.4	41.2	44.8	47.5	49.6	51.1	52.8	53.4	53.2	52.5	51.4	49.7	47.2	43.7	38.8
16000.0	35.0	39.8	43.4	46.1	48.2	49.8	51.6	52.3	51.9	51.3	50.1	48.4	45.9	42.3	37.4
20000.0	33.8	38.5	42.2	44.9	47.0	48.5	50.5	51.4	50.8	50.1	48.9	47.1	44.6	41.0	36.1
DB(A)	59.5	66.3	71.3	74.6	76.8	78.1	75.0	79.1	78.7	77.9	76.5	74.3	71.2	66.8	60.4
PNL	71.7	78.3	83.2	86.6	88.8	90.1	91.0	91.1	90.7	89.7	88.3	86.1	83.0	78.5	72.1
PNLT	73.2	79.8	84.6	87.9	89.9	91.5	92.5	92.6	92.2	91.2	89.8	87.6	84.5	80.0	73.5

HELICOPTER MAIN PLUS FREE-AIR TAIL ROTOR NOISE

SPL ON A 200.-FOOT SIDELINE , DB

1/3-OCTAVE-BAND CENTER FREQ. , HZ	FWD. 20.	30.	40.	50.	60.	70.	80.	90.	100.	110.	120.	130.	140.	150.	REAR 160.
	AZIMUTH ANGLE , DEG														
25.0	63.2	68.5	71.5	73.0	73.6	73.6	73.3	72.8	72.3	71.8	71.0	69.8	67.9	65.0	60.3
31.5	62.0	68.3	72.4	75.2	77.4	79.0	80.3	81.3	82.0	81.3	80.2	73.7	76.4	73.1	68.0
40.0	68.2	73.8	76.9	78.5	79.1	79.1	78.6	77.8	76.8	75.6	74.2	72.4	70.1	66.9	61.9
50.0	61.6	68.1	72.3	75.3	77.5	79.1	79.4	79.5	79.1	78.5	77.4	75.8	73.5	69.8	64.3
63.0	61.8	68.0	71.7	74.0	75.5	76.4	77.1	77.6	77.8	77.1	75.9	74.3	71.9	68.5	63.4
80.0	62.0	68.2	72.0	74.3	75.8	76.7	77.3	77.7	77.4	76.7	75.6	74.0	71.6	68.1	63.0
100.0	62.1	68.1	72.2	75.1	77.2	78.7	79.6	79.7	79.4	78.7	77.4	75.6	72.9	69.0	63.6
125.0	62.6	68.0	72.0	74.7	76.3	77.3	77.8	77.9	77.7	76.8	75.4	73.5	71.0	67.4	62.3
160.0	61.1	66.9	70.7	73.3	75.0	76.2	77.0	77.4	77.3	76.6	75.4	73.7	71.2	67.8	62.7
200.0	61.7	67.3	71.3	74.1	76.2	77.8	78.8	79.1	78.9	78.3	77.1	75.3	72.6	68.9	63.7
250.0	62.4	67.8	71.7	74.5	76.4	77.7	78.4	78.8	78.7	78.1	76.9	75.2	72.7	69.1	64.1
315.0	61.3	66.8	70.9	73.8	75.8	77.2	78.0	78.3	78.2	77.6	76.5	74.6	71.9	68.2	63.1
400.0	59.8	65.4	69.4	72.3	74.3	75.7	76.7	77.0	76.8	76.2	75.1	73.2	70.6	66.9	61.8
500.0	59.1	64.8	68.8	71.7	73.7	75.0	75.9	76.2	76.1	75.4	74.3	72.4	69.8	66.1	60.9
630.0	58.9	64.5	68.6	71.5	73.5	74.8	75.6	76.0	75.9	75.2	74.2	72.7	69.7	65.8	60.6
800.0	58.4	64.2	68.1	71.0	73.1	74.6	75.5	75.7	75.5	75.0	73.7	71.8	69.3	65.5	60.3
1000.0	58.1	63.8	67.8	70.6	72.7	74.2	75.0	75.4	75.2	74.6	73.3	71.4	68.9	65.1	59.9
1250.0	56.9	62.7	66.9	69.7	71.9	73.3	74.1	74.4	74.3	73.6	72.3	70.3	67.8	63.9	58.6
1600.0	56.0	61.8	66.3	69.0	71.1	72.5	73.3	73.5	73.4	72.8	71.4	69.4	66.8	62.8	57.5
2000.0	54.9	60.7	65.3	68.1	70.2	71.4	72.1	72.3	72.1	71.2	69.7	67.6	65.0	61.1	56.0
2500.0	53.8	59.2	63.4	65.8	67.9	69.1	69.8	70.1	70.1	69.4	68.0	66.2	63.8	60.1	55.2
3150.0	52.8	57.9	62.2	64.5	66.7	67.9	68.7	69.2	69.2	68.6	67.3	65.5	63.1	59.5	54.6
4000.0	52.3	57.4	61.5	63.9	66.1	67.4	68.2	68.7	68.7	68.2	66.8	65.0	62.6	59.0	54.1
5000.0	51.1	56.2	60.4	62.7	64.9	66.2	67.1	67.5	67.5	67.0	65.6	63.8	61.4	57.8	52.9
6300.0	49.9	55.1	59.3	61.6	63.8	65.1	65.9	66.3	66.4	65.8	64.4	62.6	60.2	56.6	51.7
8000.0	48.8	54.0	58.3	60.5	62.7	64.0	64.8	65.2	65.3	64.7	63.2	61.4	59.1	55.5	50.6
10000.0	47.8	53.0	57.3	59.5	61.7	63.0	63.8	64.2	64.2	63.6	62.1	60.3	58.0	54.4	49.5
12500.0	46.6	51.8	56.2	58.4	60.6	61.8	62.6	63.0	63.0	62.4	60.9	59.1	56.8	53.1	48.2
16000.0	45.4	50.7	55.1	57.3	59.5	60.7	61.5	61.9	61.9	61.3	59.7	57.9	55.6	52.0	47.0
20000.0	44.3	49.7	54.1	56.2	58.4	59.3	60.4	60.8	60.8	60.2	58.5	56.7	54.4	50.8	45.9
DB(A)	67.7	73.3	77.4	80.1	82.2	83.6	84.4	84.7	84.6	84.0	82.7	80.8	78.3	74.5	69.4
PNL	80.7	86.4	90.7	93.4	95.5	96.8	97.6	97.9	97.8	97.2	95.8	94.0	91.4	87.6	82.4
PNLT	80.7	86.4	90.7	93.4	95.5	96.8	97.6	97.9	97.8	97.2	95.8	94.0	91.4	87.6	82.4

CORE-ENGINE COMPRESSOR NOISE

HELICOPTER SAMPLE CASE - GENERALIZED ENGINE, MAXIMUM PRINTING   04/14/76 16:57:48

RPM = 39627. , FIRST STAGE DIAMETER = 0.60 FT , 29. BLADES , ROTOR/STATOR SPACING = 10.0 %, STAGE PRESSURE RATIO = 1.2013
BLADE PASSING FREQUENCY = 19153. HZ , CONFIGURATION FROM GENERALIZATION

SPL ON A 200.-FOOT SIDELINE , DB

1/3-OCTAVE-BAND CENTER FREQ. , HZ	FWD. 20.	30.	40.	50.	60.	70.	AZIMUTH ANGLE , DEG 80.	90.	100.	110.	120.	130.	140.	150.	REAR 160.
25.0	29.8	33.0	35.0	36.4	37.2	35.7	32.5	27.8	21.4	14.8	7.9	6.6	4.9	2.6	-0.8
31.5	30.8	34.0	36.0	37.4	38.2	36.7	33.9	28.8	22.4	15.8	8.9	7.6	5.9	3.6	0.2
40.0	31.8	35.0	37.1	38.4	39.3	37.8	34.9	29.8	23.5	16.8	9.9	8.7	7.0	4.7	1.3
50.0	32.8	36.0	38.0	39.4	40.2	38.7	35.9	30.8	24.4	17.8	10.9	9.6	7.9	5.6	2.2
63.0	33.8	37.0	39.0	40.4	41.2	39.7	36.9	31.8	25.4	18.8	11.9	10.6	8.9	6.6	3.2
80.0	34.8	38.0	40.1	41.4	42.3	40.8	37.9	32.8	26.5	19.8	12.9	11.7	10.0	7.6	4.2
100.0	35.7	39.0	41.0	42.4	43.2	41.7	38.9	33.8	27.4	20.8	13.9	12.6	10.9	8.6	5.2
125.0	36.7	39.9	42.0	43.3	44.2	42.7	39.9	34.8	28.4	21.8	14.8	13.6	11.9	9.6	6.1
160.0	37.7	41.0	43.0	44.4	45.3	43.8	40.9	35.8	29.5	22.8	15.9	14.6	12.9	10.6	7.1
200.0	38.7	41.9	44.0	45.4	46.2	44.7	41.9	36.8	30.4	23.8	16.9	15.6	13.9	11.5	8.1
250.0	39.6	42.9	44.9	46.3	47.2	45.7	42.8	37.7	31.4	24.7	17.8	16.5	14.8	12.5	9.0
315.0	40.5	43.8	45.9	47.3	48.2	46.7	43.8	38.7	32.4	25.7	18.8	17.5	15.8	13.4	9.9
400.0	41.4	44.8	46.9	48.3	49.2	47.7	44.9	39.8	33.4	26.7	19.8	18.5	16.8	14.4	10.9
500.0	42.3	45.7	47.8	49.2	50.1	48.6	45.8	40.7	34.3	27.7	20.7	19.5	17.7	15.3	11.7
630.0	43.2	46.6	48.8	50.2	51.1	49.6	46.8	41.7	35.3	28.7	21.7	20.4	18.7	16.2	12.6
800.0	44.0	47.5	49.7	51.2	52.1	50.6	47.8	42.7	36.3	29.6	22.7	21.4	19.6	17.2	13.4
1000.0	44.8	48.4	50.6	52.1	53.0	51.5	48.7	43.6	37.2	30.6	23.6	22.3	20.5	18.0	14.2
1250.0	45.5	49.2	51.4	52.9	53.9	52.4	49.6	44.5	38.1	31.5	24.5	23.2	21.3	18.8	14.9
1600.0	46.1	50.0	52.3	53.9	54.8	53.4	50.6	45.5	39.1	32.4	25.5	24.1	22.2	19.6	15.5
2000.0	46.6	50.7	53.1	54.7	55.7	54.2	51.5	46.4	40.0	33.3	26.3	24.9	23.0	20.3	16.1
2500.0	47.0	51.3	53.8	55.5	56.5	55.1	52.3	47.2	40.8	34.1	27.1	25.7	23.7	20.9	16.4
3150.0	47.0	51.6	54.4	56.1	57.2	55.9	53.1	48.0	41.5	34.9	27.9	26.4	24.3	21.3	16.4
4000.0	46.6	51.8	54.8	56.7	57.9	56.6	53.9	48.8	42.4	35.7	28.5	27.0	24.7	21.5	16.1
5000.0	46.6	52.2	55.4	57.4	58.6	57.3	54.6	49.6	43.2	36.4	29.3	27.6	25.3	21.8	16.0
6300.0	45.3	51.8	55.4	57.6	59.0	57.8	55.2	50.1	43.7	36.9	29.7	27.9	25.3	21.4	14.7
8000.0	42.4	50.4	54.8	57.4	59.1	58.0	55.4	50.4	44.0	37.1	29.7	27.7	24.7	20.1	11.8
10000.0	37.6	47.9	53.3	56.5	58.6	57.7	55.3	50.3	43.8	36.8	29.2	26.8	23.2	17.5	7.0
12500.0	30.6	43.9	50.8	54.9	57.4	56.9	54.6	49.7	43.1	35.9	28.0	25.1	20.7	13.5	-0.0
16000.0	19.6	37.6	46.7	52.1	55.4	55.3	53.3	48.4	41.8	34.4	26.0	22.3	35.9	26.4	8.2
20000.0	19.8	44.4	56.6	63.2	66.6	67.1	65.4	60.6	53.7	45.9	40.7	35.8	9.9	-2.8	-27.9
DB(A)	57.2	62.0	65.0	67.1	68.5	67.5	64.9	59.9	53.4	46.5	39.6	37.5	35.9	31.9	26.6
PNL	70.3	75.3	78.2	80.1	81.3	80.0	77.2	72.1	65.6	58.6	51.3	49.7	47.5	44.3	39.2
PNLT	70.3	75.3	78.2	80.1	81.3	80.0	77.2	72.1	65.5	58.6	51.3	49.7	47.5	44.3	39.2

CORE-ENGINE COMBUSTION NOISE

HELICOPTER SAMPLE CASE - GENERALIZED ENGINE, MAXIMUM PRINTING 04/14/76 16:57:48

INLET TOTAL PRESSURE = 22644. PSF , INLET TOTAL TEMPERATURE = 1101. R , EXIT TOTAL TEMPERATURE = 2204. R
MASS FLOW RATE = 3.4 LB/SEC , TURBOSHAFT ENGINE , CONFIGURATION FROM GENERALIZATION

SPL ON A 200.-FOOT SIDELINE , DB
AZIMUTH ANGLE , DEG

1/3-OCTAVE-BAND CENTER FREQ. , HZ	FWD. 20.	30.	40.	50.	60.	70.	80.	90.	100.	110.	120.	130.	140.	150.	REAR 160.
25.0	10.9	16.6	21.1	24.9	28.2	31.2	33.8	36.2	38.3	40.1	41.0	38.7	34.4	29.4	23.3
31.5	13.3	19.0	23.5	27.3	30.6	33.6	36.2	38.6	40.7	42.5	43.4	41.1	36.8	31.8	25.7
40.0	15.8	21.5	25.9	29.8	33.1	36.0	38.7	41.1	43.2	45.0	45.8	43.6	39.2	34.3	28.2
50.0	18.1	23.8	28.3	32.1	35.4	38.4	41.0	43.4	45.5	47.3	48.2	45.9	41.6	36.6	30.5
63.0	20.5	26.2	30.7	34.5	37.8	40.8	43.4	45.8	47.9	49.7	50.6	48.3	44.0	39.0	32.9
80.0	23.0	28.6	33.1	37.0	40.3	43.2	45.9	48.3	50.4	52.2	53.1	50.8	46.4	41.5	35.4
100.0	25.3	31.0	35.5	39.3	42.6	45.6	48.2	50.6	52.7	54.5	55.4	53.1	48.8	43.8	37.7
125.0	27.6	33.3	37.8	41.6	44.9	47.9	50.5	52.9	55.0	56.9	57.7	55.4	51.1	46.1	40.0
160.0	30.1	35.8	40.3	44.1	47.5	50.4	53.1	55.5	57.6	59.4	60.2	58.0	53.6	48.6	42.5
200.0	32.4	38.1	42.6	46.4	49.8	52.7	55.4	57.8	59.9	61.7	62.5	60.3	55.9	50.9	44.8
250.0	34.6	40.4	44.9	48.7	52.1	55.0	57.7	60.1	62.2	64.0	64.8	62.6	58.2	53.2	47.0
315.0	37.0	42.7	47.3	51.1	54.5	57.4	60.1	62.5	64.6	66.4	67.2	64.9	60.6	55.5	49.4
400.0	39.4	45.1	49.7	53.5	56.9	59.9	62.5	64.9	67.0	68.8	69.7	67.4	63.0	58.0	51.7
500.0	41.5	47.4	52.0	55.8	59.2	62.2	64.8	67.2	69.3	71.1	71.9	69.6	65.3	60.2	53.9
630.0	43.8	49.7	54.3	58.2	61.5	64.5	67.2	69.5	71.7	73.5	74.3	72.0	67.6	62.5	56.2
800.0	[illegible]	50.6	55.2	59.1	62.5	65.5	68.1	70.5	72.6	74.4	75.2	72.9	68.5	63.4	57.0
1000.0	44.6	50.6	55.3	59.2	62.6	65.6	68.3	70.7	72.8	74.6	75.4	73.0	68.6	63.4	57.0
1250.0	43.3	49.4	54.2	58.1	61.5	64.5	67.2	69.6	71.7	73.5	74.3	71.9	67.5	62.2	55.7
1600.0	40.7	47.0	51.8	55.8	59.2	62.2	64.9	67.3	69.4	71.2	72.0	69.6	65.1	59.8	53.0
2000.0	37.8	44.3	49.1	53.2	56.6	59.7	62.4	64.8	66.9	68.7	69.4	67.0	62.4	57.1	50.2
2500.0	34.7	41.4	46.4	50.5	54.0	57.1	59.8	62.2	64.3	66.0	66.8	64.3	59.7	54.2	47.1
3150.0	31.1	38.2	43.4	47.6	51.1	54.2	57.0	59.4	61.4	63.2	63.9	61.4	56.7	51.0	43.4
4000.0	26.9	34.5	40.0	44.3	48.0	51.1	53.9	56.3	58.3	60.1	60.7	58.1	53.2	47.3	39.2
5000.0	23.3	31.4	37.0	41.4	45.2	48.3	51.1	53.5	55.6	57.3	57.9	55.3	50.3	44.2	35.7
6300.0	18.0	26.9	33.0	37.7	41.6	44.9	47.7	50.1	52.2	53.9	54.4	51.6	46.3	39.8	30.4
8000.0	10.8	21.2	28.0	33.1	37.2	40.7	43.6	46.0	48.1	49.6	50.0	46.9	41.3	34.0	23.2
10000.0	1.3	14.0	21.9	27.6	32.1	35.7	38.8	41.3	43.2	44.7	44.9	41.4	35.2	26.8	13.7
12500.0	-10.7	5.0	14.4	20.9	25.9	29.9	33.1	35.6	37.5	38.9	38.7	34.8	27.7	17.8	1.6
16000.0	-28.1	-7.7	3.9	11.7	17.5	21.9	25.3	28.0	29.3	30.9	30.3	25.6	17.2	5.1	-15.8
20000.0	-52.7	-24.9	-10.0	-0.3	6.6	11.7	15.5	18.2	19.9	20.6	19.3	13.5	3.3	-12.1	-39.8
DB(A)	51.2	57.3	62.1	66.0	69.4	72.4	75.1	77.5	79.5	81.4	82.2	79.8	75.4	70.1	63.6
PNL	59.8	66.3	71.2	75.3	78.8	81.9	84.6	87.0	89.1	90.9	91.7	89.3	84.7	79.2	72.3
PNLT	59.8	66.3	71.2	75.3	78.8	81.9	84.6	87.0	89.1	90.9	91.7	89.3	84.7	79.2	72.3

CORE-ENGINE TURBINE NOISE

HELICOPTER SAMPLE CASE - GENERALIZED ENGINE, MAXIMUM PRINTING 04/14/76 16:57:48

LAST ROTOR STAGE HAS 112. BLADES , STATOR-ROTOR SPACING/STATOR CHORD = 57.1 % , EXHAUST CORRECTION = 0. DB
RPM = 28703. , BLADE PASSING FREQUENCY =53579. HZ , LAST ROTOR RELATIVE TIP SPEED = 626. FPS , EXIT SPEED OF SOUND = 1722. FPS
MASS FLOW RATE = 4.0 LB/SEC , DESIGN (TAKEOFF) HORSEPOWER = 1050. , OPERATING HP = 420. , CONFIGURATION FROM GENERALIZATION

SPL ON A 200.-FOOT SIDELINE , DB

1/3-OCTAVE-BAND CENTER FREQ. , HZ	AZIMUTH ANGLE , DEG: FWD. 20.	30.	40.	50.	60.	70.	80.	90.	100.	110.	120.	130.	140.	150.	REAR 160.
25.0	1.7	8.9	14.8	20.1	24.9	28.3	31.4	34.2	36.8	37.3	35.1	30.0	24.4	17.1	8.7
31.5	2.7	9.9	15.8	21.1	25.9	29.3	32.4	35.2	37.8	38.3	36.1	31.0	25.4	18.1	9.6
40.0	3.7	10.9	16.9	22.2	26.9	30.4	33.5	36.3	38.8	39.3	37.1	32.0	26.5	19.1	10.7
50.0	4.7	11.8	17.8	23.1	27.9	31.3	34.4	37.2	39.9	40.3	38.1	33.0	27.4	20.1	11.6
63.0	5.7	12.8	18.8	24.1	28.9	32.3	35.4	38.2	40.8	41.3	39.1	34.0	28.4	21.1	12.6
80.0	6.7	13.9	19.9	25.1	29.9	33.4	36.4	39.3	41.8	42.3	40.1	35.0	29.5	22.1	13.6
100.0	7.6	14.8	20.8	26.1	30.9	34.3	37.4	40.2	42.8	43.3	41.1	36.0	30.4	23.0	14.6
125.0	8.6	15.8	21.8	27.1	31.9	35.3	38.4	41.2	43.7	44.2	42.0	36.9	31.4	24.0	15.5
160.0	9.6	16.8	22.8	28.1	32.9	36.3	39.4	42.2	44.8	45.3	43.1	38.0	32.4	25.0	16.5
200.0	10.5	17.7	23.8	29.1	33.9	37.3	40.4	43.2	45.7	46.2	44.0	38.9	33.4	26.0	17.5
250.0	11.4	18.7	24.7	30.0	34.8	38.2	41.3	44.1	46.7	47.2	45.0	39.8	34.3	26.9	18.4
315.0	12.3	19.6	25.6	31.0	35.8	39.2	42.3	45.1	47.7	48.1	45.9	40.8	35.2	27.8	19.3
400.0	13.3	20.6	26.6	32.0	36.8	40.2	43.3	46.1	48.7	49.1	46.9	41.8	36.2	28.8	20.2
500.0	14.1	21.4	27.5	32.9	37.7	41.1	44.2	47.0	49.6	50.1	47.9	42.7	37.1	29.7	21.0
630.0	14.9	22.3	28.4	33.8	38.6	42.1	45.2	48.0	50.5	51.0	48.8	43.6	38.0	30.6	21.9
800.0	15.7	23.2	29.4	34.7	39.6	43.0	46.1	48.9	51.5	52.0	49.7	44.6	39.0	31.4	22.7
1000.0	16.4	24.0	30.2	35.6	40.4	43.9	47.0	49.8	52.4	52.8	50.6	45.4	39.8	32.2	23.4
1250.0	17.1	24.7	31.0	36.4	41.3	44.7	47.8	50.7	53.2	53.7	51.4	46.2	40.6	33.0	24.0
1600.0	17.7	25.5	31.8	37.3	42.2	45.6	48.8	51.6	54.1	54.6	52.3	47.1	41.4	33.7	24.6
2000.0	18.1	26.1	32.5	38.0	42.9	46.4	49.5	52.4	54.9	55.3	53.1	47.8	42.1	34.3	25.0
2500.0	18.3	26.5	33.0	38.6	43.6	47.1	50.2	53.1	55.6	56.0	53.7	48.4	42.6	34.7	25.2
3150.0	18.1	26.7	33.4	39.1	44.1	47.6	50.8	53.6	56.2	56.6	54.3	48.9	43.0	34.9	25.0
4000.0	17.4	26.5	33.5	39.3	44.4	48.1	51.3	54.1	56.6	57.0	54.6	49.2	43.1	34.8	24.3
5000.0	17.2	26.7	33.8	39.8	44.9	48.6	51.8	54.7	57.2	57.5	55.1	49.6	43.4	34.9	24.1
6300.0	15.2	25.7	33.3	39.5	44.8	48.5	51.8	54.7	57.2	57.5	55.0	49.3	42.9	33.9	22.2
8000.0	11.5	23.5	31.8	38.4	44.0	47.8	51.2	54.1	56.6	56.8	54.1	48.2	41.4	31.7	18.5
10000.0	5.4	19.6	29.0	36.2	42.1	46.2	49.7	52.6	55.0	55.2	52.3	46.0	38.6	27.8	12.3
12500.0	-3.4	13.9	24.8	32.8	39.2	43.6	47.3	50.3	52.6	52.6	49.4	42.6	34.4	22.1	3.6
16000.0	-17.1	4.8	17.9	27.2	34.5	39.3	43.2	46.2	48.6	48.3	44.6	37.1	27.5	13.1	-10.2
20000.0	-37.9	-9.1	7.3	18.5	26.8	32.4	36.6	39.8	42.0	41.3	37.0	28.4	16.9	-0.8	-31.0
DB(A)	28.3	36.9	43.7	49.4	54.6	58.2	61.4	64.2	66.7	67.1	64.7	59.3	53.3	45.1	35.3
PNL	41.0	49.7	56.6	62.5	67.7	71.4	74.6	77.5	80.0	80.4	78.0	72.5	66.4	58.0	48.0
PNLT	41.0	49.7	56.6	62.5	67.7	71.4	74.6	77.5	80.0	80.4	78.0	72.5	66.4	58.0	48.0

TOTAL CORE ENGINE NOISE

HELICOPTER SAMPLE CASE - GENERALIZED ENGINE, MAXIMUM PRINTING 04/14/76 16:57:48

SPL ON A 200.-FOOT SIDELINE , DB

1/3-OCTAVE-BAND CENTER FREQ. , HZ	FWD. 20.	30.	40.	50.	60.	70.	80.	90.	100.	110.	120.	130.	140.	150.	REAR 160.
	AZIMUTH ANGLE , DEG														
25.0	23.9	33.1	35.3	36.8	38.0	37.6	37.6	38.7	40.7	41.9	42.0	39.2	34.8	29.6	23.5
31.5	30.9	34.2	36.3	37.9	39.1	38.9	39.2	40.5	42.5	43.9	44.1	41.5	37.1	32.0	25.8
40.0	31.9	35.2	37.4	39.1	40.4	40.4	41.0	42.5	44.5	46.1	46.4	43.9	39.5	34.4	28.3
50.0	32.9	36.3	38.5	40.2	41.7	42.0	42.9	44.5	46.5	48.1	48.6	46.1	41.7	36.7	30.6
63.0	34.0	37.4	39.7	41.5	43.0	43.6	44.8	46.6	48.7	50.3	50.9	48.5	44.1	39.1	32.9
80.0	35.1	38.5	40.9	42.8	44.6	45.5	46.9	48.9	51.0	52.6	53.3	50.9	46.5	41.5	35.4
100.0	36.1	39.6	42.1	44.2	46.1	47.3	49.0	51.1	53.1	54.9	55.5	53.2	48.8	43.8	37.7
125.0	37.2	40.8	43.4	45.6	47.7	49.2	51.1	53.3	55.3	57.1	57.8	55.5	51.1	46.1	40.0
160.0	38.4	42.1	44.9	47.3	49.6	51.4	53.5	55.7	57.9	59.6	60.3	58.0	53.6	48.0	42.5
200.0	39.6	43.4	46.4	49.0	51.4	53.5	55.7	58.0	60.0	61.8	62.6	60.3	55.9	50.9	44.8
250.0	40.8	44.8	48.0	50.7	53.4	55.6	57.9	60.2	62.3	64.1	64.9	62.6	58.2	53.2	47.0
315.0	42.1	46.3	49.7	52.6	55.4	57.8	60.3	62.6	64.7	66.5	67.3	64.9	60.6	55.5	49.4
400.0	43.5	48.0	51.5	54.7	57.5	60.2	62.7	65.0	67.1	68.9	69.7	67.4	63.0	58.0	51.7
500.0	45.0	49.6	53.4	56.7	59.7	62.4	64.9	67.2	69.3	71.2	72.0	69.6	65.3	60.2	53.9
630.0	46.5	51.4	55.4	58.8	61.9	64.7	67.2	69.6	71.7	73.5	74.3	72.0	67.6	62.5	56.2
800.0	47.4	52.3	56.3	59.8	62.9	65.6	68.2	70.5	72.6	74.5	75.2	72.9	68.5	63.4	57.0
1000.0	47.7	[illegible]	[illegible]	[illegible]	63.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	73.1	[illegible]	[illegible]	[illegible]
1250.0	47.5	52.3	56.0	59.1	62.2	64.8	67.3	69.6	71.7	73.5	74.3	71.9	67.5	62.2	55.7
1600.0	47.2	51.8	55.1	58.0	60.6	62.8	65.2	67.4	69.5	71.3	72.0	69.6	65.1	59.8	53.1
2000.0	47.2	51.6	54.6	57.1	59.3	60.9	62.9	65.1	67.1	68.9	69.5	67.1	62.5	57.1	50.2
2500.0	47.2	51.7	54.6	55.7	56.6	59.5	60.9	62.8	64.8	[illegible]	67.0	64.4	59.8	54.3	47.1
3150.0	47.1	51.9	54.8	56.8	56.3	58.5	59.1	60.6	62.6	64.1	64.4	61.6	56.8	51.1	43.5
4000.0	46.7	[illegible]	[illegible]	[illegible]	[illegible]	58.1	57.9	[illegible]	60.0	61.6	61.7	58.6	54.7	47.7	39.4
5000.0	[illegible]	52.3	[illegible]	[illegible]	54.0	58.3	57.6	[illegible]	59.5	[illegible]	[illegible]	[illegible]	51.1	44.7	36.0
6300.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	57.3	57.0	[illegible]	59.1	57.7	[illegible]	[illegible]	[illegible]	[illegible]
8000.0	42.4	50.4	54.8	57.5	59.2	58.5	57.0	56.1	[illegible]	57.0	55.0	50.7	44.4	36.2	24.7
10000.0	37.6	47.9	53.3	56.6	58.7	58.1	56.4	54.8	55.6	55.6	53.0	47.4	40.3	30.6	16.6
12500.0	30.6	43.9	50.8	54.9	57.5	57.1	55.4	53.1	53.2	52.9	49.8	43.4	35.4	23.9	6.8
16000.0	19.6	37.6	46.7	52.1	55.4	55.4	53.7	50.5	49.4	48.5	44.8	37.5	36.6	26.7	8.3
20000.0	19.8	44.4	56.6	63.2	66.6	67.1	65.4	60.6	54.0	47.2	42.3	36.6	17.9	1.5	-26.0
DB(A)	58.2	63.3	66.8	69.7	72.1	73.7	75.7	77.8	79.8	81.6	82.3	79.9	75.4	70.2	63.6
PNL	71.0	76.2	79.5	82.0	84.0	84.8	86.2	88.0	90.0	91.6	92.1	89.5	84.8	79.3	72.4
PNLT	71.0	76.2	79.5	82.0	84.0	84.8	86.2	88.0	90.0	91.6	92.1	89.5	84.8	79.3	72.4

TOTAL PROPULSOR NOISE WITHOUT NOISE SUPPRESSION

HELICOPTER SAMPLE CASE - GENERALIZED ENGINE, MAXIMUM PRINTING 04/14/76 16:57:48

SPL ON A 200.-FOOT SIDELINE , DB

1/3-OCTAVE-BAND CENTER FREQ. , HZ	AZIMUTH ANGLE , DEG FWD. 20.	30.	40.	50.	60.	70.	80.	90.	100.	110.	120.	130.	140.	150.	REAR 160.
25.0	63.2	68.5	71.5	73.0	73.6	73.6	73.3	72.8	72.3	71.8	71.0	69.8	67.9	65.0	60.3
31.5	62.0	68.3	72.4	75.2	77.4	79.0	80.3	81.3	82.0	81.3	80.2	78.7	76.4	73.1	68.0
40.0	68.2	73.8	76.9	78.5	79.1	79.1	78.6	77.8	76.8	75.6	74.2	72.4	70.1	66.9	61.9
50.0	61.6	68.1	72.3	75.3	77.5	79.1	79.5	79.5	79.1	78.5	77.4	75.8	73.5	69.9	64.3
63.0	61.9	68.0	71.7	74.0	75.5	76.4	77.1	77.6	77.8	77.1	75.9	74.3	71.9	68.5	63.4
80.0	62.0	68.2	72.0	74.3	75.8	76.7	77.3	77.7	77.4	76.7	75.6	74.0	71.6	68.1	63.0
100.0	62.2	68.1	72.2	75.1	77.2	78.7	79.6	79.7	79.4	78.7	77.5	75.6	72.9	69.0	63.6
125.0	62.6	68.0	72.0	74.7	76.3	77.3	77.8	77.9	77.7	76.8	75.5	73.6	71.0	67.4	62.4
160.0	61.1	66.9	70.7	73.3	75.1	76.2	77.0	77.4	77.3	76.7	75.6	73.8	71.3	67.8	62.7
200.0	61.8	67.3	71.3	74.2	76.3	77.8	78.8	79.1	79.0	78.4	77.3	75.4	72.7	69.0	63.7
250.0	62.4	67.8	71.7	74.5	76.4	77.7	78.5	78.8	78.8	78.3	77.2	75.4	72.8	69.2	64.2
315.0	61.3	66.8	70.9	73.8	75.8	77.2	78.1	78.5	78.4	78.0	77.0	75.1	72.2	68.5	63.3
400.0	59.9	65.5	69.5	72.3	74.4	75.8	76.8	77.3	77.3	77.0	76.2	74.2	71.3	67.4	62.2
500.0	59.3	64.9	69.0	71.8	73.8	75.3	76.3	76.7	76.9	76.8	76.3	74.3	71.1	67.1	61.7
630.0	59.1	64.7	68.8	71.8	73.8	75.2	76.2	76.9	77.3	77.5	77.3	75.1	71.8	67.5	62.0
800.0	58.7	64.5	68.4	71.4	73.5	75.2	76.3	76.8	77.3	77.7	77.6	75.4	71.9	67.6	62.0
1000.0	58.4	64.1	68.1	71.0	73.2	74.8	75.9	76.6	77.2	77.6	77.5	75.3	71.8	67.4	61.7
1250.0	57.4	63.0	67.3	70.1	72.3	73.9	74.9	75.6	76.2	76.6	76.4	74.2	70.6	66.2	60.4
1600.0	56.6	62.2	66.6	69.3	71.5	72.9	73.4	74.5	74.9	75.1	74.7	72.5	69.0	64.6	58.9
2000.0	55.6	61.2	65.7	68.4	70.6	71.8	72.6	73.1	73.3	73.2	72.6	70.4	66.9	62.0	57.0
2500.0	54.7	59.9	64.0	66.3	68.4	69.5	70.3	70.8	71.2	71.2	70.5	68.4	65.2	61.1	55.9
3150.0	53.9	58.9	62.9	65.2	67.3	68.4	69.2	69.8	70.1	69.9	69.1	67.0	64.0	60.1	54.9
4000.0	53.3	58.5	62.4	64.7	66.8	67.9	68.6	69.1	69.4	69.1	63.0	65.9	63.1	59.3	54.3
5000.0	52.4	57.7	61.5	63.9	65.9	66.9	67.5	68.0	68.2	67.8	66.6	64.5	61.8	58.0	53.0
6300.0	51.2	56.7	60.8	63.1	65.1	65.9	66.4	66.8	67.0	66.6	65.2	63.1	60.4	56.7	51.7
8000.0	49.7	55.6	59.9	62.3	64.3	65.1	65.5	65.7	65.9	65.5	63.9	61.3	59.2	55.5	50.6
10000.0	48.2	54.1	58.7	61.3	63.5	64.2	64.5	64.7	64.8	64.3	62.6	60.6	58.1	54.4	49.5
12500.0	46.7	52.5	57.3	60.0	62.3	63.1	63.3	63.4	63.4	62.9	61.2	59.2	56.8	53.1	48.2
16000.0	45.4	50.9	55.7	58.4	60.9	61.8	62.1	62.2	62.1	61.5	59.8	58.0	55.7	52.0	47.0
20000.0	44.3	50.8	58.5	64.0	67.2	67.8	66.6	63.7	61.6	50.4	58.6	56.8	54.5	50.8	45.9
DB(A)	68.1	73.7	77.8	80.5	82.6	84.0	85.0	85.5	85.8	85.9	85.5	83.4	80.1	75.9	70.4
PNL	81.3	86.9	91.1	93.8	95.9	97.2	98.0	98.5	98.7	98.5	97.7	95.6	92.5	88.4	82.9
PNLT	81.3	86.9	91.1	93.8	95.9	97.2	98.0	98.5	98.7	98.5	97.7	95.6	92.5	88.4	82.9

TOTAL PROPULSOR SOUND POWER AND DIRECTIVITY INDICES

HELICOPTER SAMPLE CASE - GENERALIZED ENGINE, MAXIMUM PRINTING 04/14/76 16:57:48

1/3-OCTAVE-BAND CENTER FREQ., HZ	SOUND POWER LEVEL, DB	DIRECTIVITY INDICES, DB AZIMUTH ANGLE, DEG FWD. 20.	30.	40.	50.	60.	70.	80.	90.	100.	110.	120.	130.	140.	150.	REAR 160.
25.0	147.6	-3.0	-0.6	0.7	1.3	1.4	1.1	0.8	0.5	0.2	-0.1	-0.5	-0.9	-1.5	-2.4	-3.9
31.5	141.1	-4.1	-1.4	0.0	0.7	1.0	1.1	1.0	0.8	0.6	0.3	-0.1	-0.6	-1.3	-2.5	-4.3
40.0	125.0	-5.7	-4.4	-3.0	-1.7	-0.6	0.3	1.0	1.5	1.7	1.6	1.2	0.5	-0.6	-2.0	-3.5
50.0	137.8	-5.5	-2.4	-0.6	0.4	0.9	1.1	1.1	1.0	0.8	0.6	0.2	-0.4	-1.2	-2.4	-4.2
63.0	135.8	-5.9	-2.8	-0.9	0.2	0.8	1.0	1.1	1.1	0.9	0.7	0.3	-0.3	-1.1	-2.3	-4.2
80.0	134.7	-6.0	-3.0	-1.2	-0.1	0.6	1.0	1.1	1.1	1.0	0.8	0.5	-0.1	-1.0	-2.3	-4.1
100.0	137.1	-6.1	-4.2	-1.9	-0.4	0.6	1.1	1.4	1.5	1.4	1.1	0.5	-0.4	-1.7	-3.5	-5.7
125.0	134.0	-5.9	-3.6	-1.8	-0.6	0.2	0.7	1.1	1.3	1.3	1.2	0.8	0.2	-0.8	-2.2	-3.9
160.0	134.4	-5.9	-3.8	-2.1	-0.9	-0.0	0.6	1.0	1.3	1.4	1.3	1.0	0.3	-0.7	-2.1	-3.8
200.0	136.6	-6.4	-4.4	-2.4	-1.0	0.0	0.7	1.2	1.5	1.5	1.3	0.9	0.1	-1.1	-2.7	-4.6
250.0	136.9	-6.3	-4.4	-2.6	-1.2	-0.2	0.6	1.1	1.4	1.5	1.5	1.1	0.3	-0.8	-2.4	-4.2
315.0	135.3	-6.0	-4.3	-2.8	-1.5	-0.5	0.3	0.9	1.3	1.5	1.6	1.4	0.7	-0.5	-2.0	-3.7
400.0	135.0	-6.8	-4.7	-2.9	-1.5	-0.4	0.3	0.9	1.3	1.5	1.7	1.6	0.8	-0.7	-2.4	-4.3
500.0	134.6	-7.2	-5.1	-3.3	-1.9	-0.8	-0.0	0.6	1.0	1.5	1.9	2.2	1.3	-0.4	-2.3	-4.3
630.0	135.1	-7.7	-5.7	-3.9	-2.5	-1.4	-0.6	0.2	0.8	1.5	2.2	2.8	1.8	-0.1	-2.1	-4.3
800.0	135.2	-8.0	-6.1	4.4	-2.9	-1.8	-0.9	-0.1	0.6	1.5	2.4	3.2	2.1	0.1	-2.1	-4.2
1000.0	135.1	-8.2	-6.3	-4.6	-3.2	-2.0	-1.1	-0.3	0.6	1.5	2.5	3.3	2.3	0.1	-2.0	-4.2
1250.0	134.0	-8.1	-6.2	-4.5	-3.1	-2.0	-1.1	-0.3	0.5	1.4	2.5	3.3	2.3	0.1	-2.1	-4.3
1600.0	132.6	-7.5	-5.6	-3.9	-2.6	-1.6	-0.8	-0.1	0.6	1.4	2.4	3.0	2.0	[illegible]	[illegible]	-4.4
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-1.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.7	[illegible]	[illegible]	-4.5
2500.0	129.6	-5.4	-4.1	-2.8	-1.8	-0.9	-0.4	0.2	0.7	1.4	2.0	2.5	1.5	-0.3	-2.1	-4.1
3150.0	128.8	-4.4	-3.3	-2.2	-1.2	-0.5	-0.0	0.4	0.8	1.3	1.8	2.0	1.0	-0.6	-2.3	-4.2
4000.0	128.2	-3.4	-2.4	-1.5	-0.7	-0.0	0.2	0.5	0.8	1.2	1.6	1.5	0.6	-0.9	-2.5	-4.3
5000.0	127.4	-2.2	-1.5	-0.8	-0.1	0.4	0.4	0.5	0.7	1.1	1.3	[illegible]	0.1	-1.3	-2.9	-4.7
6300.0	126.9	-0.8	-0.4	0.1	0.6	0.9	0.5	0.3	0.4	0.8	1.0	0.7	-0.5	-1.9	-3.5	-5.3
8000.0	126.9	0.7	0.9	1.2	1.4	1.5	0.7	0.1	-0.1	0.3	0.5	-0.0	-1.4	-2.8	-4.4	-6.2
10000.0	127.5	2.1	2.1	2.2	2.2	2.2	1.0	-0.3	-1.0	-0.5	-0.3	-1.0	-2.6	-4.1	-5.8	-7.7
12500.0	128.9	3.3	3.2	3.2	3.1	2.9	1.2	-0.7	-2.1	-1.9	-1.7	-2.6	-4.5	-6.2	-7.9	-9.9
16000.0	131.7	4.2	4.1	4.0	3.8	3.6	1.5	-1.1	-3.8	-4.3	-4.2	-5.3	-7.5	-9.4	-11.3	-13.3
20000.0	151.3	6.1	5.7	5.2	4.5	3.2	0.9	-2.4	-7.6	-13.6	-18.6	-20.5	-21.5	-22.2	-22.7	-23.0

FOR SIDELINE DISTANCE OF 200. FT THE EFFECTIVE PERCEIVED NOISE LEVEL = 94.8 EPNDB sideline. The next six pages give the same information for the tail rotor. Then the total rotor noise (sum of the noise levels from the main and tail rotors) is printed.

The next four pages are the core engine design and operating data and calculated noise levels. The engine noise levels, for this case, are those from two engines since two core engines were specified in the input.

Finally, the last two pages show the total propulsor SPL's, dB(A), PNL, and PNLT levels and the total propulsor 1/3 octave band PWL's and directivity indices and the Effective Perceived Noise Level for the vehicle.

VARIABLE PITCH FAN SAMPLE CALCULATION

Inputs

In this sample case, the calculation of noise from a variable pitch fan with outlet guide vanes is illustrated. Also, the printing option will be used to minimize the amount of output. Since standard ambient conditions are desired, the default values are used thereby greatly simplifying the input data.

The input for this case is shown in Figure 21. Since this is the first case for the run, locations 1. to 9. and 124. to 126. are left blank to specify standard day ambient conditions, static operation, and a 200 ft. sideline. Locations 18. and 19. indicate that noise is to be calculated for one fan and that the fan jet noise is to be included in the calculation. Location 156. defines the design power and location 158. defines the design pressure ratio. Location 157. indicates that the minimum tip speed is to be 750 ft/sec for the design case. Locations 161., 162., and 165. define the fan number of blades, number of vanes, and the distance between blade and vane mid-chords, respectively. Location 163. indicates that the operating condition is for a net thrust of 13272 lbs. The data input for this case is terminated with the 0-1. card.

Outputs

The program output is shown in the next few pages. For this minimum printing, the design and operating ambient conditions, flight speeds, slant ranges, and propulsion system definitions are printed. On the next page, the fan thrust, power, tip speed, and pressure ratio for the design and operating condition are printed out. The next page shows some error messages printed by the jet noise calculation routine. The last two pages show the total (i.e. fan plus jet) propulsion system SPL's, dB(A), PNL, and PNLT and the 1/3 octave band PWL's and directivity indices. Note that EPNL was not calculated, since the horizontal flight velocity is zero.

PROGRAM INFO		INPUT DATA					LABEL
n	LOCATION NO.	1	2	3	4	5	
	VARIABLE PITCH FAN SAMPLE CASE - MINIMUM PRINTING						
2	18.	1.	1.				
4	156.	9671.	750.	1.2	.45		
5	161.	15.	11.	13272.	0.	2.95	
0	-1.						

FIGURE 21. INPUT DATA FOR VARIABLE PITCH FAN SAMPLE CASE

VARIABLE PITCH FAN SAMPLE CASE - MINIMUM PRINTING 04/14/76 16:59:53

DESIGN (TAKEOFF) CONDITION
TEMPERATURE = 0. DEG F , PRESSURE = 14.70 PSIA , VELOCITY = 0.0 KNOTS
OPERATING (NOISE) CONDITION
TEMPERATURE = 77. DEGF , RELATIVE HUMIDITY =, 70.% , PRESSURE = 14.7C PSIA , PRESSURE ALTITUDE = 0. FT
HORIZONTAL VELOCITY = 0.0 KNOTS = 0.0 FPS , VERTICAL VELOCITY = 0.0 FPS , FLIGHT VELOCITY = 0.0 FPS
FLIGHT ANGLE = 0.0 DEG , VEHICLE ALTITUDE ABOVE OBSERVER = 0. FT , SIDELINE DISTANCE = 200. FT , SLANT DISTANCE = 200. FT

ROTARY PROPULSION SYSTEM ANALYSED CONSISTS OF :

UNIT DESCRIPTION	NUMBER OF UNITS	JET NOISE	POWER TRANSMISSION	NOISE SUPPRESSION	INTEGRAL ENGINE
VAR.-PITCH FAN WITH OGV	1.	YES	NONE	NO	NO

```
                    VARIABLE-PITCH FAN WITH OGV NOISE

VARIABLE PITCH FAN SAMPLE CASE - MINIMUM PRINTING                  04/14/76  16:59:53

CONFIGURATION
DIAMETER =  6.24 FT , HUB/TIP DIAMETER RATIO = 0.4510 ,11. OGVS ,15. BLADES , AREA RATIO = 0.93 , STACKING LINE DISTANCE = 2.950
TAKEOFF CONDITION
  0.0 KNOTS ,  0. DEG F , 14.696 PSIA , NET THRUST =16600.7 LBS , HP = 9671.0 , TIP SPEED = 753.00 FPS , PRESSURE RATIO = 1.20
OPERATING CONDITION
NET THRUST =13259.0 LBS , HP = 7678.2 , TIP SPEED = 696.45 FPS , PRESSURE RATIO = 1.16 , SHAFT ANGLE =   0.
```

```
JET NCISE
***** OFF SPECTRUM CURVE AT  4000.0 HZ
***** OFF SPECTRUM CURVE AT  5000.0 HZ
***** CFF SPECTRUM CURVE AT  6300.C HZ
***** OFF SPECTRUM CURVE AT  8000.0 HZ
***** OFF SPECTRUM CURVE AT 10C00.C HZ
***** CFF SPECTRUM CURVE AT 12500.C HZ
***** OFF SPECTRUM CURVE AT 16C00.0 HZ
***** OFF SPECTRUM CURVE AT 20C00.C HZ
```

TOTAL PROPULSOR NOISE WITHOUT NOISE SUPPRESSION

VARIABLE PITCH FAN SAMPLE CASE - MINIMUM PRINTING 04/14/76 16:59:53

SPL ON A 200.-FOOT SIDELINE , DB

1/3-OCTAVE-BAND CENTER FREQ. , HZ	AZIMUTH ANGLE , DEG FWD. 20.	30.	40.	50.	60.	70.	80.	90.	100.	110.	120.	130.	140.	150.	REAR 160.
25.0	50.7	54.9	58.0	60.5	62.5	64.2	65.7	66.9	67.7	69.0	69.0	70.4	70.6	70.3	67.5
31.5	51.9	56.1	59.2	61.7	63.7	65.4	66.9	68.1	68.9	70.1	70.3	71.3	71.2	70.4	67.7
40.0	52.8	57.0	60.1	62.6	64.6	66.3	67.8	68.9	70.0	71.1	71.0	71.8	71.5	70.4	67.7
50.0	53.7	57.9	60.9	63.3	65.3	66.9	68.4	69.6	70.7	71.8	71.6	72.1	71.5	70.3	[illegible]
63.0	55.2	59.0	61.8	64.0	65.9	67.6	69.0	70.2	71.3	72.3	72.3	72.1	71.2	69.8	67.0
80.0	55.9	59.8	62.8	65.1	66.8	68.4	69.7	70.7	71.6	72.5	72.6	72.3	70.8	69.1	66.3
100.0	57.3	61.7	64.6	66.4	67.9	69.0	70.2	71.2	72.1	72.8	72.9	72.3	70.5	59.7	65.9
125.0	59.1	63.3	65.8	67.5	69.0	70.0	71.2	72.1	72.7	73.3	73.1	72.2	70.3	68.4	65.5
160.0	61.1	65.1	67.2	68.7	70.1	71.3	72.3	73.1	73.7	74.3	74.2	72.6	70.4	68.6	65.6
200.0	62.5	66.5	68.6	70.3	71.5	72.6	73.6	74.4	74.9	75.3	75.4	73.9	71.4	69.0	65.5
250.0	63.7	67.8	70.3	71.9	73.1	74.3	75.3	76.1	76.8	76.9	76.5	75.2	72.9	69.5	65.6
315.0	65.6	69.9	72.2	73.4	75.5	75.8	77.0	77.3	78.2	78.4	78.1	76.9	74.9	70.4	65.5
400.0	67.2	71.0	73.6	75.5	78.8	78.7	79.5	79.5	79.6	80.5	80.1	78.6	76.2	70.1	65.7
500.0	81.4	84.7	86.7	89.3	91.6	91.8	92.1	93.1	93.3	94.0	94.1	92.7	90.2	82.8	78.3
630.0	70.5	74.5	76.3	78.1	78.8	79.7	80.6	81.4	82.4	83.0	81.9	80.5	77.6	72.7	68.6
800.0	69.7	73.9	76.2	77.5	78.5	79.2	79.9	80.5	81.6	82.6	82.2	79.9	76.8	72.0	67.7
1000.0	78.5	82.3	84.8	86.2	87.7	88.5	88.3	89.5	90.4	90.5	91.8	89.0	85.7	80.8	76.3
1250.0	67.3	71.5	74.1	75.7	77.2	77.6	78.2	78.9	79.2	79.9	79.7	77.7	74.1	69.1	64.8
1600.0	75.9	79.7	82.6	84.4	85.4	86.3	87.2	87.8	88.4	88.4	88.1	85.8	82.7	77.1	72.6
2000.0	73.4	78.0	80.7	82.6	83.5	84.2	84.6	85.4	86.5	86.7	86.1	84.2	80.5	74.4	70.0
2500.0	71.2	75.7	78.1	80.1	81.0	81.5	81.8	83.1	83.9	84.8	84.5	82.5	78.8	72.3	67.7
3150.0	69.0	74.1	76.8	78.7	79.6	80.2	80.4	81.5	82.6	83.4	83.1	81.4	77.4	70.7	65.8
4000.0	69.4	75.0	77.7	79.8	80.8	81.3	81.7	82.8	83.9	84.9	84.5	82.7	78.8	71.9	66.6
5000.0	67.7	73.1	75.9	78.0	79.3	79.6	80.1	81.4	82.5	83.3	83.2	81.2	77.4	70.3	64.5
6300.0	66.4	72.2	75.6	77.5	79.0	79.4	80.1	81.0	82.5	83.3	83.1	81.4	77.2	[illegible]	[illegible]
8000.0	62.4	68.8	72.6	75.1	76.6	77.1	78.1	79.4	80.7	81.5	81.4	79.4	74.8	67.7	61.3
10000.0	54.9	67.4	71.4	74.2	75.9	76.6	77.8	79.3	80.5	81.2	81.0	79.0	74.1	66.7	59.0
12500.0	54.2	63.2	67.9	71.0	73.0	73.8	75.1	76.6	77.8	78.4	78.1	75.8	70.6	62.5	53.4
16000.0	47.2	58.4	64.2	68.0	70.4	71.4	72.8	74.3	75.5	75.0	75.5	72.9	67.0	57.8	46.4
20000.0	36.3	50.9	58.4	63.0	66.0	67.3	68.9	70.5	71.6	71.9	71.0	67.9	61.1	50.3	35.5
DB(A)	84.6	88.7	91.2	93.2	94.6	95.2	95.6	96.5	97.3	97.8	97.9	95.8	92.5	86.4	81.8
PNL	95.4	99.9	102.6	104.6	105.8	106.4	107.1	108.0	108.9	109.6	109.4	107.6	104.2	97.9	93.2
PNLT	[illegible]	103.9	106.5	108.8	110.1	110.6	111.1	112.2	113.0	113.7	113.8	111.9	108.6	101.7	97.0

TOTAL PRCFULSOR SOUNC POWER AND DIRECTIVITY INDICES

VARIABLE PITCH FAN SAMPLE CASE - MINIMUM PRINTING

04/14/76 16:59:53

1/3-OCTAVE-BAND CENTER FREQ., HZ	SOUND POWER LEVEL, DB	DIRECTIVITY INDICES, DB														
		AZIMUTH ANGLE, DEG														
		FWD. 20.	30.	40.	50.	6C.	70.	80.	90.	100.	110.	120.	130.	140.	150.	REAR 160.
25.0	126.4	-9.8	-9.0	-8.C	-7.1	-6.1	-5.1	-4.0	-2.9	-2.0	-0.3	0.4	2.9	4.6	6.4	7.0
31.5	127.1	-9.3	-8.5	-7.5	-6.6	-5.6	-4.7	-3.5	-2.5	-1.5	0.1	1.0	3.0	4.4	5.9	6.4
40.0	127.6	-8.9	-8.C	-7.1	-6.2	-5.2	-4.2	-3.1	-2.2	-1.0	0.6	1.1	3.0	4.3	5.4	5.9
50.0	127.9	-8.3	-7.5	-6.6	-5.8	-4.9	-3.9	-2.8	-1.3	-0.6	0.9	1.5	3.0	4.0	4.9	5.5
63.0	128.1	-7.0	-6.5	-5.9	-5.2	-4.4	-3.5	-2.4	-1.4	-0.2	1.2	2.0	2.8	3.5	4.3	4.8
80.0	128.3	-6.4	-5.9	-5.1	-4.3	-3.6	-2.8	-1.9	-1.0	0.1	1.4	2.1	2.9	3.0	3.5	4.0
100.0	128.5	-5.3	-4.2	-3.5	-3.2	-2.8	-2.4	-1.6	-0.8	0.3	1.4	2.7	2.6	2.4	2.8	3.2
125.0	129.0	-3.9	-3.0	-2.7	-2.5	-2.2	-1.8	-1.0	-0.3	0.4	1.4	2.0	2.2	1.8	2.1	2.5
160.C	129.9	-2.7	-2.1	-2.2	-2.2	-1.9	-1.4	-0.8	-0.1	0.6	1.6	2.2	1.7	1.0	1.4	1.8
200.0	131.0	-2.4	-1.8	-1.9	-1.8	-1.6	-1.3	-0.7	-0.0	C.6	1.5	2.2	1.8	0.9	0.6	0.5
250.0	132.5	-2.7	-2.C	-1.7	-1.6	-1.5	-1.0	-0.4	0.3	1.0	1.6	1.9	1.7	0.9	-0.3	-0.7
315.0	134.1	-2.4	-1.4	-1.3	-1.7	-0.7	-1.1	-0.3	-C.2	0.9	1.5	1.9	1.8	1.3	-0.9	-1.4
400.0	136.1	-2.6	-2.3	-2.0	-1.6	0.6	-C.2	0.2	0.1	0.3	1.7	1.9	1.5	0.7	-3.1	-4.1
500.C	149.6	-1.9	-2.0	-2.3	-1.2	-0.1	-0.6	-0.7	0.1	0.5	1.6	2.4	2.1	1.2	-3.9	-5.0
630.0	138.1	-1.1	-0.6	-1.1	-C.9	-1.3	-1.1	-0.6	0.0	1.2	2.1	1.8	1.5	0.2	-2.4	-3.0
8C0.0	137.7	-1.3	-0.7	-0.8	-1.0	-1.1	-1.1	-0.8	-0.4	0.8	2.3	2.6	1.4	-0.1	-2.6	-3.3
1000.0	146.7	-1.3	-1.1	-C.9	-1.2	-C.8	-0.8	-1.3	-0.3	0.7	1.3	3.3	1.7	-0.0	-2.7	-3.4
1250.0	135.8	-1.3	-0.8	-0.6	-0.6	-C.3	-0.6	-0.5	0.1	C.5	1.7	2.3	1.4	-0.6	-3.2	-3.8
1600.0	144.5	-1.1	-1.1	-C.7	-0.5	-0.6	-0.5	-0.0	0.4	1.2	1.5	2.0	0.9	-0.5	-3.7	-4.4
2CCJ.J	142.7	-1.3	-0.6	-0.5	-0.3	-C.6	-0.6	-C.7	-J.0	1.2	1.9	2.0	1.3	-0.7	-4.3	-4.8
25CC.C	140.7	-1.0	-0.7	-C.8	-0.6	-0.9	-1.2	-1.3	-0.2	0.8	2.1	2.6	1.8	-0.1	-4.0	-4.4
3150.0	139.7	-1.3	-0.6	-0.6	-C.5	-C.9	-1.2	-1.4	-0.5	0.8	2.1	2.6	2.1	-0.1	-4.1	-4.6
4CCC.0	141.3	-1.6	-0.8	-0.9	-C.7	-1.0	-1.4	-1.4	-C.5	0.8	2.2	2.7	2.1	0.1	-3.9	-4.4
5CCC.0	140.1	-1.5	-1.C	-1.1	-1.0	-1.0	-1.6	-1.5	-0.4	0.9	2.2	2.9	2.3	0.3	-3.8	-4.7
6300.0	140.6	-1.9	-1.4	-1.2	-1.4	-1.3	-1.7	-1.5	-0.3	0.9	2.1	2.9	2.6	0.4	-3.4	-4.0
8CC0.0	139.4	-2.5	-2.0	-1.8	-1.6	-1.6	-2.0	-1.6	-0.5	1.0	2.3	3.2	2.8	0.4	-3.1	-3.6
1CCC0.0	140.3	-2.6	-2.2	-2.1	-1.9	-1.8	-2.3	-1.7	-0.4	1.0	2.3	3.2	2.9	0.6	-2.8	-3.4
12500.0	139.1	-2.6	-2.2	-2.1	-1.9	-1.8	-2.3	-1.7	-0.4	1.0	2.3	3.2	2.9	0.6	-2.8	-3.4
16000.0	139.3	-2.6	-2.2	-2.1	-1.9	-1.8	-2.3	-1.7	-0.4	1.0	2.3	3.2	2.9	0.6	-2.8	-3.4
2CCC0.0	139.2	-2.6	-2.2	-2.1	-1.9	-1.8	-2.3	-1.7	-0.4	1.0	2.3	3.2	2.9	0.6	-2.8	-3.4

COMPUTER PROGRAM LISTING

INTRODUCTION

The computer program, written in machine-independent FORTRAN IV, is presented in this section. The program consists of a main routine which inputs the data, selects the appropriate subroutines to calculate the aerodynamic performance and noise for the defined propulsion system and numerous subroutines for calculating performance and noise, dB(A), PNL, PNLT, interpolating tables, etc.

PROGRAM LISTINGS

The listings are presented in the following pages.

Main Program

This program manages data input and output and selects the subroutines to calculate performance and noise for the propulsion system specified by the user.

```
MASTER FILE          LIBR.G04
ADDED TO MASTER      05/16/75
LAST DATE COPIED       NONE
LAST UPDATE          04/14/76  1653         *** TEMPORARY UPDATE ***

PASS.CRC             TDSG
PROGRAMMER           F.W.BARRY
PROC PARAMETER       $NOJCL

C     PROGRAM PREDICTS NOISE OF FREE-AIR PROPELLER, SHROUDED PROPELLER, C0000020
C     VARIABLE-PITCH FAN, FIXED-PITCH FAN, VARIABLE-PITCH LIFT FAN,     00000030
C     FIXED-PITCH LIFT FAN, HELICOPTER MAIN ROTOR, HELICOPTER FREE-AIR  C0000040
C     TAIL ROTOR, HELICOPTER SHROUDED TAIL ROTOR, CORE ENGINE (COMPRESS-C0000050
C     OR,COMBUSTOR,TURBINE&JET), & GEARBOX ON A 200-FT SIDELINE AT 15   C0000060
C     AZIMUTH ANGLES FROM 20 TO 160DEG AND 1/3-OCTAVE-BAND FREQUENCIES  C0000070
C     FROM 25 TO 20000HZ. NOISE INCLUDES SPL,DB(A),PNL,PNLT,PWL & DI.   C0000080
C     ACCOUNTS FOR NOISE SUPPRESSION (SONIC INLET, DUCT TREATMENT),     C0000090
C     NUMBER OF UNITS ON AIRCRAFT AND ATMOSPHERIC ABSORPTION.           C0000100
C     WRITTEN FOR FAA BY HAMILTON STANDARD DIV. OF UTC (DOT-FA74WA-3477)00000110
C     PROGRAM CONSISTS OF MAIN PROGRAM, FUNCTIONS TONE , VMACH & GAAFM: C0000120   08/22/75
C     SUBROUTINES LOAD, ATTN, PNLC, NOYS, HELI, ROTOR, BJSIGN, BESJH,   C0000130   06/25/75
C     FPFAN, FAPROP, COENG, SHRP, VPFAN, RVINT, REVN, JETN, SPECTR,     00000140   06/25/75
C     FPLFAN, VPLFAN, SHTR, GAAVPF, GAADES, GAAPFM, GAASEC, GAASIA,     C0000150   08/20/75
C     GAASIB, GAASIC, GAASID, GAACLK, GAA123, TREAT, GRBOXN, GAAFPF     C0000160   09/10/75
C     , GAAFDS, GAAFPM, RVINTS, BLOCK DATA, GAAINL, GAAEXL              C0000170   11/05/75
C     MAIN PROGRAM CALLS EXIT, LOAD, ATTN, FAPROP, SHRP, VPFAN, FPFAN,  00000180   03/16/75
C      HELI, VPLFAN, FPLFAN, COENG, PNLC, NOYS, TONE, BIQUAD            00000190   09/04/75
      DIMENSION NAME(6,10),JET(2),PWRT(3,3),PWL(30),SPL(24),ZNOY(24),   C0000200   09/04/75
     1 TPNLT(33),ENGA(10),ENGB(6),D(7)                                  00000210   11/05/75
      COMMON /DATA/ ANGLE(15),BCFR(30),NR,NP,C,HOL(20),DATE(2),TIME(2), C0000220
     1 ATTNT(30),SPLT(15,30),SPLTU(15,30),CBNU(7),XC(15),XD(15),ZO(15), C0000230
     2 PSI(15),DO(15),DDO(15),HPT,TR,VELFL,VM(15),PWLT(15,30),          00000240   08/16/75
     3 DIRIN(498),DIREX(498),BLF(31),DPWSP(15),RPMG,CHPT,RRPM,CSUM(15)  C0000250   09/04/75
C     SPLT  SUM OF SPL OF ALL UNITS                                     C0000260   08/27/75
C     PWLT  SUM OF SPL OF ALL UNITS WITHOUT DOPPLER FREQUENCY SHIFTS FOR00000270   08/27/75
C      POWER AND DIRECTIVITY CALCULATIONS                               C0000280   08/27/75
      COMMON /DATAI/DATAIN(400)                                         00000290   09/30/75
      COMMON / PTREAT / NOWALI,DWDDI(2),ZLWDDI(2),NORINI,DRDDI(5),ZLRDDI00000300   11/05/75
     1(5),NOWALE,DWDDE(2),ZLWDDE(2),NORINE,DRDDE(5),ZLRDDE(5),ZTREAT,   C0000310   11/05/75
     2ZMTHR                                                             00000320   11/05/75
      EQUIVALENCE (BLNK,NAME(1,1)),(DATAIN(100),ENGA(1)),(DATAIN(110),ENC0000330   09/09/75
     1GB(1))                                                            C0000340   09/09/75
C     TEMPERATURE AND RELATIVE HUMIDITY OF PREVIOUS CASE                C0000350   10/08/75
      DATA PTEMP,PHUM / 77.,70. /                                       00000360   09/04/75
      DATA NAME /4H    ,4H  FR,4HEE-A,4HIR P,4HROPE,4HLLER,4H VAR,4H.-PI00000370   10/08/75
     1.    4HTCH ,4HFAN ,4HWITH,4H IGV,4H VAR,4H.-PI,4HTCH ,4HFAN ,4HWITHC0000380   10/08/75
     2.    4H OGV,4H    ,4H    ,4H FIX,4HED-P,4HITCH,4H FAN,4H VAR,4HIABL00000390   10/08/75
     3.    4HE-PI,4HTCH ,4HLIFT,4H FAN,4H    ,4HFIXE,4HD-PI,4HTCH ,4HLIFT00000400
     4.    4H FAN,4H    H,4HELIC,4HOPTE,4HR MA,4HIN R,4HOTOR,4H    ,4H FREC0000410
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     5.   4HE-AI,4HR TA,4HIL R,4HOTOR,4H    ,4H SHR,4HOUDE,4HD TA,4HIL R00000420
     6.   4HOTOR,4H    ,4H    ,4H    ,4H COR,4HE EN,4HGINE /         00000430
      DATA JET,PWRT / 4H NO ,4H YES,4HTIP ,4HTURB,4HINE ,4H    ,4HNONE,4CC000440
     1H    ,4H   G,4HEAR ,4HBOX  /                                   00000450
      DATA TFNLT / 1.,15.,0.,30*0. /                                 C0000460    09/04/75
      CALL DATEJC(DATE)                                              000C0470
      DC 5 I=49,498                                                  C0000480    02/10/76
      CIRIN(I) = - CIRIN(I)                                          CC000490    02/10/76
    5 DIREX(I) = - DIREX(I)                                          00000500    02/10/76
   10 READ (NR,20) HCL                                               C00C0510    05/30/75
   20 FCRMAT (20A4)                                                  C0000520
      DC 30 I=1,20                                                   00000530
      IF (HCL(I) .NE. BLNK) GO TO 40                                 CC000540
   30 CCNTINUE                                                       00000550
      CALL EXIT                                                      CC000560
C     BROAD OUTLINE CF INPUT DATA BLOCK ORGANIZATICN                 00000570
C     LCCATIONS   DESCRIPTION OF DATA BLOCK                          00000580
C        1-  9    GENERAL DATA                                       CCCC0590
C       10- 49    PROPULSICN SYSTEM DEFINITION                       C0000600
C       50- 62    HELICOPTER MAIN ROTCR                              C0000610
C       63- 76    HELICOPTER FREE-AIR TAIL ROTOR                     C0000620
C       77- 92    FIXED-PITCH FAN                                    00000630    09/30/75
C       94- 99    FREE-AIR PROPELLER                                 C0000640    05/19/75
C      100-104    CORE ENGINE COMPRESSOR                             00000650    05/30/75
C      105-109    CORE ENGINE COMBUSTOR                              C0000660    05/30/75
C      110-115    CCRE ENGINE TURBINE                                0000067C    09/12/75
C      116-123    FIXED-PITCH FAN REVERSER                           00000680    06/11/75
C      124-126    DESIGN (TAKEOFF) DATA                              00000690    09/04/75
C      127-143    VARIABLE-PITCH FAN WITH IGV                        00000700    10/03/75
C          144    MAIN & FREE-AIR HELICOPTER ROTOR DESIGN HP         00000710    09/04/75
C      145-146    FREE-AIR PROPELLER DESIGN CCNDITIONS               00000720    09/04/75
C      147-150    CORE ENGINE                                        00000730    09/04/75
C          151    CRIVE FOR VARIABLE-PITCH-FAN WITH IGV              C0000740    10/08/75
C          152    FIXED-PITCH FAN NEAR-SONIC INLET                   C0000750    09/04/75
C      153-154    FREE-AIR PRCPELLER ENGINE                          00000760    09/30/75
C      155-197    VARIABLE-PITCH FAN WITH CGV                        00000770    10/08/75
C      198-199    VARIABLE-PITCH FAN WITH IGV TREATMENT              00000780    10/08/75
C      200-210    SHROUDED TAIL RCTCR                                C0000790    09/08/75
C      211-236    FIXED PITCH FAN                                    C0000800    09/10/75
C      237-256    VARIABLE-PITCH FAN WITH IGV ENGINE                 C0000810    10/03/75
C      257-276    FREE-AIR PROPELLER INTEGRAL ENGINE                 C0000820    09/30/75
C      277-316    VARIABLE-PITCH LIFT FAN                            C0000830    09/30/75
C      317-351    FIXED-PITCH LIFT FAN                               00000840    09/30/75
C      352-400    NOT SPECIFICALLY ALLOCATED , MAY USE FOR GEARBOXES CCCC0850    09/30/75
C                                                                    C0000860
C     GENERAL DATA READ INTO LOCATICNS 1 TO 9 , 124 TO 126           C0000870    10/02/75
C       1  AMBIENT TEMPERATURE , DEG F (DEFAULT = 77)                C0000880
C       2  AMBIENT RELATIVE HUMIDITY , % (DEFAULT = 70)              C0000890
C       3  AMBIENT PRESSURE , PSIA (DEFAULT = 14.696)                CCCC0900
C       4  HORIZONTAL SPEED , FPS (KNOTS IF NEGATIVE)                00000910
C       5  VERTICAL SPEED , FPS                                      00000920
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C      6  PRINT CONTROL , 0 MINIMUM TO 3 MAXIMUM PRINTING              00000930
C         0 PRINT INPUTS, SYSTEM & UNIT DESCRIPTIONS , TOTAL PROPULSOR  00000940
C            NOISE (SPL,DB(A),PNL,PNLT,PNLDCI)                         00000950
C         1 PLUS SPL FOR EACH UNIT WITH NOISE SUPPRESSION (IF ANY)     00000960
C         2 PLUS SPL FOR EACH UNIT AND TOTAL WITHOUT NOISE SUPPRESSION 00000970
C         3 PLUS TONE AND BROADBAND CONTRIBUTIONS TO 1/3-O.B. NOISE     00000980
C      7  VERTICAL HEIGHT ABOVE OBSERVER , FT                          00000990
C      8  ANGLE OF SHAFT , 0. FOR HORIZONTAL , 90. FOR VERTICAL         00001000
C          APPLIES TO FREE-AIR PROPELLER, VARIABLE-PITCH FAN WITH IGV OR00001010    02/10/76
C          CGV, FIXED-PITCH FAN AND INTEGRAL CORE ENGINE ONLY          00001020    02/10/76
C      9  SIDELINE DISTANCE , FT, IF 7=9=0. SET TO 200.                 00001030    09/08/75
C    124  = DESIGN (TAKE OFF) SPEED , KNOTS                             00001040    08/22/75
C    125  = DESIGN (TAKE OFF) AMBIENT TEMPERATURE , DEG F               00001050    08/22/75
C    126  = DESIGN (TAKE OFF) AMBIENT PRESSURE , PSIA , DEFAULT=14.696 00001060    08/22/75
C                                                                      00001070
C    PROPULSION SYSTEM DEFINITION , DATA LOCATIONS 10 TO 49 :           00001080
C       UNIT DESCRIPTION      NO.UNITS  JET  PWR.TRANS.  SUPPRESSION   00001090    05/30/75
C    FREE-AIR PROPELLER          10     11=0.   12        13=0.        00001100    05/30/75
C    VARIABLE-PITCH FAN - IGV    14     15      16        17           00001110    10/08/75
C    VARIABLE-PITCH FAN - CGV    18     19      20        21           00001120    10/08/75
C    FIXED-PITCH FAN             22     23      24        25           00001130
C    VARIABLE-PITCH LIFT FAN     26     27      28        29           00001140
C    FIXED-PITCH LIFT FAN        30     31      32        33           00001150
C    HELICOPTER MAIN ROTOR       34     35=0.   36        37=0.        00001160    05/30/75
C    FREE-AIR TAIL ROTOR         38     39=0.   40        41=0.        00001170    05/30/75
C    SHROUDED TAIL ROTOR         42     43=0.   44        45=0.        00001180    09/08/75
C    CORE ENGINE                 46     47      48        49           00001190    09/08/75
C    NO. UNITS = 0 IF NONE , OTHERWISE 1,2,3,4 ETC. AS APPROPRIATE     00001200
C    JET = 0 IF NO JET NOISE, =1 IF JET NOISE TO BE INCLUDED           00001210
C    PWR.TRANS. = -1 IF TIP TURBINE, = 0 IF NONE, OTHERWISE NUMBER OF  00001220
C                FIRST LOCATION DEFINING TRANSMISSION SYSTEM           00001230    08/20/
C    SUPPRESSION = 0 IF NONE, = 1 IF THERE IS NOISE SUPPRESSION        00001240
C                                                                      00001250
C    REQUIRED INPUT VIA DATAIN FOR MAIN AND FREE-AIR TAIL ROTORS , LOC 00001260
C    MAIN TAIL      NAME  MEANING OF PARAMETER                         00001270
C     50   63       CASE  ROTOR AIRLOADING K FACTOR , DEFAULT = 1.44 - 00001280    10/02/75
C                         .0741667*TWIST - .0018056*TWIST**2           00001290    10/02/75
C                          LIMITS 1.55.LE.CASE.LE.2.22                 00001300    11/07/75
C     51   64        ETA  RADIAL LOADING STATION (.7 .LE. ETA .LE. .9) 00001310    11/07/75
C                         DEFAULT = 1.+.01667*TWIST                    00001320    10/02/75
C     52   65      BIGBR  NUMBER OF ROTOR BLADES                       00001330
C     53   66       BIGR  ROTOR RADIUS , FT                            00001340
C     54   67      CMEGN  ROTOR ROTATIONAL SPEED , RPM                 00001350
C     55   68        SIC  ROTOR DISK INCIDENCE ANGLE , DEG             00001360
C     56   69     CHCRDR  ROTOR BLADE CHORD , INCH                     00001370
C     57   70     THRUSR  ROTOR THRUST , LB                            00001380
C     58   71     TORQUE  ROTOR TORQUE , FT-LB                         00001390
C     59   72       BETA  ROTOR CONING ANGLE , DEG                     00001400
C     60   73      TWIST  BLADE TWIST , DEG , TYPICALLY NEGATIVE       00001410    10/02/75
C     61   74      CCNLC  CORRELATION LENGTH , DEFAULT = .7            00001420    10/02/75
C          75      TRCOR  NUMBER OF TAIL ROTOR HARMONICS               00001430
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C      144 TOTAL DESIGN HP                                                00001440        08/22/75
C                                                                         00001450
C      INPUT DATA FOR FIXED-PITCH FAN                                     00001460        09/30/75
C        77 TSDS   DESIGN TIP SPEED , FPS                                 00001470        09/30/75
C        78 D      FAN DIAMETER , FT                                      00001480        09/30/75
C        79 VNSTG  NUMBER OF FAN STAGES , 1. TO 3.                        00001490        09/30/75
C        80 VC     =1. FOR SHORT FAN DUCT                                 00001500        09/30/75
C                  =2. FOR 3/4-LENGTH DUCT                                00001510        09/30/75
C                  =3. FOR LONG FAN DUCTS WITH COPLANAR PRIMARY /         00001520        09/30/75
C                          SECONDARY NOZZLE EXITS                         00001530        09/30/75
C                  =4. FOR LONG FAN DUCTS WITH RETRACTED PRIMARY NOZZLE   00001540        09/30/75
C                          (JT8D)                                         00001550        09/30/75
C        81 PCTTH  OPERATING THRUST / DESIGN THRUST                       00001560        09/30/75
C        82 HUT    HUB / TIP DIAMETER RATIO , DEFAULT = .4                00001570        09/30/75
C        83 PRSTDS DESIGN PRESSURE RATIO OF FIRST STAGE , 1.1 TO 1.75     00001580        09/30/75
C        84        DESIGN PRESSURE RATIO OF SECOND STAGE (IF 79 = 2 OR 3) 00001590        09/30/75
C        85        DESIGN PRESSURE RATIO OF THIRD STAGE (IF 79 = 3.)      00001600        09/30/75
C        86 TRSS   ROTOR-STATOR SPACING IN PERCENT , STAGE 1              00001610        09/30/75
C        87        ROTOR-STATOR SPACING IN PERCENT , STAGE 2              00001620        09/30/75
C        88        ROTOR-STATOR SPACING IN PERCENT , STAGE 3              00001630        09/30/75
C        89 TB     NUMBER OF BLADES IN STAGE 1                            00001640        09/30/75
C        90        NUMBER OF BLADES IN STAGE 2                            00001650        09/30/75
C        91        NUMBER OF BLADES IN STAGE 3                            00001660        09/30/75
C        92 QIGV   =0. IF NO IGV , =1. IF IGV                             00001670        09/30/75
C      152         MACH NUMBER IN NEAR SONIC INLET IF GT.4, LT.1          00001680        09/30/75
C      211         INLET TREATMENT LENGTH , PERCENT OF DIAMETER           00001690        09/30/75
C      212         EXHAUST TREATMENT LENGTH , PERCENT OF DIAMETER         00001700        09/30/75
C      213         DOF , 1. OR 2.                                         00001710        09/30/75
C      214         NUMBER OF INLET SPLITTERS                              00001720        09/30/75
C      215         NUMBER OF EXHAUST SPLITTERS                            00001730        09/30/75
C      216         = 0. IF SHAFT DRIVE , =1. IF INTEGRAL ENGINE           00001740        09/30/75
C      217         =0. IF USE TYPICAL TURBOSHAFT ENGINE , =1. IF USE:     00001750        09/30/75
C      218 RPMC    COMPRESSOR RPM                                         00001760        09/30/75
C      219 D       COMPRESSOR DIAMETER , FT                               00001770        09/30/75
C      220 FPR     COMPRESSOR FIRST-STAGE PRESSURE RATIO                  00001780        09/30/75
C      221 RSS     COMPRESSOR FIRST-STAGE ROTOR-STATOR SPACING IN PERCENT 00001790        09/30/75
C      222 BC      COMPRESSOR FIRST-STAGE NUMBER OF BLADES                00001800        09/30/75
C      224 P3      COMBUSTOR INLET TOTAL PRESSURE , PSF                   00001810        09/30/75
C      225 T3      COMBUSTOR INLET TOTAL TEMPERATURE , DEG R              00001820        09/30/75
C      226 T4      COMBUSTOR EXIT  TOTAL TEMPERATURE , DEG R              00001830        09/30/75
C      227 QMA     COMBUSTOR MASS FLOW RATE , LB/SEC                      00001840        09/30/75
C      228 CMT     TURBINE MASS FLOW RATE , LB/SEC                        00001850        09/30/75
C      229 VTR     RELATIVE TIP SPEED OF LAST TURBINE ROTOR , FPS         00001860        09/30/75
C      230 CL      SPEED OF SOUND AT TURBINE EXIT , FPS                   00001870        09/30/75
C      231 SOC     LAST STAGE STATOR-ROTOR SPACING / STATOR CHORD         00001880        09/30/75
C      232 VK      =0. FOR COPLANAR EXHAUSTS , -10. FOR RECESSED EXHAUST  00001890        09/30/75
C      233 BT      NUMBER OF BLADES IN LAST TURBINE ROTOR                 00001900        09/30/75
C      234 RPMT    TURBINE RPM                                            00001910        09/30/75
C      235 THRT    JET THRUST , LB                                        00001920        09/30/75
C      236 AREA    JET AREA , SQ FT                                       00001930        09/30/75
C                                                                         00001940
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C      INPUT DATA FOR FREE-AIR PROPELLER                                   00001950        05/30/75
C       94  SHP     PROPELLER HORSEPOWER                                   00001960
C       95  THRUST  PROPELLER THRUST IF SHP=0. , POUNDS                    00001970
C       96  D       PROPELLER DIAMETER , FT                                00001980
C       97  BLADN   NUMBER OF BLADES (2 TO 8)                              00001990
C       98          PROPELLER TIP SPEED (FPS) IF GT 0. , RPM IF LT 0.      00002000
C       99          BLADE CHORD (FT) AT 80% RADIUS , AF IF LT 0.           00002010
C      145          PROPELLER HORSEPOWER FOR DESIGN (TAKEOFF) CONDITION    00002020        08/22/75
C      146          PROPELLER THRUST FOR DESIGN CONDITION IF HP=0., LB     00002030        08/22/75
C      153          =0. IF SHAFT DRIVE , =1. IF INTEGRAL ENGINE            00002040        09/30/75
C      154          =0. IF USE TYPICAL TURBOSHAFT ENGINE, =1. IF USE:      00002050        09/30/75
C      257  RPMC    COMPRESSOR RPM                                         00002060        09/30/75
C      258  D       COMPRESSOR DIAMETER , FT                               00002070        09/30/75
C      259  FPR     COMPRESSOR FIRST-STAGE PRESSURE RATIO                  00002080        09/30/75
C      260  RSS     COMPRESSOR FIRST-STAGE ROTOR-STATOR SPACING IN PERCENT00002090        09/30/75
C      261  BC      COMPRESSOR FIRST-STAGE NUMBER OF BLADES                00002100        09/30/75
C      262  CK      = 0.                                                   00002110        09/30/75
C      263  P3      COMBUSTOR INLET TOTAL PRESSURE , PSF                   00002120        09/30/75
C      264  T3      COMBUSTOR INLET TOTAL TEMPERATURE , DEG R              00002130        09/30/75
C      265  T4      COMBUSTOR EXIT  TOTAL TEMPERATURE , DEG R              00002140        09/30/75
C      266  QMA     COMBUSTOR MASS FLOW RATE , LB/SEC                      00002150        09/30/75
C      267  QMT     TURBINE MASS FLOW RATE , LB/SEC                        00002160        09/30/75
C      268  VTR     RELATIVE TIP SPEED OF LAST TURBINE ROTOR , FPS         00002170        09/30/75
C      269  CL      SPEED OF SOUND AT TURBINE EXIT , FPS                   00002180        09/30/75
C      270  SOC     LAST STAGE STATOR-ROTOR SPACING / STATOR CHORD         00002190        09/30/75
C      271  VK      =0. FOR COPLANAR EXHAUSTS , -10. FOR RECESSED EXHAUST 00002200        09/30/75
C      272  BT      NUMBER OF BLADES IN LAST TURBINE ROTOR                 00002210        09/30/75
C      273  RPMT    TURBINE RPM                                            00002220        09/30/75
C      274          =1. IF JET NOISE , =0. IF NO JET NOISE                 00002230        10/29/75
C      275  THRT    JET THRUST , LB                                        00002240        09/30/75
C      276  AREA    AREA OF JET , SQ FT                                    00002250        09/30/75
C                                                                          00002260
C      INPUT DATA FOR CORE ENGINE NOISE                                    00002270        09/10/75
C      147  = 0. IF USE TYPICAL TURBOSHAFT ENGINE , 1. IF USE FOLLOWING    00002280        08/26/75
C      INPUT DATA FOR CORE ENGINE COMPRESSOR NOISE                         00002290        05/30/75
C      100  RPMC COMPRESSOR RPM                                            00002300        05/30/75
C      101  D    COMPRESSOR DIAMETER , FT                                  00002310        05/30/75
C      102  FPR  COMPRESSOR FIRST-STAGE PRESSURE RATIO                     00002320        05/30/75
C      103  RSS  COMPRESSOR FIRST-STAGE ROTOR-STATOR SPACING IN PERCENT    00002330        05/30/75
C      104  BC   COMPRESSOR FIRST-STAGE NUMBER OF BLADES                   00002340        05/30/75
C      INPUT DATA FOR COMBUSTION NOISE                                     00002350        05/30/75
C      105  CK   =0. FOR TURBOSHAFT ENGINE, =1. FOR TURBOFAN ENGINE        00002360        05/30/75
C      106  P3   COMBUSTOR INLET TOTAL PRESSURE , PSF                      00002370        05/30/75
C      107  T3   COMBUSTOR INLET TOTAL TEMPERATURE , DEG R                 00002380        05/30/75
C      108  T4   COMBUSTOR EXIT TOTAL TEMPERATURE , DEG R                  00002390        05/30/75
C      109  QMA  MASS FLOW RATE , LBM / SEC                                00002400        05/30/75
C      INPUT DATA FOR CORE ENGINE TURBINE NOISE                            00002410        05/30/75
C      148  QMT  MASS FLOW RATE , LBM / SEC                                00002420        08/26/75
C      110  VTR  RELATIVE TIP SPEED OF LAST TURBINE ROTOR , FPS            00002430        05/30/75
C      111  CL   SPEED OF SOUND AT TURBINE EXIT , FPS                      00002440        05/30/75
C      112  SOC  LAST STAGE STATOR-ROTOR SPACING / STATOR CHORD            00002450        05/30/75
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C     113  VK    =0. FOR CO-PLANAR EXHAUSTS , -10. FOR RECESSED EXHAUST  00002460   05/30/75
C     114  BT    NUMBER OF BLADES IN LAST TURBINE ROTOR                  00002470   05/30/75
C     115  RPMT TURBINE RPM                                              00002480   05/30/75
C     INPUT DATA FOR JET NOISE                                           00002490   08/26/75
C     149  THRT THRUST OF JET , LB                                       00002500   08/26/75
C     150  AREA AREA OF JET , SQ. FT                                     00002510   08/25/75
C                                                                        00002520
C     INPUT DATA FOR FIXED-PITCH FAN REVERSER                            00002530   06/11/75
C     116  =-2. FOR V-GUTTER TARGET TYPE                                 00002540   06/11/75
C          =-1. FOR SEMICYLINDRICAL TARGET TYPE                          00002550   06/11/75
C          = 0. IF NO REVERSER                                           00002560   06/11/75
C          = 1. FOR CASCADE TYPE WITH CONSTANT-THICKNESS VANES , NO      00002570   06/11/75
C                 INTERNAL FLOW DEFLECTOR (BLOCKER)                      00002580   06/11/75
C          = 2. FOR CASCADE TYPE WITH CONSTANT-THICKNESS VANES AND       00002590   06/11/75
C                 BLOCKER                                                00002600   06/11/75
C          = 3. FOR CASCADE TYPE WITH AIRFOIL-SHAPED VANES , NO BLOCKER  00002610   06/11/75
C          = 4. FOR CASCADE TYPE WITH AIRFOIL-SHAPED VANES AND BLOCKER   00002620   06/11/75
C     117  = FULLY-EXPANDED JET AREA , SQ FT                             00002630   06/11/75
C     118  = TOTAL TEMPERATURE OF JET , DEG R                            00002640   06/11/75
C     119  = FULLY-EXPANDED JET VELOCITY , FPS                           00002650   06/11/75
C     120  = FULLY-EXPANDED JET DENSITY , LB SEC**2 / FT**4              00002660   06/11/75
C     121  = EFFECTIVE DIAMETER , DE , FT                                00002670   06/11/75
C     122  = DH / DE                                                     00002680   06/11/75
C     123  = CASCADE-EXIT-TO-TAILPIPE AREA (AHEAD OF REVERSER) RATIO ,   00002690   06/11/75
C              FOR CASCADE REVERSERS ONLY                                00002700   [illegible]
C                                                                        00002710
C     INPUT DATA FOR VARIABLE-PITCH FAN WITH IGV                         00002720   10/08/75
C     127  = DESIGN (TAKE OFF) NET THRUST , LB, USED IF GT 0.            00002730   08/20/75
C     128  = DESIGN (TAKE OFF) SHP, USED IF 127 LE 0.                    00002740   08/20/75
C     129  = DESIGN (TAKE OFF) TIP SPEED (FPS), USED IF GT MINIMUM       00002750   08/20/75
C     130  = DESIGN (TAKE OFF) PRESSURE RATIO, 1.0 TO 1.75, USED IF      00002760   09/04/75
C              132 = 0.                                                  00002770   08/20/75
C     131  = HUB / TIP DIAMETER RATIO, USE IF GT MINIMUM, MINIMUM OF .4  00002780   09/04/75
C     132  = TIP DIAMETER (FT), USED IF GT 0.                            00002790   08/20/75
C     133  = NUMBER OF BLADES                                            00002800   08/15/75
C     134  = NUMBER OF IGVS                                              00002810   08/16/75
C     135  = NET THRUST , LB, USED IF GT 0.                              00002820   08/20/75
C     136  = SHP, USED IF 135 LE 0.                                      00002830   08/20/75
C     137  = STACKING LINE DISTANCE , FT, IF GT 0., -BVGAP IF LT 0.,     00002840   08/20/75
C              IF = 0. BVGAP = 2. USED                                   00002850   08/20/75
C     138  = STANDARD DEVIATION OF PAM , 0. REPLACED BY 0.5              00002860   08/16/75
C     139  = STANDARD DEVIATION OF PPM , 0. REPLACED BY 0.01             00002870   08/15/75
C     141  = INLET TREATMENT LENGTH , PERCENT OF DIAMETER                00002880   08/20/75
C     142  = EXHAUST TREATMENT LENGTH , PERCENT OF DIAMETER              00002890   08/20/75
C     143  = DOF , 1. OR 2.                                              00002900   08/16/75
C     151  = 0. IF SHAFT DRIVE , =1. IF INTEGRAL ENGINE                  00002910   09/30/75
C     198  = NUMBER OF INLET SPLITTERS                                   00002920   09/08/75
C     199  = NUMBER OF EXHAUST SPLITTERS                                 00002930   09/08/75
C     237  = 0. IF USE TYPICAL TURBOSHAFT ENGINE , =1. IF USE:           00002940   09/30/75
C     238  RPMC COMPRESSOR RPM                                           00002950   09/30/75
C     239  D     COMPRESSOR DIAMETER , FT                                00002960   09/30/75
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C      240  FPR   COMPRESSOR FIRST-STAGE PRESSURE RATIC                    00002970         09/30/75
C      241  RSS   COMPRESSOR FIRST-STAGE ROTOR-STATOR SPACING IN PERCENT   00002980         09/30/75
C      242  BC    CCMPRESSOR FIRST-STAGE NUMBER OF BLADES                  00002990         09/30/75
C      243  CK    = 0.                                                     00003000         09/30/75
C      244  P3    CCMBUSTCR INLET TOTAL PRESSURE , PSF                     00003010         09/30/75
C      245  T3    COMBUSTOR INLET TOTAL TEMPERATURE , DEG R                00003020         09/30/75
C      246  T4    CCMBUSTOR EXIT  TCTAL TEMPERATURE , CEG R                00003030         09/30/75
C      247  QMA   CCMBUSTCR MASS FLOW RATE , LB/SEC                        00003040         09/30/75
C      248  CMT   TURBINE MASS FLOW RATE , LB / SEC                        00003050         09/30/75
C      249  VTR   RELATIVE TIP SPEED OF LAST TURBINE ROTOR , FT/SEC        00003060         09/30/75
C      250  CL    SPEED CF SOUND AT TURBINE EXIT , FPS                     00003070         09/30/75
C      251  SOC   LAST STAGE STATCR-RCTCR SPACING / STATOR CHORD           00003080         09/30/75
C      252  VK    =C. FOR COPLANAR EXHAUSTS , -10. FCR RECESSED EXHAUST    00003090         09/30/75
C      253  BT    NUMBER CF BLADES IN LAST TURBINE RCTCR                   00003100         09/30/75
C      254  RPMT  TURBINE RPM                                              00003110         09/30/75
C      255  THRT  JET THRUST , LB                                          00003120         09/30/75
C      256  AREA  JET AREA , SQ FT                                         00003130         09/30/75
C                                                                          00003140         09/04/75
C      INPUT DATA FOR VARIABLE-PITCH FAN (ROTOR+OGV)                       00003150         09/04/75
C      155  = DESIGN (TAKEOFF) NET THRUST , LB , USED IF GT 0.             00003160         09/05/75
C      156  = DESIGN (TAKEOFF) SHP, USED IF 155 LE C.                      00003170         09/05/75
C      157  = DESIGN (TAKECFF) TIP SPEEC (FPS), USED IF GT MINIMUM         00003180         09/05/75
C      158  = DESIGN (TAKEOFF) PRESSURE RATIC, 1.0 TO 1.75, USED IF        00003190         09/05/75
C             160 = 0.                                                     00003200         09/05/75
C      159  = HUB / TIP DIAMETER RATIC, USE IF GT MINIMUM                  00003210         09/05/75
C      160  = TIP DIAMETER , FT , USED IF GT 0.                            00003220         09/05/75
C      161  = NUMBER OF BLADES                                             00003230         09/05/75
C      162  = NUMBER CF OGVS                                               00003240         09/05/75
C      163  = NET THRUST , LB , USED IF NE 0. , REVERSE IF LT 0.           00003250         11/07/75
C      164  = SHP , USED IF 163 EQ 0.                                      00003260         11/07/75
C      165  = STACKING LINE DISTANCE , FT , IF GT 0., -BVGAP IF LT 0.,     00003270         09/05/75
C             IF = 0. BVGAP = 2. USED                                      00003280         09/05/75
C      166  = STANDARD DEVIATION OF PAM , C. REPLACEC BY 1.0               00003290         09/05/75
C      167  = STANDARD DEVIATICN OF PPM , C. REPLACED BY 0.02              00003300         09/05/75
C      168  = INLET TREATMENT LENGTH , PERCENT OF CIAMETER                 00003310         09/30/75
C      169  = MID TREATMENT LENGTH , PERCENT OF CIAMETER                   00003320         09/05/75
C      170  = EXHAUST TREATMENT LENGTH , PERCENT CF CIAMETER               00003330         09/05/75
C      171  = DOF , 1. CR 2.                                               00003340         09/05/75
C      172  = INLET SPLITTERS                                              00003350         09/05/75
C      173  = EXHAUST SPLITTERS                                            00003360         09/05/75
C      174  = THRCAT MACH NUMBER CF NEAR-SONIC INLET (NONE IF LE .4)       00003370         09/09/75
C      175  =0 IF REVERSE THRCUGH FLAT PITCH, =1 IF THROUGH FEATHER        00003380         09/08/75
C      176  =0 IF SHAFT CRIVE , =1. IF INTEGRAL ENGINE                     00003390         09/05/75
C      177  = REVERSE TIP SPEEC / CESIGN TIP SPEED , .75 TO 1.             00003400         09/30/75
C      178  = 0. IF USE TYPICAL TURBOSHAFT ENGINE , =1. IF USE :           00003410         09/08/75
C      179  RPMC COMPRESSCR RPM                                            00003420         09/08/75
C      180  D     COMPRESSOR DIAMETER , FT                                 00003430         09/08/75
C      181  FPR   COMPRESSOR FIRST-STAGE PRESSURE RATIO                    00003440         09/08/75
C      182  RSS   CCMPRESSOR FIRST-STAGE RCTCR-STATOR SPACING IN PERCENT   00003450         09/08/75
C      183  BC    COMPRESSOR FIRST-STAGE NUMBER OF BLADES                  00003460         09/08/75
C      184  CK    =0.                                                      00003470         09/08/75
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C      185  P3   COMBUSTOR INLET TOTAL PRESSURE , PSF                  00003480    09/08/75
C      186  T3   COMBUSTOR INLET TOTAL TEMPERATURE , DEG R             00003490    09/08/75
C      187  T4   COMBUSTOR EXIT  TOTAL TEMPERATURE , DEG R             00003500    09/08/75
C      188  CMA  COMBUSTOR MASS FLOW RATE , LB/SEC                     00003510    09/08/75
C      189  OMT  TURBINE MASS FLOW RATE , LB/SEC                       00003520    09/08/75
C      190  VTR  RELATIVE TIP SPEED OF LAST TURBINE ROTOR , FPS        00003530    09/08/75
C      191  CL   SPEED OF SOUND AT TURBINE EXIT , FPS                  00003540    09/09/75
C      192  SOC  LAST STAGE STATOR-ROTOR SPACING / STATOR CHORD        00003550    09/08/75
C      193  VK   =0. FOR COPLANAR EXHAUSTS , -10. FOR RECESSED EXHAUST 00003560    09/08/75
C      194  BT   NUMBER OF BLADES IN LAST TURBINE ROTOR                00003570    09/08/75
C      195  RPMT TURBINE RPM                                           00003580    09/08/75
C      196  THRT JET THRUST , LB                                       00003590    09/10/75
C      197  AREA JET AREA , SQ FT                                      00003600    09/10/75
C                                                                      00003610    09/08/75
C      INPUT DATA FOR SHROUDED TAIL ROTOR                              00003620    09/08/75
C      200  = DESIGN & OPERATING NET THRUST , LB , USED IF GT 0.       00003630    09/08/75
C      201  = DESIGN & OPERATING SHP , USED IF 200 LE 0.               00003640    09/08/75
C      202  = DESIGN & OPERATING TIP SPEED (FPS), USED IF GT MINIMUM   00003650    09/08/75
C      203  = DESIGN & OPERATING PRESSURE RATIO, 1.0 TO 1.75, USED IF  00003660    09/08/75
C             205 = 0.                                                 00003670    09/08/75
C      204  = HUB / TIP DIAMETER RATIO, USE IF GT MINIMUM              00003680    09/08/75
C      205  = TIP DIAMETER , FT , USED IF GT 0.                        00003690    09/08/75
C      206  = NUMBER OF BLADES                                         00003700    09/08/75
C      207  = NUMBER OF IGVS                                           00003710    09/10/75
C      208  STACKING LINE DISTANCE ,FT, IF GT 0., -BVGAP IF LT 0., IF = 00003720   09/08/75
C           0. BVGAP = 2. USED                                         00003730    09/08/75
C      209  STANDARD DEVIATION OF PAM , 0. REPLACED BY .5              00003740    09/08/75
C      210  STANDARD DEVIATION OF PPM , 0. REPLACED BY .01             00003750    09/08/75
C                                                                      00003760
C      INPUT DATA FOR VARIABLE-PITCH LIFT FAN                          00003770    09/30/75
C      277  = DESIGN (TAKEOFF) NET LIFT , LB , USED IF GT 0.           00003780    09/30/75
C      278  = DESIGN (TAKEOFF) SHP , USED IF 277 LE 0.                 00003790    09/30/75
C      279  = DESIGN (TAKEOFF) TIP SPEED (FPS) , USED IF GT MINIMUM    00003800    09/30/75
C      280  = DESIGN (TAKEOFF) PRESSURE RATIO , 1.0 TO 1.75, USED IF   00003810    09/30/75
C             282 = 0.                                                 00003820    09/30/75
C      281  = HUB / TIP DIAMETER RATIO , USE IF GT MINIMUM             00003830    09/30/75
C      282  = TIP DIAMETER , FT , USED IF GT 0.                        00003840    09/30/75
C      283  = NUMBER OF BLADES                                         00003850    09/30/75
C      284  = NUMBER OF OGVS                                           00003860    09/30/75
C      285  = NET LIFT , LB , USED IF NE 0.                            00003870    09/30/75
C      286  = SHP , USED IF 285 = 0.                                   00003880    09/30/75
C      287  = STACKING LINE DISTANCE , FT , IF GT 0., -BVGAP IF LT 0., 00003890    09/30/75
C             IF = 0. BVGAP = 2. USED                                  00003900    09/30/75
C      288  = STANDARD DEVIATION OF PAM , 0. REPLACED BY 1.            00003910    09/30/75
C      289  = STANDARD DEVIATION OF PPM , 0. REPLACED BY .02           00003920    09/30/75
C      290  = INLET TREATMENT LENGTH , PERCENT OF DIAMETER              00003930    09/30/75
C      291  = MID TREATMENT LENGTH , PERCENT OF DIAMETER               00003940    09/30/75
C      292  = EXHAUST TREATMENT LENGTH , PERCENT OF DIAMETER           00003950    09/30/75
C      293  = DOF , 1. OR 2.                                           00003960    09/30/75
C      294  = NUMBER OF INLET SPLITTERS                                00003970    09/30/75
C      295  = NUMBER OF EXHAUST SPLITTERS                              00003980    09/30/75
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C      256  = 0. IF SHAFT DRIVE , = 1. IF INTEGRAL ENGINE                 00003990   09/30/75
C      297  = 0. IF USE TYPICAL TURBOSHAFT ENGINE , = 1. IF USE:          00004000   09/30/75
C      298  RPMC COMPRESSOR RPM                                           00004010   09/30/75
C      299  D    COMPRESSOR DIAMETER , FT                                 00004020   09/30/75
C      300  FPR  COMPRESSOR FIRST-STAGE PRESSURE RATIO                    00004030   09/30/75
C      301  RSS  COMPRESSOR FIRST-STAGE ROTOR-STATOR SPACING IN PERCENT   00004040   09/30/75
C      302  BC   COMPRESSOR FIRST-STAGE NUMBER OF BLADES                  00004050   09/30/75
C      303  CK   = 0. FOR TURBOSHAFT ENGINE                               00004060   09/30/75
C      304  P3   COMBUSTOR INLET TOTAL PRESSURE , PSF                     00004070   09/30/75
C      305  T3   COMBUSTOR INLET TOTAL TEMPERATURE , DEG R                00004080   09/30/75
C      306  T4   COMBUSTOR EXIT  TOTAL TEMPERATURE , DEG R                00004090   09/30/75
C      307  QMA  COMBUSTOR MASS FLOW RATE , LB/SEC                        00004100   09/30/75
C      308  CMT  TURBINE MASS FLOW RATE , LB/SEC                          00004110   09/30/75
C      309  VTR  RELATIVE TIP SPEED OF LAST TURBINE ROTOR , FPS           00004120   09/30/75
C      310  CL   SPEED OF SOUND AT TURBINE EXIT , FPS                     00004130   09/30/75
C      311  SOC  LAST STAGE STATOR-ROTOR SPACING / STATOR CHORD           00004140   09/30/75
C      312  VK   =0. FOR COPLANAR EXHAUSTS , -10. FOR RECESSED EXHAUST    00004150   09/30/75
C      313  BT   NUMBER OF BLADES IN LAST TURBINE ROTOR                   00004160   09/30/75
C      314  RPMT TURBINE RPM                                              00004170   09/30/75
C      315  THRT JET THRUST , LB                                          00004180   09/30/75
C      316  AREA JET AREA , SQ FT                                         00004190   09/30/75
C                                                                         00004200   09/30/75
C      INPUT DATA FOR FIXED-PITCH LIFT FAN                                00004210   09/30/75
C      317 TSDS    DESIGN TIP SPEED , FPS                                 00004220   09/30/75
C      318 D       FAN DIAMETER , FT                                      00004230   09/30/75
C      319 VC      = 1. FOR SHORT FAN DUCT                                00004240   09/30/75
C                  = 2. FOR 3/4-LENGTH DUCT                               00004250   09/30/75
C                  = 3. FOR LONG FAN DUCTS WITH COPLANAR PRIMARY /        00004260   09/30/75
C                           SECONDARY NOZZLE EXITS                        00004270   09/30/75
C                  = 4. FOR LONG FAN DUCTS WITH RETRACTED PRIMARY NOZZLE  00004280   09/30/75
C                           (JT8D)                                        00004290   09/30/75
C      320 PCTTH   OPERATING THRUST / DESIGN THRUST                       00004300   09/30/75
C      321 HOT     HUB / TIP DIAMETER RATIO , DEFAULT = .4                00004310   09/30/75
C      322 FPR     DESIGN PRESSURE RATIO , 1.1 TO 1.75                    00004320   09/30/75
C      323 TRSS    ROTOR-STATOR SPACING IN PERCENT                        00004330   09/30/75
C      324 TB      NUMBER OF BLADES                                       00004340   09/30/75
C      325 QIGV    = 0. IF NO IGV , = 1. IF IGV                           00004350   09/30/75
C      326         INLET TREATMENT LENGTH , PERCENT OF DIAMETER           00004360   09/30/75
C      327         EXHAUST TREATMENT LENGTH , PERCENT OF DIAMETER         00004370   09/30/75
C      328         DOF , 1. OR 2.                                         00004380   09/30/75
C      329         NUMBER OF INLET SPLITTERS                              00004390   09/30/75
C      330         NUMBER OF EXHAUST SPLITTERS                            00004400   09/30/75
C      331         =0. IF SHAFT DRIVE, =1. IF INTEGRAL ENGINE, 32=-1. IF  00004410   09/30/75
C                  TIP TURBINE (MUST INPUT 342-348,350&351)               00004420   09/30/75
C      332         =0. IF USE TYPICAL TURBOSHAFT ENGINE , =1. IF USE:     00004430   09/30/75
C      333 RPMC    COMPRESSOR RPM                                         00004440   09/30/75
C      334 D       COMPRESSOR DIAMETER , FT                               00004450   09/30/75
C      335 FPR     COMPRESSOR FIRST-STAGE PRESSURE RATIO                  00004460   09/30/75
C      336 RSS     COMPRESSOR FIRST-STAGE ROTOR-STATOR SPACING IN PERCENT 00004470   09/30/75
C      337 BC      COMPRESSOR FIRST-STAGE NUMBER OF BLADES                00004480   09/30/75
C      339 P3      COMBUSTOR INLET TOTAL PRESSURE , PSF                   00004490   09/30/75
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C     340 T3      COMBUSTOR INLET TOTAL TEMPERATURE , DEG R            09/30/75
C     341 T4      COMBUSTOR EXIT  TOTAL TEMPERATURE , DEG R            09/30/75
C     342 CMA     COMBUSTOR MASS FLOW RATE , LB/SEC                    09/30/75
C     343 CMT     TURBINE MASS FLOW RATE , LB/SEC                      09/30/75
C     344 BTR     RELATIVE TIP SPEED OF LAST TURBINE ROTOR , FPS       09/30/75
C     345 CL      SPEED OF SOUND AT TURBINE EXIT , FPS                 09/30/75
C     346 SOC     LAST STAGE STATOR-ROTOR SPACING / STATOR CHORD       09/30/75
C     347 VK      =0. FOR COPLANAR EXHAUSTS , -10. FOR RECESSED EXHAUST 09/30/75
C     348 BT      NUMBER OF BLADES IN LAST TURBINE ROTOR               09/30/75
C     349 RPMT    TURBINE RPM                                          09/30/75
C     350 THRT    JET THRUST , LB                                      09/30/75
C     351 AREA    JET AREA , SQ FT                                     09/30/75
C                                                                      09/30/75
   40 CALL LOAD (DATAIN)
      CALL RTIME (TIME)                                                09/30/75
C     DEFAULTS
      IF (DATAIN(1).EQ.0.) DATAIN(1) = 77.
      IF (DATAIN(2).EQ.0.) DATAIN(2) = 70.
      IF (DATAIN(3) .EQ. 0.) DATAIN(3) = 14.696
      DATAIN(11) = 0.                                                  05/30/75
      DATAIN(13) = 0.                                                  05/30/75
      DATAIN(35) = 0.                                                  05/30/75
      DATAIN(37) = 0.                                                  05/30/75
      IF (DATAIN(34) .EQ. 0.) DATAIN(38) = 0.                          10/04/75
      DATAIN(39) = 0.                                                  05/30/75
      DATAIN(41) = 0.                                                  05/30/75
      IF (DATAIN(34) .EQ. 0.) DATAIN(42) = 0.                          10/04/75
      DATAIN(43) = 0.                                                  09/08/75
      DATAIN(45) = 0.                                                  08/16/75
      IF (DATAIN(126) .LE. 0.) DATAIN(126) = 14.696                    08/22/75
      IF (DATAIN(7).EQ.0. .AND. DATAIN(  9).EQ.0.) DATAIN(  9) = 200.  09/10/75
      IF (DATAIN(1).NE.PTEMP) GO TO 50
      IF (DATAIN(2).NE.PHUM) GO TO 60
      GO TO 70
   50 TR      = 459.69 + DATAIN(1)                                     06/25/75
      C       = 49.02 * SQRT(TR)                                       10/30/75
      PTEMP   = DATAIN(1)
   60 CALL ATTN
      PHUM    = DATAIN(2)
   70 IF (DATAIN(4) .LT. 0.) DATAIN(4) = -DATAIN(4) * 1.6878
      VKTS    = DATAIN(4) / 1.6878
      ANGL    = 0.
      IF (DATAIN(4).NE.0..AND.DATAIN(5).NE.0.) ANGL = ATAN2(DATAIN(5),DA
     1TAIN(4)) / .0174532925
      C2      = 145447.76 * (1.-(DATAIN(3)/14.696)**.190255132)
      VELFL   = SQRT(DATAIN(4)**2 + DATAIN(5)**2)                      06/25/75
      C5      = SQRT(DATAIN(7)**2 + DATAIN(9)**2)                      10/30/75
      WRITE (NP,80) HCL,DATE,TIME, DATAIN(125),DATAIN(126),DATAIN(124), 08/26/75
     1DATAIN(1),DATAIN(2),DATAIN(3),C2,VKTS,DATAIN(4),DATAIN(5),VELFL,  08/26/75
     2ANGL,DATAIN(7),DATAIN(9),C5                                      09/11/75
   80 FORMAT (1H1,20A4,2X,2A4,2X,2A4//27H DESIGN (TAKEOFF) CONDITION/14H 08/26/75
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     1 TEMPERATURE =,F5.0,15H DEG F , PRESSURE =,F6.2,18H PSIA , VELOCIT     08/26/75
     2Y =,F6.1,6H KNOTS / 28H OPERATING (NOISE) CONDITION / 14H TENPERAT     08/28/75
     3URE =,F5.0,29H DEGF , RELATIVE HUMIDITY =,F5.0,14H% , PRESSURE =,F     08/28/75
     46.2,27H PSIA , PRESSURE ALTITUDE =,F6.0,3H FT / 22H HORIZONTAL VEL     08/28/75
     5OCITY =,F6.1,8H KNOTS =,F6.1,26H FPS , VERTICAL VELOCITY =,F6.1,24     08/28/75
     6H FPS . FLIGHT VELOCITY =,F6.1,4H FPS / 15H FLIGHT ANGLE =,F6.1, 4     08/28/75
     70H DEG , VEHICLE ALTITUDE ABOVE OBSERVER =,F5.0,25H FT , SIDELINE      09/04/75
     8DISTANCE =,F6.0,22H FT , SLANT DISTANCE =,F6.0,3H FT // 10X,47HROT     09/11/75
     9ARY PROPULSION SYSTEM ANALYSED CONSISTS OF : / 26X,24HNUMBER    JE     09/11/75
     AT      POWER,9X,5HNOISE,5X,8HINTEGRAL / 4X,16HUNIT DESCRIPTION,5X,     10/?0/75
     B50HOF UNITS  NOISE  TRANSMISSION  SUPPRESSION  ENGINE /)               10/30/75
      DO 110 I=10,46,4
      IF (DATAIN(I) .EQ. 0.) GO TO 110
      J1       = 1
      IF (DATAIN(I+1) .GT. 0.) J1 = 2
      J2       = 2
      IF (DATAIN(I+2) .LT. 0.) J2 = 1
      IF (DATAIN(I+2) .GT. 0.) J2 = 3
      J3       = 1
      IF (DATAIN(I+3) .GT. 0.) J3 = 2
      L        = (I-6) / 4
      J4       = 1                                                           10/31/75
      IF (I.EQ.10 .AND. DATAIN(153).NE.0.) J4 = 2                            10/31/75
      IF (I.EQ.14 .AND. DATAIN(151).NE.0.) J4 = 2                            10/31/75
      IF (I.EQ.18 .AND. DATAIN(176).NE.0.) J4 = 2                            10/31/75
      IF (I.EQ.22 .AND. DATAIN(216).NE.0.) J4 = 2                            10/31/75
      IF (I.EQ.26 .AND. DATAIN(296).NE.0.) J4 = 2                            10/31/75
      IF (I.EQ.30 .AND. DATAIN(331).NE.0.) J4 = 2                            10/31/75
      WRITE (NP,100) (NAME(J,L),J=1,6),DATAIN(I),JET(J1),(PWRT(J,J2),J=1
     1,3),JET(J3),JET(J4)                                                    10/30/75
  100 FORMAT (6A4,F6.0,5X,A4,3X,3A4,5X,A4,7X,A4)                             10/30/75
  110 CONTINUE
      IT       = 0                                                           11/05/75
      ITT      = 0                                                           11/05/75
      ZTREAT   = 0.                                                          11/05/75
      C2       = SIN(.0174532925*DATAIN(8)) * DATAIN(7)                      11/05/75
      C3       = COS(.0174532925*DATAIN(8))                                  11/05/75
      C4       = DATAIN(5) * DATAIN(7)                                       11/05/75
      DO 130 IA=1,15                                                         11/05/75
      XO(IA)   = C5 * COTAN(.0174532925*ANGLE(IA))                           11/05/75
      ZO(IA)   = SQRT (XO(IA)**2 + C5**2)                                    11/05/75
      VM(IA)   = 1. - (XO(IA)*DATAIN(4) + C4) / (C*ZO(IA))                   11/05/75
  130 PSI(IA) = ARCCS((XO(IA)*C3 + C2) / ZO(IA)) / .0174532925               11/05/75
C     REFERENCE RADIUS FOR PWL AND DIRECTIVITY CALCULATIONS = C2 FT            /75
C     C2 = .42193 FOR 77F AND 14.696PSIA                                     1 /75
      C2       = .04799806 * SQRT(C / DATAIN(3))                             0?/11/76
      DO 145 IA=1,15                                                         11/05/75
  145 DPWSP(IA) = 20. * ALOG10(ZO(IA)/C2)                                    11/05/75
C     INITIALIZE TOTAL HORSEPOWER , TOTAL SPL & UNSUPPRESSED SPL
  115 HPT      = 0.                                                          11/05/75
      DHPT     = 0.                                                          08/22/75
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      RRFM    = 1.                                         00005520  08/26/75
      DC 120 J=1,30                                        00005530  06/25/75
      DO 120 I=1,15                                        00005540  06/25/75
      PWLT(I,J) = 0.                                       00005550  06/25/75
  120 SPLT(I,J) = 0.                                       00005560  11/05/75
      IF (DATAIN(10) .LE. C.) GO TO 150                    00005570  08/16/75
C     FREE-AIR PROPELLER NOISE                             00005580
      CALL FAPRCP                                          00005590
      GC TO 180                                            00005600
  150 IF (DATAIN(14) .LE. 0.) GO TO 160                    00005610
C     VARIABLE-PITCH FAN WITH IGV NOISE                    00005620  10/08/75
      D(1)    = DATAIN(127)                                00005630  11/05/75
      D(2)    = DATAIN(129)                                00005640  11/05/75
      D(3)    = DATAIN(130)                                00005650  11/05/75
      D(4)    = DATAIN(131)                                00005660  11/05/75
      D(5)    = CATAIN(132)                                00005670  11/05/75
      C(6)    = CATAIN(135)                                00005680  11/05/75
      D(7)    = CATAIN(17)                                 00005690  11/05/75
      CATAIN(17) = 0.                                      00005700  11/05/75
      ZMTHR   = 0.                                         00005710  11/05/75
      IF (C(7) .NE. 0.) ITT = 1                            00005720  11/05/75
      IF (D(7).EQ.0. .OR. IT.EQ.C) GC TO 158               00005730  11/05/75
      CATAIN(17) = C(7)                                    00005740  11/05/75
      ZTREAT  = 1.                                         00005750  11/05/75
      NOWALI  = 0                                          00005760  11/05/75
      IF (CATAIN(141) .LE. 0.) GO TO 154                   00005770  11/05/75
      NOWALI  = 2                                          00005780  11/05/75
      ZLWCCI(1) = DATAIN(141) / 100.                       00005790  11/05/75
      ZLWDCI(2) = ZLWDDI(1)                                00005800  11/05/75
      NCRINI  = MIN1(5.,CATAIN(198))                       00005810  11/06/75
      IF (NORINI .LE. 0) GO TO 154                         00005820  11/05/75
      DO 152 I=1,NORINI                                    00005830  11/05/75
  152 ZLRDDI(I) = .8 * ZLWDDI(I)                           00005840  11/05/75
  154 NOWALE  = 0                                          00005850  11/05/75
      IF (CATAIN(142) .LE. C.) GC TO 158                   00005860  11/05/75
      NCWALE  = 2                                          00005870  11/05/75
      ZLWCDE(1) = CATAIN(142) / 1C0.                       00005880  11/05/75
      ZLWDDE(2) = ZLWCDE(1)                                00005890  11/05/75
      NORINE  = MIN1(5.,DATAIN(199))                       00005900  11/05/75
      IF (NORINE .LE. 0) GC TC 158                         00005910  11/05/75
      DC 156 I=1,NORINE                                    00005920  11/05/75
  156 ZLRDDE(I) = .8 * ZLWDDE(I)                           00005930  11/05/75
  158 CALL SMPP                                            00005940  11/05/75
      DATAIN(127) = C(1)                                   00005950  11/05/75
      DATAIN(129) = C(2)                                   00005960  11/05/75
      DATAIN(130) = D(3)                                   00005970  11/05/75
      DATAIN(131) = D(4)                                   00005980  11/05/75
      DATAIN(132) = C(5)                                   00005990  11/05/75
      CATAIN(135) = D(6)                                   00006000  11/05/75
      CATAIN(17) = C(7)                                    00006010  11/05/75
      GC TO 180                                            00006020
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  160 IF (DATAIN(18) .LE. C.) GC TO 17C
C     VARIABLE-PITCH FAN WITH OGV NOISE                           10/08/75
      C(1)     = CATAIN(155)                                      11/05/75
      D(2)     = CATAIN(157)                                      11/05/75
      D(3)     = DATAIN(158)                                      11/05/75
      D(4)     = DATAIN(159)                                      11/05/75
      C(5)     = DATAIN(160)                                      11/05/75
      D(6)     = CATAIN(163)                                      11/05/75
      D(7)     = CATAIN(21)                                       11/05/75
      IF (D(7) .NE. 0.) ITT = 1                                   11/05/75
      CATAIN(21) = C.                                             11/05/75
      ZTREAT   = 0.                                               11/05/75
      IF (IT.EQ.C .CR. D(7).EQ.0.) GC TO 168                      11/05/75
      DATAIN(21) = D(7)                                           11/05/75
      ZTREAT   = 1.                                               11/05/75
      ZMTHR    = CATAIN(174)                                      11/05/75
      NCWALI   = 0                                                11/05/75
      IF (DATAIN(168) .LE. 0.) GO TO 164                          11/05/75
      NOWALI   = 2                                                11/05/75
      ZLWDDI(1) = DATAIN(168) / 100.                              11/05/75
      ZLWDDI(2) = ZLWDDI(1)                                       11/05/75
      NCRINI   = MIN1(5.,DATAIN(172))                             11/05/75
      IF (NORINI .LE. 0) GO TO 164                                11/05/75
      DO 162 I=1,NORINI                                           11/05/75
  162 ZLRDDI(I) = .8 * ZLWDDI(1)                                  11/05/75
  164 NOWALE   = 0                                                11/05/75
      IF (DATAIN(169).LE.0. .AND. DATAIN(170).LE.0.) GO TO 168    11/05/75
      NCWALE   = 2                                                11/05/75
      ZLWCCE(1) = (CATAIN(169) + CATAIN(170)) / 100.              11/05/75
      ZLWDDE(2) = ZLWCDE(1)                                       11/05/75
      NORINE   = MIN1(5.,DATAIN(173))                             11/05/75
      IF (NCRINE .LE. 0) GC TC 168                                11/05/75
      DC 166 I=1,NORINE                                           11/05/75
  166 ZLRCDE(I) = .CC8 * DATAIN(170)                              11/05/75
  168 CALL VPFAN                                                  11/05/75
      CATAIN(155) = D(1)                                          11/05/75
      DATAIN(157) = C(2)                                          11/05/75
      CATAIN(158) = D(3)                                          11/05/75
      CATAIN(159) = D(4)                                          11/05/75
      DATAIN(160) = D(5)                                          11/05/75
      CATAIN(163) = D(6)                                          11/05/75
      DATAIN(21)  = C(7)                                          11/05/75
      GC TO 180
  170 IF (CATAIN(22) .LE. 0.) GO TO 180
C     FIXED-PITCH FAN NOISE
      D(1)     = DATAIN(82)                                       11/05/75
      D(2)     = CATAIN(25)                                       11/05/75
      IF (D(2) .NE. C.) ITT = 1                                   11/05/75
      CATAIN(25) = C.                                             11/05/75
      ZTREAT   = 0.                                               11/05/75
      IF (IT.EQ.C .OR. D(2).EQ.0.) GO TO 178                      11/05/75
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      CATAIN(25) = C(2)                                              00006540    11/05/75
      ZTREAT  = 1.                                                   00006550    11/05/75
      ZMTHR   = DATAIN(152)                                          00006560    11/05/75
      NOWALI  = 0                                                    00006570    11/05/75
      IF (CATAIN(211) .LE. 0.) GO TO 174                             00006580    11/05/75
      NCWALI  = 2                                                    00006590    11/05/75
      ZLWDDI(1) = DATAIN(211) / 100.                                 00006600    11/05/75
      ZLWDDI(2) = ZLWDDI(1)                                          00006610    11/05/75
      NCRINI  = MIN1(5.,DATAIN(214))                                 00006620    11/05/75
      IF (NORINI .LE. 0) GO TO 174                                   00006630    11/05/75
      DO 172 I=1,NORINI                                              00006640    11/05/75
  172 ZLRUDI(I) = .8 * ZLWDDI(1)                                     00006650    11/05/75
  174 NOWALE  = C                                                    00006660    11/05/75
      IF (DATAIN(212) .LE. 0.) GO TO 178                             00006670    11/05/75
      NOWALE  = 2                                                    00006680    11/05/75
      ZLWDDE(1) = DATAIN(212) / 100.                                 00006690    11/05/75
      ZLWDDE(2) = ZLWDDE(1)                                          00006700    11/05/75
      NCRINE  = MIN1(5.,DATAIN(215))                                 00006710    11/05/75
      IF (NORINE .LE. 0) GO TO 178                                   00006720    11/05/75
      DO 176 I=1,NCRINE                                              00006730    11/05/75
  176 ZLRDCE(I) = .8 * ZLWDDE(1)                                     00006740    11/05/75
  178 CALL FPFAN                                                     00006750    11/05/75
      CATAIN(82) = D(1)                                              00006760    11/05/75
      CATAIN(25) = D(2)                                              00006770    11/05/75
  180 IF (CATAIN(34) .LE. 0.) GO TO 190                              00006780
C     HELICOPTER MAIN ROTOR , FREE-AIR TAIL ROTOR AND SHROUDED TAIL  00006790
C       ROTOR NOISE                                                  00006800
      DHPT    = DHPT + DATAIN(144)                                   00006810    08/22/75
      RRPM    = 1.                                                   00006820    09/09/75
      ZTREAT  = 0.                                                   00006830    11/05/75
      CALL HELI                                                      00006840
  190 IF (DATAIN(26) .LE. 0.) GO TO 200                              00006850
C     VARIABLE-PITCH LIFT FAN NOISE                                  00006860
      D(1)    = CATAIN(277)                                          00006870    11/05/75
      D(2)    = DATAIN(279)                                          00006880    11/05/75
      D(3)    = DATAIN(280)                                          00006890    11/05/75
      D(4)    = CATAIN(281)                                          00006900    11/05/75
      D(5)    = CATAIN(282)                                          00006910    11/05/75
      D(6)    = CATAIN(295)                                          00006920    11/05/75
      D(7)    = CATAIN(29)                                           00006930    11/05/75
      IF (D(7) .NE. 0.) ITT = 1                                      00006940    11/05/75
      DATAIN(29) = 0.                                                00006950    11/05/75
      ZTREAT  = 0.                                                   00006960    11/05/75
      ZMTHR   = 0.                                                   00006970    11/05/75
      IF (IT.EQ.0 .OR. D(7).EQ.0.) GO TO 198                         00006980    11/05/75
      CATAIN(29) = D(7)                                              00006990    11/05/75
      ZTREAT  = 1.                                                   00007000    11/05/75
      NOWALI  = C                                                    00007010    11/05/75
      IF (CATAIN(290) .LE. 0.) GO TO 194                             00007020    11/05/75
      NCWALI  = 2                                                    00007030    11/05/75
      ZLWDDI(1) = DATAIN(290) / 100.                                 00007040    11/05/75
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      ZLWDDI(2) = ZLWDDI(1)                                          00007050   11/05/75
      NORINI  = MIN1(5.,DATAIN(294))                                 00007060   11/05/75
      IF (NORINI .LE. 0) GO TO 194                                   00007070   11/05/75
      DO 192 I=1,NORINI                                              00007080   11/05/75
  192 ZLRDDI(I) = .8 * ZLWDDI(1)                                     00007090   11/05/75
  194 NOWALE  = 0                                                    00007100   11/05/75
      IF (DATAIN(291).LE.0. .AND. DATAIN(292).LE.0.) GO TO 198       00007110   11/05/75
      NOWALE  = 2                                                    00007120   11/05/75
      ZLWDDE(1) = (DATAIN(291) + DATAIN(292)) / 100.                 00007130   11/05/75
      ZLWDDE(2) = ZLWDDE(1)                                          00007140   11/05/75
      NORINE  = MIN1(5.,DATAIN(295))                                 00007150   11/05/75
      IF (NORINE .LE. 0) GO TO 198                                   00007160   11/05/75
      DO 196 I=1,NORINE                                              00007170   11/05/75
  196 ZLRDDE(I) = .008 * DATAIN(292)                                 00007180   11/05/75
  198 CALL VPLFAN                                                    00007190   11/05/75
      DATAIN(277) = D(1)                                             00007200   11/05/75
      DATAIN(279) = D(2)                                             00007210   11/05/75
      DATAIN(280) = D(3)                                             00007220   11/05/75
      DATAIN(281) = D(4)                                             00007230   11/05/75
      DATAIN(282) = D(5)                                             00007240   11/05/75
      DATAIN(285) = D(6)                                             00007250   11/05/75
      DATAIN(29)  = D(7)                                             00007260   11/05/75
      GO TO 210                                                      00007270
  200 IF (DATAIN(30) .LE. 0.) GO TO 210                              00007280
C     FIXED-PITCH LIFT FAN NOISE                                     00007290
      D(1)      = DATAIN(321)                                        00007300   11/05/75
      D(2)      = DATAIN(33)                                         00007310   11/05/75
      IF (D(2) .NE. 0.) ITT = 1                                      00007320   11/05/75
      DATAIN(33) = 0.                                                00007330   11/05/75
      ZTREAT  = 0.                                                   00007340   11/05/75
      ZMTHR   = 0.                                                   00007350   11/05/75
      IF (IT.EQ.0 .OR. D(2).EQ.0.) GO TO 208                         00007360   11/05/75
      DATAIN(33) = D(2)                                              00007370   11/05/75
      ZTREAT  = 1.                                                   00007380   11/05/75
      NOWALI  = 0                                                    00007390   11/05/75
      IF (DATAIN(326) .LE. 0.) GO TO 204                             00007400   11/05/75
      NOWALI  = 2                                                    00007410   11/05/75
      ZLWDDI(1) = DATAIN(326) / 100.                                 00007420   11/05/75
      ZLWDDI(2) = ZLWDDI(1)                                          00007430   11/05/75
      NORINI  = MIN1(5.,DATAIN(329))                                 00007440   11/05/75
      IF (NORINI .LE. 0) GO TO 204                                   00007450   11/05/75
      DO 202 I=1,NORINI                                              00007460   11/05/75
  202 ZLRDDI(I) = .8 * ZLWDDI(1)                                     00007470   11/05/75
  204 NOWALE  = 0                                                    00007480   11/05/75
      IF (DATAIN(327) .LE. 0.) GO TO 208                             00007490   11/05/75
      NOWALE  = 2                                                    00007500   11/05/75
      ZLWDDE(1) = DATAIN(327) / 100.                                 00007510   11/05/75
      ZLWDDE(2) = ZLWDDE(1)                                          00007520   11/05/75
      NORINE  = MIN1(5.,DATAIN(330))                                 00007530   11/05/75
      IF (NORINE .LE. 0) GO TO 208                                   00007540   11/05/75
      DO 206 I=1,NORINE                                              00007550   11/05/75
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  206 ZLRCDE(I) = .8 * ZLWCDE(I)                                         00007560    11/05/75
  208 CALL FPLFAN                                                        00007570    11/05/75
      DATAIN(321) = C(1)                                                 00007580    11/05/75
      DATAIN(33)  = D(2)                                                 00007590    11/05/75
  210 IF (DATAIN(46).LE.0. .OR. HPT.LE.0. .OR. DHPT.LE.C.) GO TO 220    00007600    09/30/75
C     CORE ENGINE NOISE                                                  00007610    05/30/75
      CBN     = C.                                                       00007620    09/08/75
      IF (DATAIN(46).GT.1.) LBN = DBNU(IFIX(DATAIN(46)-.9))              00007630    09/08/75
      IF (DATAIN(8) .EQ. 0.) GO TO 214                                   00007640    02/10/76
      DO 212 I=1,15                                                      00007650    02/10/76
  212 PSI(I)  = ANGLE(I)                                                 00007660    02/10/76
  214 I       = C                                                        00007670    02/10/76
      C4      = 0.                                                       00007680    09/10/75
      CALL COENG (I,DHPT/DATAIN(46),HPT/DATAIN(46),DBN,IFIX(DATAIN(147))00007690    09/08/75
     1,RRPM,ENGA,DATAIN(148),ENGB,CATAIN(47),DATAIN(149),DATAIN(150),C4,00007700    09/08/75
     2C4,C4)                                                             00007710    09/08/75
      IF (CATAIN(8) .EQ. 0.) GO TO 218                                   C0007720    02/10/76
      C3      = SIN(.C174532925*DATAIN(8)) * DATAIN(7)                   00007730    02/10/76
      C4      = COS(.0174532925*DATAIN(8))                               00007740    02/10/76
      DO 216 I=1,15                                                      C00C7750    02/10/76
  216 PSI(I)  = ARCOS((XO(I)*C4 + C3) / ZO(IA)) / .0174532925           00007760    02/10/76
  218 IF (DATAIN(48) .LE. 0.) GC TO 22C                                  00007770    02/10/76
      CALL GRBOXN (IFIX(DATAIN(48)),HPT/CATAIN(46),RPMG,DBN,0.)          00007780    09/12/75
  220 CCNTINUE                                                           00007790
C     PRINT TOTAL NOISE                                                  CC007800
      DO 1000 J=1,30                                                     00007810    06/25/75
      DC 1000 I=1,15                                                     C0007820    06/25/75
      PWLT (I,J) = 10. * ALOG10(PWLT (I,J))                              00007830    08/27/75
 1000 SPLT (I,J) = 10. * ALCG10(SPLT (I,J))                              00007840    11/05/75
      IF (IT .EC. 1) WRITE (NP,1010) FOL,DATE,TIME                       C0007850    11/05/75
 1010 FORMAT (1H1,32X,57HTCTAL PROPULSCR NCISE WITH ANY NOISE SUPPRESSIO00007860    11/05/75
     1N INCLUDED //1H ,20A4,2X,2A4,2X,2A4)                               00007870    11/05/75
      IF (IT .EQ. 0) WRITE (NP,1020) FCL,CATE,TIME                       00007880    11/05/75
 1020 FORMAT (1H1,37X,47HTCTAL PRCPULSOR NOISE WITHOUT NCISE SUPPRESSION00007890    11/05/75
     1//1H ,20A4,2X,2A4,2X,2A4)                                          00007900    11/05/75
      CALL PNLC (SPLT)                                                   00007910
C     CALCULATE SOUND PWL AT EACH FRECUENCY BY INTEGRATING TOTAL         00007920
C      PROPULSOR SPL OVER SPHERE                                         00007930
      DO 1040 IA=1,15                                                    00007940    11/05/75
      DC 1040 IF=1,30                                                    00007950
C     REMOVE ATMOSPHERIC ATTENUATION IN PWLT AND APPLY SPHERICAL         00007960    08/16/75
C      SPREADING TO GET NOISE AT RADIUS CF C2 FT                         00007970
 1040 SPLTU(IA,IF) = PWLT(IA,IF) + ZO(IA)*ATTN1(IF) + DPWSP(IA)          00007980    09/09/75
C     INTEGRATE SPLT OVER SPHERE TO GET PWL                              00007990
      DC 1070 IF=1,30                                                    00008000
      PWL(IF) = 0.                                                       C0008010
      DO 1050 IA=1,15                                                    00008020
 1050 PWL(IF) = PWL(IF) + CSUM(IA) * 10.**(SPLTU(IA,IF)/10.)             00008030    09/05/75
      PWL(IF) = 10. * ALOG10(PWL(IF))                                    00008040
C     DIRECTIVITY INDICES , C2 IS SPL CORRESPONCING TO PWL               00008050
      C2      = PWL(IF) - 3.0103                                         00008060
```

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      DO 1060 IA=1,15                                                     00008070
 1060 SPLTU(IA,IF) = SPLTU(IA,IF) - C2                                    00008080    09/05/75
 1070 CONTINUE                                                            00008090
      WRITE (NP,1080) HOL,DATE,TIME,ANGLE                                 00008100
 1080 FORMAT (1H1,35X,51HTOTAL PROPULSOR SOUND POWER AND DIRECTIVITY IND00008110
     1ICES //1H ,20A4,2X,2A4,2X,2A4 // 21H 1/3-OCTAVE-     SOUND,42X,24HD00008120
     2IRECTIVITY INDICES , DB / 29H BAND CENTER    POWER    FWD.,37X,19H00008130
     3AZIMUTH ANGLE , DEG,38X,4HREAR/22H FREQ. , HZ    LEVEL,DB,15F7.0)  00008140
      DO 1090 I=1,30                                                      00008150
 1090 WRITE (NP,1100) BCFR(I),PWL(I),(SPLTU(J,I),J=1,15)                  00008160    09/04/75
 1100 FORMAT (F12.1,F8.1,2X,15F7.1)                                       00008170
      IF (DATAIN(4) .LE. 0.) GO TO 1210                                   00008180    11/05/75
C     CALCULATE EPNL USING PROCEDURE FAR36                                00008190    09/04/75
      PNLTM   = 0.                                                        00008200    09/04/75
      DO 1130 IA=1,15                                                     00008210    09/04/75
      TPNLT(19-IA) = XO(IA)                                               00008220    09/10/75
      DO 1110 IF=1,24                                                     00008230    09/04/75
 1110 SPL(IF) = SPLT(IA,IF+3)                                             00008240    09/04/75
      TPNLT(34-IA) = 0.                                                   00008250    09/10/75
      ZNOYMX  = 0.                                                        00008260    09/04/75
      DO 1120 IF=1,24                                                     00008270    09/04/75
      CALL NOYS (SPL,IF,ZNOY)                                             00008280    09/04/75
      TPNLT(34-IA) = TPNLT(34-IA) + ZNOY(IF)                              00008290    09/10/75
 1120 ZNOYMX  = AMAX1(ZNOYMX,ZNOY(IF))                                    00008300    09/04/75
      TPNLT(34-IA) = 40. + 33.3*ALOG10(.85*ZNOYMX+.15*TPNLT(34-IA)) +     00008310    09/10/75
     1 TONE(SPL)                                                          00008320    09/04/75
      IF (TPNLT(34-IA) .LT. PNLTM) GO TO 1130                             00008330    09/10/75
      IAM     = IA                                                        00008340    09/04/75
      PNLTM   = TPNLT(34-IA)                                              00008350    09/10/75
 1130 CONTINUE                                                            00008360    09/04/75
      DX      = DATAIN(4) / 2.                                            00008370    09/04/75
      PNLTMD  = AMAX1(90.,PNLTM-10.)                                      00008380    09/04/75
      C1      = 10.**(PNLTM/10.)                                          00008390    09/04/75
 1140 C2      = TPNLT(18+IAM)                                             00008400    09/04/75
      C3      = DX + XO(IAM)                                              00008410    09/04/75
 1150 CALL BIQUAD (TPNLT,1,C3,0.,PNLT,IA)                                 00008420    09/04/75
      IF (IA .NE. 0) GO TO 1180                                           00008430    09/04/75
      IF (PNLT .GE. PNLTMD) GO TO 1160                                    00008440    09/04/75
      IF (C2+PNLT-2.*PNLTMD) 1170,1170,1180                               00008450    09/04/75
 1160 IF (PNLT .LE. PNLTM) GO TO 1170                                     00008460    09/04/75
      PNLTM   = PNLT                                                      00008470    09/04/75
      PNLTMD  = AMAX1(90.,PNLTM-10.)                                      00008480    09/04/75
 1170 C1      = C1 + 10.**(PNLT/10.)                                      00008490    09/04/75
      C2      = PNLT                                                      00008500    09/04/75
      C3      = C3 + DX                                                   00008510    09/04/75
      IF (ABS(C3) .LE. XO(1)) GO TO 1150                                  00008520    09/04/75
 1180 IF (DX .LT. 0.) GO TO 1190                                          00008530    09/04/75
      DX      = - DX                                                      00008540    09/04/75
      GO TO 1140                                                          00008550    09/04/75
 1190 EPNL    = 10.*ALOG10(C1) - 13.                                      00008560    09/04/75
      WRITE (NP,1200) DATAIN(9),EPNL                                      00008570    09/08/75
```

```
 1200 FORMAT (//25H FOR SIDELINE DISTANCE OF,F6.0,41H FT THE EFFECTIVE P00008580   09/04/75
     1ERCEIVED NOISE LEVEL =,F6.1,6H EPNDB)                           00008590   09/04/75
 1210 IF (IT.EQ.1 .OR. ITT.EQ.0) GO TO 10                              00008600   11/05/75
C      NOW REPEAT WITH ANY TREATMENT INCLUDED                          00008610   11/05/75
       IT      = 1                                                     00008620   11/05/75
       WRITE (NP,1220)                                                 00008630   11/05/75
 1220 FORMAT (//123H ABOVE CALCULATIONS EXCLUDE EFFECTS OF NOISE SUPPRES00008640   11/05/75
     1SION , FOLLOWING INCLUDES PERFORMANCE LOSSES AND NOISE REDUCTION D00008650   11/05/75
     2UE TO / 74H SPECIFIED TREATMENT AND NEAR-SONIC INLET , NOTE THAT U00008660   11/05/75
     3NIT SIZE MAY CHANGE )                                            00008670   11/05/75
       GO TO 115                                                       00008680   11/05/75
       END                                                             00008690
```

Subroutine ATTN

This subroutine calculates the atmospheric attenuation in dB per ft. for 1/3 octave band center frequencies from 25 to 20,000 Hz.

```
DESCRIPTICN         ATTN - SCUND ABSORPTICN TABLE

MASTER FILE         LIBR.G04
ADDED TC MASTER     05/16/75
LAST DATE COPIED      NCNE
LAST UPDATE         04/14/76  1653          *** TEMPCRARY UPDATE ***

PASSWCRC            XTWK
PROGRAMMER          F.W.EARRY
PRCC PARAMETER      $NCJCL

      SUBROUTINE ATTN                                                   00000010
C     CALCULATES TABLE ATTNT WHICH IS ATMOSPHERIC ABSCRPTICN OF SOUND IN00000030
C     DB/FT FOR 25 TO 20000 HZ 1/3-OCTABE BANDS , REF.: SAE ARP866, 3/7400000040
C     CALLED BY MAIN PROGRAM                                            00000050   08/16/75
      DIMENSION FREQ(30),TABLE(59),HMOLMX(30),SATTNT(30)                00000060
      CCMMCN /DATA/ ANGLE(15),BCFR(30),NR,NF,A,HOL(20),DATE(2),TIME(2), 00000070
     1 ATTNT(30)                                                        00000080
      CCMMCN /DATAI/TEMP,RELHUM                                         00000090
C     ALOGIO(FREQ)-2.4215 , FREQ=BCFR EXCEPT 4500,5600,7100,9000,11200, 00000100
C     14200,17900 HZ                                                    00000110
      DATA FREQ / -1.0236,-.9232,-.8154,-.7225,-.6222,-.5184,-.4215,-.3200000120
     146,-.2174,-.1205,-.0236,.0768,.1806,.2775,.3778,.4816,.5785,.6754,00000130
     1.7826,.8795,.9764,1.0768,1.1806,1.2317,1.3267,1.4258,1.5327,1.627700000140
     3,1.7308,1.8314/                                                   00000150
      DATA TABLE / 29.,0.,0.,.25,.315,.5,.7,.6,.84,.7,.93,.8,.975,.9,.9900000160
     16,1.,1.,1.1,.97,1.2,.9,1.3,.84,1.5,.75,1.7,.67,2.,.57,2.3,.495,2.500000170
     2,.45,2.8,.4,3.,.37,3.3,.33,3.6,.3,4.15,.26,4.45,.245,4.8,.23,5.25,00000180
     3.22,5.7,.21,6.05,.205,6.5,.2,7.,.2,10.,.2/                        00000190
C     SQRT(FREQ/1010) FCR FREQ = 25 TO 17900                            00000200
      DATA HMOLMX / .15732919,.17660158,.19900744,.22249708,.24975235,.200000210
     18143902,.31465839,.35179877,.39801488,.44499416,.49751860,.558463200000220
     24,.63931678,.70359754,.78978629,.88998832,.99503719,1.1124854,1.2500000230
     386336,1.4071951,1.5732919,1.7660158,1.9900744,2.1107926,2.3546878,00000240
     42.6513587,2.9851116,3.3300314,3.7495874,4.2098423/                00000250
C     ATMOSPHERIC ATTENUATICN FOR TEMP=77 , RELHUM= 70                  00000260
      DATA SATTNT / .00004,.00005,.00007,.00009,.00011,.00014,.00017,.0000000270
     1022,.00028,.00035,.00044,.00055,.00070,.00088,.00111,.00142,.0017800000280
     2,.00224,.00288,.00364,.00460,.00589,.00763,.00868,.01105,.01487,.0000000290
     32061,.02801,.04047,.05881 /                                       00000300
      IF (TEMP.EQ.77. .AND. RELHUM.EQ.70.) GC TC 60                     00000310
      C        = ((-3.E-7*TEMP+9.589E-5)*TEMP-.02288074)*TEMP+1.97274664 00000320
      ABSHUM   = 10.**(ALOGIC(RELHUM)-C)                                00000330
      DC 50 J=1,30                                                      00000340
      AMCLMX   = 10.**(FREQ(J)+.0046833333*TEMP)                        00000350
      HUMRAT   = ABSHUM / HMOLMX(J)                                     00000360
      L        = 3                                                      00000370
      IF (HUMRAT .LE. TABLE(2)) GO TO 30                                00000380
      DC 10 I=4,58,2                                                    00000390
      L        = I + 1                                                  00000400
```

```
      IF (TABLE(I)-HUMRAT) 1C,30,20
   10 CCNTINUE
      GC TO 30
   20 I       = I - 2
      IF (I .LT. 4) I = I + 2
      ALPRAT  = TABLE(I-1)*(HUMRAT-TABLE(I))/(TABLE(I-2)-TABLE(I))*(HUMR
     1AT-TABLE(I+2))/(TABLE(I-2)-TABLE(I+2)) - TABLE(I+1)*(HUMRAT-TABLE(
     2I-2))/(TABLE(I-2)-TABLE(I))*(HUMRAT-TABLE(I+2))/(TABLE(I)-TABLE(I+
     32)) + TABLE(I+3)*(HUMRAT-TABLE(I-2))/(TABLE(I-2)-TABLE(I+2))*(HUMR
     4AT-TABLE(I))/(TABLE(I)-TABLE(I+2))
      GO TO 50
   30 ALPRAT  = TABLE(L)
   50 ATTNT(J) = 10.**(2.05*FREQ(J)+6.33E-4*TEMP-5.639175) + ALPPAT *
     1 APCLKX / 1000.
      RETURN
   60 DC 70 I=1,30
   70 ATTNT(I) = SATTNT(I)
      RETURN
      END
```

05/30/75

Block Data

This subroutine initializes the variables in the common blocks. A data statement is included which specify the units as 5 and 6 for the read and write statements, respectively.

```
RUN NO. 5717     DATE  04/14/76     TIME  1653            LISTING OF MODULE H894B                                              PAGE    1

DESCRIPTION          BLOCK DATA

MASTER FILE          LIBR.G04
ADDED TO MASTER      05/16/75
LAST DATE COPIED       NONE
LAST UPDATE          04/14/76  1653            *** TEMPORARY UPDATE ***

PASSWORD             BMZT
PROGRAMMER           F.W.BARRY
PROC PARAMETER       $NCJCL

        BLOCK DATA                                                              C0000010
        COMMON /DATA/ ANGLE(15),BCFR(30),NR,NP,C,HOL(20),DATE(2),TIME(2),       C0000030
      1 ATTNT(30),SPLT(15,30),SPLTU(15,30),CBNU(7),XO(15),XD(15),ZO(15),        00000040
      2 PSI(15),DO(15),DDO(15),HPT,TR,VELFL,VM(15),PWLT(15,30),                 C0000050           08/16/75
      3 DIRIN(498),DIREX(498),BLF(31),DPWSP(15),RPMG,DHPT,RRPM,CSUM(15)         CCCC0060           09/04/75
        COMMON /DATAI/DATAIN(400)                                               00000070           10/02/75
        COMMON / JNX / BES(450)                                                 CC0C0080           05/30/75
        COMMON /TRANFR/RRL(50),INTG(2)                                          00000C90           10/02/75
        COMMON / PTREAT / I,A(4),J,B(10),K,D(4),L,E(12)                         00000100           11/05/75
        DIMENSION AAA(240),AAB(210),AAC(240),AAD(210),AAE(48),AAF(48)           00000110           08/16/75
        EQUIVALENCE (DIRIN(1),AAE(1)),(DIRIN(49),AAA(1)),(DIRIN(289),AAB(100000120           08/25/75
      1)),(DIREX(1),AAF(1)),(DIREX(49),AAC(1)),(DIREX(289),AAD(1))              00000130           08/25/75
C       AZIMUTH ANGLES 20(10)160 DEG                                            00000140
        DATA ANGLE / 20.,30.,40.,50.,60.,70.,80.,90.,100.,110.,120.,130.,100000150
      140.,150.,160. /                                                          00000160
C       1/3-OCTAVE-BAND-CENTER FREQUENCIES , 25 TO 20000 HZ                     00000170
        DATA BCFR / 25.,31.5,40.,50.,63.,80.,100.,125.,160.,200.,250.,315.00000180
      1,400.,500.,630.,800.,1000.,1250.,1600.,2000.,2500.,3150.,4000.,50000000190
      20.,6300.,8000.,10000.,12500.,16000.,20000. /                             00000200
C       UNITS FOR READ AND WRITE STATEMENTS                                     C0000210
        DATA NR,NP / 5,6 /                                                      00000220
C       SPEED OF SOUND FOR 77 DEG F                                             00000230
        DATA C / 1135.625 /                                                     00000240
        DATA DATE,TIME / 4H    ,4H    ,4H    ,4H     /                          00000250
C       ATMOSPHERIC ATTENUATION FOR TEMP=77 , RELHUM= 70                        C0000260
        DATA  ATTNT / .00004,.00005,.00007,.00009,.00011,.00014,.00017,.0C0000270
      1022,.00028,.00035,.00044,.00055,.00070,.00088,.00111,.00142,.00178C0000280
      2,.00224,.00288,.00364,.00460,.00589,.00763,.00868,.01105,.01487,.0C0000290
      32061,.02801,.04047,.05881 /                                              C0000300
C       DB CORRECTION FOR NUMBER OF UNITS = 2 TO 8                              C0000310
        DATA CBNU / 3.01,4.77,6.02,6.99,7.78,8.45,9.03 /                        00000320
        DATA TR,VELFL,VM / 536.69,0.,15*1. /, PWLT / 450*0. /                   00000330           06/25/75
C       FAN INLET AND EXHAUST DIRECTIVITY                                       00000340           08/16/75
        DATA AAE / 1.,15.,30., 20.,30.,40.,50.,60.,70.,80.,90.,100.,110.,100000350           02/10/76
      120.,130.,140.,150.,160.,       25.,31.5,40.,50.,63.,80.,100.,125.,100000360           02/10/76
      260.,200.,250.,315.,400.,500.,630.,800.,1000.,1250.,1600.,2000.,250C00C0370           02/10/76
      30.,3150.,4000.,5000.,6300.,8000.,10000.,12500.,16000.,20000. /           00000380           02/10/76
        DATA AAA/14.5,14.6,16.1,14.2,7.3,8.1,7.2,3.2,3.5,4.2,3.6,2.1,2.1,       00000390           08/16/75
      12.7,2.7,3.1,2.7,1.5,1.6,1.7,1.6,1.4,1.7,1.4,1.6,1.9,1.8,2.1,2.7,         00C00400           08/16/75
```

```
22.9,12.7,14.2,15.6,17.8,6.4,7.1,6.7,3.6,3.6,3.2,2.8,1.4,1.5,2.1,  00000410   08/15/75
31.8,2.8,2.9,1.1,1.,1.5,1.1,1.5,1.1,1.1,1.,1.1,1.3,1.6,2.3,2.5,    00000420   08/15/75
411.4,13.9,14.9,11.6,5.7,6.3,6.4,4.,3.1,2.8,2.9,1.7,1.9,2.,1.9,2.5,00000430   08/15/75
53.2,1.7,1.1,1.4,.9,1.2,.9,1.2,1.,1.2,1.5,1.5,2.1,2.5,9.5,13.1,    00000440   08/15/75
613.9,10.2,4.3,5.5,6.1,4.4,2.7,3.6,3.7,2.6,2.2,2.2,2.6,2.4,2.2,1.4,00000450   08/15/75
71.4,1.7,1.,1.2,.8,1.1,1.,1.1,1.4,1.8,2.,2.4,7.5,12.3,12.7,9.2,4., 00000460   08/15/75
84.9,5.6,4.4,2.9,4.6,4.7,3.5,2.8,2.6,2.1,.3,1.1,1.7,1.6,1.5,.8,1.5,00000470   08/16/75
91.2,1.5,1.5,1.6,1.6,1.8,2.1,2.4,6.1,11.2,11.1,6.1,3.3,4.6,5.4,3.9,00000480   08/16/75
A2.6,5.8,6.1,4.4,3.6,2.7,3.4,1.5,2.3,1.9,1.9,1.8,1.7,2.2,1.9,2.7,  00000490   08/16/75
B2.5,2.5,3.4,3.7,4.,4.3,5.1,9.4,9.4,7.2,2.6,5.,5.6,3.7,3.1,6.6,6.9,00000500   08/16/75
C5.3,4.3,3.,4.1,1.8,3.6,2.6,2.1,2.9,2.8,3.8,4.9,6.5,7.6,7.7,8.6,   00000510   08/16/75
D6.3,6.3,6.4,3.7,7.7,7.8,6.2,2.,5.6,5.8,3.3,4.1,7.7,7.7,6.6,5.5,4.,00000520   08/16/75
E6.1,4.2,4.2,4.2,3.7,3.8,4.5,5.2,5.4,6.5,6.4,6.4,6.6,6.6,6.8,6.7/  00000530   08/16/75
 DATA AAB/2.9,6.2,6.5,5.4,1.9,6.,5.6,3.7,5.7,9.5,8.4,8.3,7.,6.5,   00000540   08/16/75
17.5,7.,5.5,6.3,7.3,7.,7.6,6.4,8.1,9.5,9.5,10.5,10.4,10.4,10.3,    00000550   08/16/75
210.2,3.,4.,4.7,4.4,1.7,6.5,5.6,3.6,5.8,11.8,10.1,10.,8.7,8.6,10.1,00000560   08/16/75
38.5,6.7,8.4,8.9,9.1,9.7,7.6,7.4,7.2,8.3,8.2,10.1,11.1,10.9,10.9,  00000570   08/16/75
47.4,1.6,2.9,3.5,1.3,5.7,5.5,4.,5.7,13.1,13.9,12.3,11.1,10.2,12.6, 00000580   08/16/75
510.9,8.9,11.6,11.2,10.1,11.7,8.8,13.2,13.6,14.5,15.5,16.3,16.3,   00000590   08/16/75
616.,15.9,1.7,-.2,1.2,2.4,1.2,4.9,4.9,4.9,5.7,13.5,13.9,14.9,13.6, 00000600   08/16/75
712.3,15.1,13.3,11.7,14.,14.4,14.7,14.7,12.2,16.1,16.5,17.2,18.,   00000610   08/16/75
819.,18.7,18.5,18.3,1.1,-1.3,.7,1.9,1.5,4.8,4.5,5.,6.2,14.,13.9,   00000620   08/16/75
916.9,16.5,16.9,18.1,16.2,14.7,16.8,18.1,19.2,18.8,15.4,20.,20.4,  00000630   08/16/75
A21.3,22.1,22.9,22.8,22.8,22.6,1.2,-1.5,1.4,2.8,2.,3.7,4.1,3.6,    00000640   08/16/75
B6.3,14.6,14.8,18.9,19.1,21.3,22.9,22.,21.1,20.,20.5,23.,23.6,20.6,00000650   08/16/75
C26.6,27.4,28.4,29.2,30.1,29.8,29.5,30.1,1.9,-.9,2.,4.1,2.7,3.9,   00000660   08/16/75
D4.2,3.,6.5,15.7,15.6,20.9,21.8,25.1,26.2,25.2,26.5,24.8,24.1,25.2,00000670   08/16/75
E26.3,23.4,30.1,30.8,31.9,32.7,34.,33.4,32.9,32.7/                 00000680   08/16/75
 DATA AAF / 2.,15.,30., 20.,30.,40.,50.,60.,70.,80.,90.,100.,110.,100000690   02/10/76
120.,130.,140.,150.,160.,      25.,31.5,40.,50.,63.,80.,100.,125.,100000700   02/10/76
260.,200.,250.,315.,400.,500.,630.,800.,1000.,1250.,1600.,2000.,25000000710   02/10/76
30.,3150.,4000.,5000.,6300.,8000.,10000.,12500.,16000.,20000. /    00000720   02/10/76
 DATA AAC/8.6,10.,12.,9.7,12.3,10.7,9.1,9.5,11.2,7.1,5.8,8.4,10.4, 00000730   08/16/75
113.4,14.7,18.1,16.1,17.,20.2,21.,21.2,19.2,20.6,21.3,22.5,22.8,   00000740   08/16/75
223.7,24.,26.6,28.9,6.7,9.,11.4,8.9,11.1,9.4,8.4,9.9,11.2,5.7,4.6, 00000750   08/16/75
38.4,9.7,11.8,12.8,16.1,15.3,15.9,18.7,20.,19.9,17.2,17.,18.,18.9, 00000760   08/16/75
420.,21.2,21.5,22.2,22.4,5.7,8.3,10.6,8.,9.8,8.2,7.8,9.9,10.5,4.7, 00000770   08/16/75
54.2,8.7,9.6,10.5,11.4,14.2,14.4,15.8,17.6,18.7,18.6,14.4,17.2,18.,00000780   08/16/75
617.8,18.,18.3,18.3,18.9,19.3,4.4,7.3,9.3,6.9,8.5,6.8,7.,9.6,9.,   00000790   08/16/75
74.2,3.7,7.1,8.4,9.2,10.3,12.7,11.8,14.5,16.2,17.1,16.9,12.1,14.1, 00000800   08/16/75
814.9,14.8,14.9,15.2,15.6,15.8,16.2,3.3,6.3,7.7,6.,7.2,5.3,6.,8.9, 00000810   08/16/75
98.4,3.7,3.,4.9,6.6,7.9,7.8,9.2,8.5,13.4,14.3,13.6,12.9,9.8,12.6,  00000820   08/16/75
A13.,13.2,13.3,13.3,13.5,13.8,14.1,2.6,5.5,6.,4.6,5.9,3.6,4.7,7.4, 00000830   08/16/75
B6.7,3.3,2.6,3.5,4.8,6.,6.,8.4,6.8,10.2,11.2,9.8,8.4,6.4,7.8,7.7,  00000840   08/16/75
C8.2,8.9,7.,6.8,7.1,7.3,2.1,4.5,4.3,3.2,4.6,2.6,3.6,6.3,5.5,2.8,   00000850   08/16/75
D1.7,2.4,3.2,4.1,3.4,5.3,4.7,5.8,7.7,7.9,5.2,2.9,3.1,3.3,3.,3.,2.8,00000860   08/16/75
E3.8,3.8,3.9,1.3,3.2,2.6,1.3,3.3,1.8,2.5,3.8,3.7,1.9,1.1,1.3,1.8,  00000870   08/16/75
F2.,2.1,2.9,2.7,2.4,3.7,3.6,2.3,1.4,1.9,1.7,2.1,2.2,2.,1.8,2.,1.9/ 00000880   08/16/75
 DATA AAD/1.3,2.3,1.2,.1,2.5,1.2,1.3,1.4,1.8,.8,.7,.3,.6,.1,.2,1.2,00000890   08/16/75
11.5,.1,.2,.5,.5,.1,-.3,0.,-.1,-.1,-.2,-.2,-.3,-.4,1.5,1.2,-.2,-.8,00000900   08/16/75
21.8,1.1,.4,0.,.8,.4,.3,-.5,-.4,-.7,-.6,-.6,-.3,-1.3,-1.7,-.5,-1.1,00000910   08/16/75
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     3-.6,-.9,-1.2,-1.3,-1.5,-1.6,-1.6,-1.8,-1.8,.9,-.1,-1.3,-1.5,1.1,  00000920   08/16/75
     40.,-.4,-.3,-.1,-.8,.1,-.8,-1.3,-1.1,-1.1,-1.,-1.6,-1.3,-1.9,-2.8,  00000930   08/16/75
     5-1.9,-1.4,-1.5,-2.1,-2.2,-2.3,-2.5,-2.5,-2.8,-2.9,.6,-1.2,-2.5,    00000940   08/16/75
     6-1.5,.8,-1.1,-1.5,-.2,-1.2,-1.6,-.8,-.6,-1.3,-1.2,-1.3,-.8,-1.4,   00000950   08/16/75
     7-1.2,-1.,-1.2,-1.1,-.4,-.8,-1.3,-1.7,-1.8,-1.9,-2.2,-2.4,-2.6,.5,  00000960   08/16/75
     E-1.9,-2.8,-1.,1.1,-1.5,-2.2,-.7,-1.7,-1.9,-1.6,-.9,-.8,-.8,-1.1,   00000970   08/16/75
     9-.2,-.6,0.,.4,.4,.9,.9,1.1,.5,.4,.2,0.,-.1,-.1,-.3,.3,-1.7,-1.8,   00000980   08/16/75
     A.3,1.2,-2.9,-2.8,-2.2,-2.,-2.3,-1.7,-1.3,-.6,.4,1.1,2.5,4.6,2.9,   00000990   08/16/75
     B2.9,3.,3.4,3.9,4.6,4.4,4.4,4.2,4.1,3.8,3.5,3.1,.5,-.8,-.9,1.5,1.3,00001000   08/16/75
     C-2.9,-2.8,-2.2,-2.,-2.3,-1.8,-1.6,-.3,1.1,1.7,4.6,5.6,3.5,3.6,3.8,00001010   08/16/75
     C4.,4.6,5.1,4.8,4.9,4.7,5.,4.4,3.9,3.7/                             00001020   08/16/75
C      1/3-OCTAVE BAND FREQUENCY LIMITS , HZ                             00001030   08/16/75
      DATA BLF / 22.4,28.2,35.5,44.7,56.2,70.8,89.1,112.,141.,178.,224.,00001040   08/16/75
     1282.,355.,447.,562.,708.,891.,1120.,1410.,1780.,2240.,2820.,3550.,00001050   08/16/75
     24470.,5620.,7080.,8910.,11200.,14100.,17800.,22400. /              00001060   08/16/75
C      DISTANCE FACTOR IN PWL - SPL CONVERSION                           00001070   08/16/75
      DATA DPWSP / 62.835,59.536,57.354,55.831,54.765,54.056,53.649,53.500001080   08/16/75
     116,53.649,54.056,54.765,55.831,57.354,59.536,62.835 /              00001090   08/16/75
      DATA DATAIN / 400*0. /                                             00001100   04/12/76
      DATA RRL,INTG / 50*0.,0,0 /                                        00001110   10/02/75
      DATA BES / 450*0. /                                                00001120   05/30/75
C      FACTORS IN ANGULAR SUMMATION OF SPL FOR PWL                       00001130   09/04/75
      DATA CSUM / .05961804,.08715574,.1120452526,.13353035,.15095818,.100001140   09/04/75
     179922,.1716633,.174311485,.1716633,.16379922,.15095818,.13353035,.00001150   09/04/75
     211204526,.08715574,.05961804 /                                     00001160   09/04/75
      DATA I,J,K,L,A,B,D,E / 4*0,0.,1.,13*0.,1.,14*0. /                  00001170   11/05/75
      END                                                                00001180
```

Subroutine PNLC

This subroutine calculates the values of dB(A), PNL, and PNLT and prints them and the 1/3 octave band SPL from which they are calculated.

```
DESCRIPTION        PNLC - PRINTS SPL,DBA,PNL&PNLT

MASTER FILE        LIBR.G04
ADDED TO MASTER    05/16/75
LAST DATE COPIED     NONE
LAST UPDATE        04/14/76  1653          *** TEMPORARY UPDATE ***

PASSWORD           JHFT
PROGRAMMER         F.W.BARRY
PROC PARAMETER     $NOJCL

      SUBROUTINE PNLC (SPL)
C     CALCULATES DBA,PNL & PNLT FOR 15 AZIMUTHS
C     PRINT SPL,DBA,PNL & PNLT TABLES
C     PNLC CALLS NOYS, TONE                                                08/16/75
      DIMENSION SPL(15,30),SPLF(24),ZNOY(24),DDBA(30),DBA(15),PNL(15),
     1 PNLT(15)
      COMMON /DATA/ ANGLE(15),BCFR(30),NR,NP
      COMMON /DATA1/ DA(300)                                               09/04/75
C     PARAMETERS IN CALCULATION OF DB(A) FROM SPL
      DATA DDBA / -44.7,-39.4,-34.6,-30.2,-26.1,-22.3,-19.1,-16.2,-13.2,
     1-10.3,-8.6,-6.5,-4.8,-3.3,-1.9,-.8,.0,.5,1.,1.2,1.2,1.2,1.,.5,-.2,
     2-1.1,-2.5,-4.3,-6.6,-9.3 /
      DO 50 I=1,15
C     CALCULATE DB(A) FOR EACH AZIMUTH ANGLE
      DBA(I)  = 0.
      DO 20 J=1,30
   20 DBA(I)  = DBA(I) + 10.**((SPL(I,J)+DDBA(J))/10.)
      DBA(I)  = 10. * ALOG10(DBA(I))
C     CALCULATE PNL AND PNLT FOR EACH AZIMUTH ANGLE
      DO 30 J=1,24
   30 SPLF(J) = SPL(I,J+3)
      PNL(I)  = 0.
      ZNOYMX  = 0.
      DO 40 J=1,24
      CALL NOYS (SPLF,J,ZNOY)
      PNL(I)  = PNL(I) + ZNOY(J)
   40 ZNOYMX  = AMAX1(ZNOYMX,ZNOY(J))
      PNL(I)  = 40. + 33.3*ALOG10(.85*ZNOYMX+.15*PNL(I))
   50 PNLT(I) = PNL(I) + TONE(SPLF)
      WRITE (NP,60) DA(9),ANGLE                                            09/08/75
   60 FORMAT (//12H 1/3-OCTAVE-,37X,8HSPL ON A,F6.0,19H-FOOT SIDELINE ,   09/04/75
     1DB / 19H BAND CENTER   FWD.,37X,19HAZIMUTH ANGLE , DEG,38X,4HREAR   09/04/75
     2/ 12H  FREQ. , HZ,15F7.0)                                            09/04/75
      DO 70 I=1,30
   70 WRITE (NP,80) BCFR(I),(SPL(J,I),J=1,15)
   80 FORMAT (F12.1,15F7.1)
      WRITE (NP,90) DBA,PNL,PNLT
   90 FORMAT (/7X,5HDB(A),15F7.1/9X,3HPNL,15F7.1/8X,4HPNLT,15F7.1)
      RETURN
```

```
      END                                                    C0000410
```

Subroutines JETN and SPECTR

Subroutine JETN calculates the noise made by a jet and includes coaxial bypass flow corrections. Subroutine SPECTR is called by JETN to calculate the frequency spectrum of the jet.

```
DESCRIPTION        JETN,SPECTR - JET NOISE

MASTER FILE        LIBR.G04
ADDED TO MASTER    05/16/75
LAST DATE COPIED   NONE
LAST UPDATE        04/14/76  1653          *** TEMPORARY UPDATE ***

PASSWORD           FXVR
PROGRAMMER         F.W.BARRY
PROC PARAMETER     $NOJCL

      SUBROUTINE JETN (WTFLC,THRSTC,AREAC,WTFLB,THRSTB,AREAB,SPL,SPLJC)    06/25/75
C     CALCULATES CORE AND BYPASS JET NOISE PER EXTENDED AND MODIFIED       06/25/75
C     ROLLS ROYCE METHOD                                                  06/25/75
C     JETN CALLS SPECTR, BIQUAD; CALLED BY FPFAN, COENG, VPFAN, VPLFAN,    10/02/75
C     FPLFAN                                                              10/02/75
C     WTFLC    WEIGHT FLOW OF CORE JET , LB/SEC                           06/25/75
C     THRSTC   THRUST OF CORE JET , LB                                    06/25/75
C     AREAC    AREA OF CORE JET , SQ FT                                   06/25/75
C     WTFLB    WEIGHT FLOW OF BYPASS JET , LB/SEC                         06/25/75
C     THRSTB   THRUST OF BYPASS JET , LB                                  06/25/75
C     AREAB    AREA OF BYPASS JET , SQ FT                                 06/25/75
      DIMENSION BPINC(30),SPLJC(15,30),T(178),SPL(15,30),                 06/25/75
     1 TCBC(30),COAX1(104),COAX2(104),COAX3(104),BPIN(30)                 06/25/75
      COMMON /DATA/ ANGLE(15),BCFR(30),NR,NP,C,HOL(20),DATE(2),TIME(2),   06/25/75
     1 ATTNT(30),SPLT(15,30),SPLTU(15,30),DBNU(7),XO(15),XD(15),ZO(15),   06/25/75
     2 PSI(15),CO(15),DDO(15),HPT,TR,VELFL,VM(15),PWLT(15,30)             06/25/75
      DATA T /1.,10.,15.,-.55,-.5,-.4,-.3,-.2,-.1,0.,.1,.2,.3,20.,30.,    06/25/75
     140.,50.,60.,70.,80.,90.,100.,110.,120.,130.,140.,150.,160.,93.,     06/25/75
     293.5,94.,94.6,95.1,96.,97.1,98.,99.,100.,101.,101.9,102.6,103.4,    06/25/75
     3103.7,95.4,96.8,97.3,98.2,99.,100.2,101.1,102.,103.,103.9,105.,     06/25/75
     4105.9,106.7,107.6,108.,103.,103.9,104.8,105.7,106.6,107.6,108.6,    06/25/75
     5109.6,110.5,111.5,112.4,113.3,114.3,115.3,115.9,109.7,110.6,111.5,  06/25/75
     6112.5,113.5,114.5,115.8,116.9,118.,119.3,120.7,122.,122.9,123.9,    06/25/75
     7124.4,116.9,117.8,118.6,119.6,120.7,121.8,123.1,124.3,125.8,127.,   06/25/75
     8128.7,130.1,131.2,132.1,132.6,124.4,125.2,126.2,127.1,128.2,129.3,  06/25/75
     9130.9,132.,133.8,135.1,137.,138.7,139.9,140.8,141.4,131.6,132.6,    06/25/75
     A133.7,134.7,135.7,136.9,138.2,139.8,141.4,143.1,145.3,147.3,149.4,  06/25/75
     B150.7,151.4,141.,141.5,142.2,142.9,143.7,144.3,145.7,147.3,149.5,   06/25/75
     C152.2,155.2,157.6,160.7,161.6,161.5,150.4,150.5,150.6,150.9,151.4,  06/25/75
     D152.2,153.8,155.2,157.1,160.5,164.3,169.3,172.1,172.4,170.8,158.,   06/25/75
     E158.2,158.5,159.,159.9,160.8,162.,163.8,166.3,170.,173.9,177.5,     06/25/75
     F179.9,178.1,172.5/                                                  06/25/75
      DATA COAX1/1.,16.,5.,.008,.016,.0315,.063,.125,.25,.5,1.,2.,4.,8.,  06/25/75
     116.,32.,63.,125.,250.,-.4,-.3,-.2,-.1,0.,19.5,19.5,19.8,20.9,23.,   06/25/75
     211.8,11.8,12.1,13.7,16.1,7.,7.1,7.9,9.2,11.8,3.3,3.8,5.,6.7,9.3,    06/25/75
     3.6,1.5,2.9,4.7,7.4,-1.2,-.3,1.,3.,5.8,-2.5,-2.,-.9,1.3,4.5,-3.7,    06/25/75
     4-3.6,-2.6,-.3,3.5,-4.8,-5.1,-4.5,-1.9,2.4,-7.,-7.,-6.4,-3.4,1.4,    06/25/75
     5-8.2,-8.2,-7.5,-4.9,.3,-9.7,-9.7,-8.1,-6.4,-.7,-11.,-11.,-10.6,     06/25/75
     6-8.,-1.8,-12.1,-12.1,-12.1,-9.6,-2.7,-13.5,-13.5,-13.5,-11.1,-3.7,  06/25/75
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      7-14.8,-14.8,-14.0,-12.7,-4.8/                                      06/25/75
       DATA COAX2/1.,16.,5.,.008,.016,.0315,.063,.125,.25,.5,1.,2.,4.,8., 06/25/75
      116.,32.,63.,125.,250.,-.4,-.3,-.2,-.1,0.,13.6,20.9,24.1,26.,27.7,  06/25/75
      28.,12.9,15.4,17.8,20.2,4.2,7.4,5.8,12.7,15.5,1.5,3.4,5.2,8.7,12.6, 06/25/75
      3-.9,.3,1.6,5.3,10.,-3.,-2.4,-1.,2.5,8.4,-4.8,-4.5,-3.5,0.,6.9,     06/25/75
      4-6.5,-6.3,-5.5,-2.2,5.7,-8.,-8.1,-7.2,-3.6,4.7,-9.5,-9.5,-8.9,     06/25/75
      5-5.8,3.9,-10.9,-10.9,-10.,-7.4,2.9,-11.7,-11.7,-11.,-8.9,2.1,      06/25/75
      6-12.6,-12.6,-12.,-10.4,1.5,-13.4,-13.4,-13.,-11.9,.8,-14.2,-14.2,  06/25/75
      7-14.,-13.3,0.,-15.,-15.,-15.,-14.8,-.7/                            06/25/75
       DATA COAX3/1.,16.,5.,.008,.016,.0315,.063,.125,.25,.5,1.,2.,4.,8., 06/25/75
      116.,32.,63.,125.,250.,-.4,-.3,-.2,-.1,0.,18.3,22.5,24.8,28.2,31.,  06/25/75
      28.9,12.8,15.8,19.9,23.4,4.,6.9,10.4,14.6,18.9,.9,2.9,6.3,10.9,     06/25/75
      315.5,-1.5,0.,3.,7.7,13.1,-3.5,-2.3,.3,5.2,11.3,-5.1,-4.4,-2.1,2.9, 06/25/75
      49.9,-6.5,-6.,-4.5,.7,8.9,-8.1,-7.5,-6.4,-1.2,8.1,-9.3,-8.9,-8.5,   06/25/75
      5-3.1,7.6,-11.,-10.7,-10.4,-4.9,6.9,-12.2,-12.2,-12.,-6.5,6.1,      06/25/75
      6-14.1,-14.1,-14.1,-8.2,5.5,-16.1,-16.1,-16.1,-9.9,4.9,-18.,-18.,   06/25/75
      7-18.,-11.5,4.2,-20.,-20.,-20.,-13.,3.8/                            06/25/75
       IF (THRSTC.LE.0..AND.THRSTB.LE.0.) RETURN                          06/25/75
       IF (WTFLC.LE.0..AND.WTFLB.LE.0.) RETURN                            06/25/75
       IF (AREAC.LE.0..AND.AREAB.LE.0.) RETURN                            06/25/75
C                                                                         06/25/75
C      CALCULATE JET NOISE PER METHOD OF PROPOSED REVISION TO AIR 876     06/25/75
C      BY ROLLS-ROYCE + ATMOS ATT                                         06/25/75
C                                                                         06/25/75
       VELB=0.                                                            06/25/75
       FLAG=1.                                                            06/25/75
       DSPL=0.                                                            06/25/75
       DO 52 I=1,30                                                       06/25/75
    52 BPINC(I)=0.                                                        06/25/75
       IF (WTFLC.EQ.0.) WTFLC=.001                                        06/25/75
       RHOA     = 39.69 / TR                                              06/25/75
       SOUND    = C                                                       06/25/75
       VK1      = VELFL                                                   06/25/75
C                                                                         06/25/75
C      CORE JET NOISE                                                     06/25/75
C                                                                         06/25/75
       VELC=32.2*THRSTC/WTFLC + VK1                                       06/25/75
       IF (THRSTB.EQ.0..OR.WTFLB.EQ.0..OR.AREAB.EQ.0.) GO TO 60           06/25/75
       VELB=32.2*THRSTB/WTFLB + VK1                                       06/25/75
       IF (VELC.GE.VELB) GO TO 60                                         06/25/75
C                                                                         06/25/75
C      BYPASS VEL GT CORE- CALC CORE JET USING BYPASS DATA                06/25/75
C                                                                         06/25/75
       VELCT=VELC                                                         06/25/75
       AREACT=AREAC                                                       06/25/75
       WTFLCT=WTFLC                                                       06/25/75
       VELC=VELB                                                          06/25/75
       AREAC=AREAB                                                        06/25/75
       WTFLC=WTFLB                                                        06/25/75
       FLAG=0.                                                            06/25/75
       WRITE (NP,1015)                                                    06/25/75
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 1015 FORMAT (//49H ***** BYPASS VELOCITY GREATER THAN CORE VELOCITY)    06/25/75
   60 RHOC     = WTFLC / (AREAC*VELC)                                     06/25/75
      TEMPC=39.6598/RHOC                                                  06/25/75
      VVAR=ALOG10(VELC/SOUND)                                             06/25/75
      IF (VVAR.GE.-.55) GO TO 80                                          06/25/75
      VVAR=-.55                                                           06/25/75
      VELCC=SOUND*.281838                                                 06/25/75
   70 WRITE (NP,1020) VELC,VELCC                                          06/25/75
 1020 FORMAT (//42H ***** CORE JET VELOCITY OUT OF RANGE. WAS,F8.2,9H ,   06/25/75
     1SET TC,F8.2,7H FT/SEC)                                              06/25/75
   80 IF (VVAR.LE..3) GO TO 90                                            06/25/75
      VVAR=.3                                                             06/25/75
      VELCC=SOUND*1.99526                                                 06/25/75
      GO TO 70                                                            06/25/75
   90 IF (VVAR)100,100,110                                                06/25/75
  100 OMEGA=(((19.1*VVAR+18.7663)*VVAR+9.44054)*VVAR+6.22843)*VVAR+.7912  06/25/75
     134                                                                  06/25/75
      GO TO 120                                                           06/25/75
  110 OMEGA=((((3426.24*VVAR-2318.42)*VVAR+469.149)*VVAR-33.6377)*VVAR+6  06/25/75
     1.84207)*VVAR+.79114                                                 06/25/75
  120 COR=10.*ALOG10((RHOC/RHOA)**OMEGA * AREAC)                          06/25/75
      DIAC     = 1.1283792 * SQRT(AREAC)                                  06/25/75
      TERM=(DIAC/VELC) * (TEMPC/TR)**.26                                  06/25/75
      CALL SPECTR (TERM,1,TEMPC,TOBC)                                     06/25/75
      DO 130 IA=1,15                                                      06/25/75
      CALL BIQUAD (T,1,VVAR,PSI(IA),CALVL,K)                              06/25/75
      CALVL    = CALVL + COR - 20.*ALOG10(ZO(IA))                         06/25/75
      IF (VK1 .EQ. 0.) GO TO 122                                          06/25/75
      OALVL    = OALVL - 10.*ALOG10(VM(IA))                               06/25/75
      IF (PSI(IA) .LE. 90.1) GO TO 122                                    06/25/75
      X        = 7.75                                                     06/25/75
      IF (PSI(IA) .LT. 155.) X = (.015*PSI(IA)-2.483)*PSI(IA)+101.97      06/25/75
      OALVL    = CALVL - X*ALOG10(VELC/(VELC-VK1))                        06/25/75
  122 IF (IA .LT. 9) GO TO 125                                            06/25/75
      IDIR=MINO(IA-7,7)                                                   06/25/75
      CALL SPECTR (TERM,IDIR,TEMPC,TOBC)                                  06/25/75
  125 DO 130 IF=1,30                                                      06/25/75
  130 SPLJC(IA,IF) = OALVL - TOBC(IF)                                     06/25/75
      IF (FLAG.NE.0.) GO TO 150                                           06/25/75
C                                                                         06/25/75
C     CASE WHERE BYPASS WAS GT CORE VELOCITY - RESET CORE DATA FOR        06/25/75
C     TAILPIPE NOISE AND OMIT BYPASS CORRECTION                           06/25/75
C                                                                         06/25/75
      VELC=VELCT                                                          06/25/75
      AREAC=AREACT                                                        06/25/75
      WTFLC=WTFLCT                                                        06/25/75
      DIAC=2.*SQRT(AREAC/3.14159)                                         06/25/75
  150 IF (THRSTB.EQ.0..OR.WTFLB.EQ.0..OR.AREAB.EQ.0..OR.FLAG.EQ.0.) GO    06/25/75
     1TO 220                                                              06/25/75
C                                                                         06/25/75
C     BYPASS JET NOISE PORTION
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C       CMIT BYPASS CORRECTICN FOR ZERC EYPASS CATA                      06/25/75
C                                                                        06/25/75
        AR=AREAB/AREAC                                                   06/25/75
        VVAR2=ALOG10((VELB/VELC))                                        06/25/75
        TERM=CIAC/(VELC)                                                 06/25/75
C                                                                        06/25/75
C       COMPUTES SPECTRUM CORRECTICN FCR AREA RATIC CF 4.                06/25/75
C                                                                        06/25/75
        DO 160 IF=1,3C                                                   06/25/75
        X = TERM * BCFR(IF)                                              06/25/75
        CALL BIQUAD (COAX2,1,X,VVAR2,BPINC(IF),K)                        06/25/75
        IF (K.NE.0) WRITE (NP,1040) BCFR(IF)                             06/25/75
  1C4C  FCRMAT (32H ***** OFF COAXIAL JET CARPET AT,F8.1,3H HZ)          06/25/75
   16C  CCNTINUE                                                         06/25/75
        IF (AR-4.)170,210,19C                                            06/25/75
C                                                                        06/25/75
C       AREA RATIO LESS THAN 4. COMPUTE FOR AR=2.                        06/25/75
C                                                                        06/25/75
   170  DO 180 IF=1,3C                                                   06/25/75
        X = TERM * BCFR(IF)                                              06/25/75
        CALL BIQUAD (COAX1,1,X,VVAR2,BPIN(IF),K)                         06/25/75
C                                                                        06/25/75
C       LINEAR INTERPCLATION BETWEEN AR=2 AND AR=4                       06/25/75
C                                                                        06/25/75
   180  BPINC(IF)=BPIN(IF)+((AR/2.-1.)*(BPIN(IF)-BPIN(IF)))              06/25/75
        GO TO 210                                                        06/25/75
C                                                                        06/25/75
C       AREA RATIO GREATER THAN 4. CCMPUTE FOR AR=6.                     06/25/75
C                                                                        06/25/75
   190  DO 200 IF=1,30                                                   06/25/75
        X = TERM * BCFR(IF)                                              06/25/75
        CALL BIQUAD (COAX3,1,X,VVAR2,BPIN(IF),K)                         06/25/75
C                                                                        06/25/75
C       LINEAR INTERPOLATICN BETWEEN AR=4 AND AR=6                       06/25/75
C                                                                        06/25/75
   2C0  BPINC(IF)=BPINC(IF)+((AR/2.-2.)*(BPIN(IF)-BPINC(IF)))            06/25/75
   210  DSPL=11.5*ALOG10(VELC)-34.5                                      06/25/75
C                                                                        06/25/75
C       CCMBINES JET NOISES                                              06/25/75
C                                                                        06/25/75
   220  DO 230 IF=1,30                                                   06/25/75
        BPINC(IF)=BPINC(IF)+DSPL                                         06/25/75
        DO 230 IA=1,15                                                   06/25/75
   230  SPLJC(IA,IF) = SPLJC(IA,IF) + BPINC(IF)                          06/25/75
        DO 260 IA=1,15                                                   06/25/75
        I        = 1                                                     06/25/75
        DO 260 IF=1,30                                                   06/25/75
   240  IF (BCFR(I+1) .GE. BCFR(IF)/VM(IA)) GO TO 250                    06/25/75
        IF (I .EQ. 29) GO TO 250                                         06/25/75
        I        = I + 1                                                 06/25/75
        GO TO 240                                                        06/25/75
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  250 X        = (BCFR(IF)/VM(IA)-BCFR(I)) / (BCFR(I+1)-BCFR(I))       C0001940   06/25/75
      SPL(IA,IF) = (1.-X)*SPLJC(IA,I) + X*SPLJC(IA,I+1)-ATTNT(IF)*ZO(IA)00001950   06/25/75
  26C SPLJC(IA,IF) = SPLJC(IA,IF) - ATTAT(IF)*ZC(IA)                   CC001960   06/25/75
      RETURN                                                          00001970   06/25/75
      END                                                             00001980   06/25/75
      SLBRCUTINE SPECTR (TERP,IDIR,TEPPC,TOBC)                        00001990   06/25/75
C                                                                     00002010   06/25/75
C     SUBROUTINE TO CALCULATE CORE JET SPECTRUM BASED ON ROLLS-ROYCE  C0002020   06/25/75
C                                                                     00002030   06/25/75
C     SPECTR CALLS UNINT : CALLED BY JETN                             00002040   09/16/75
      DIMENSION          S1(33),S2(33),TOBC(30),XA(33),SPEC(33,3,7),  00002050   06/25/75
     1AAA(231),AAB(231),AAC(231)                                      00002060   06/25/75
      CCPMCN /DATA/ ANGLE(15),FREQ(3C),NR,NP                          CC002070   06/25/75
      EQUIVALENCE (SPEC(1),AAA(1)),(SPEC(232),AAB(1)),(SPEC(463),AAC(1))00002080   06/25/75
      DATA XA/-1.6,-1.5,-1.4,-1.3,-1.2,-1.1,-1.,-.9,-.8,-.7,-.6,-.5,-.4,00002090   06/25/75
     1-.3,-.2,-.1,0.,.1,.2,.3,.4,.5,.6,.7,.8,.9,1.,1.1,1.2,1.3,1.4,1.5,100002100   06/25/75
     2.6/                                                             00002110   06/25/75
      DATA AAA/35.1,32.2,29.9,27.1,25.,22.5,21.,19.1,17.3,16.,14.7,13.5,00002120   06/25/75
     112.6,11.9,11.4,11.1,11.,11.1,11.2,11.6,12.,12.6,13.2,14.,14.9,15.900002130   06/25/75
     2,16.9,18.,19.1,20.3,21.8,23.,24.3,35.1,32.2,29.9,27.1,25.,22.9,21.C0002140   06/25/75
     3,19.1,17.3,16.,14.7,13.5,12.6,11.9,11.4,11.1,11.,11.1,11.2,11.6,1200002150   06/25/75
     4.,12.8,13.7,14.7,15.5,16.7,17.5,19.1,20.5,22.,23.5,25.2,27.,35.1,300002160   06/25/75
     52.2,29.9,27.1,25.,22.9,21.,19.1,17.3,16.,14.7,13.5,12.6,11.9,11.4,00002170   06/25/75
     611.1,11.,11.1,11.2,11.6,12.,12.8,13.7,14.8,15.9,17.1,18.5,20.,21.800002180   06/25/75
     7,23.2,25.,26.8,27.4,37.1,33.7,30.5,28.1,25.6,23.4,21.3,19.6,17.9,100002190   06/25/75
     86.1,14.8,13.5,12.4,11.6,11.1,10.9,10.7,10.9,11.1,11.6,12.,12.8,13.C0002200   06/25/75
     94,14.2,15.2,16.1,17.1,18.2,19.3,20.5,21.9,23.,24.2,37.1,33.7,30.9,00002210   06/25/75
     128.1,25.6,23.4,21.3,19.6,17.9,16.1,14.8,13.5,12.4,11.6,11.1,10.9,100002220   06/25/75
     A0.7,10.9,11.1,11.7,12.5,13.2,14.,15.1,16.3,17.4,19.8,20.2,21.7,23.00002230   06/25/75
     B2,25.,27.8,28.7,37.1,33.7,30.9,28.1,25.6,23.4,21.3,19.6,17.9,16.1,00002240   06/25/75
     C14.8,13.5,12.4,11.6,11.1,10.9,10.7,10.5,11.1,11.7,12.5,13.5,14.5,100002250   06/25/75
     C6.8,17.,18.4,20.,21.4,23.1,25.,26.8,28.9,30.7,39.,35.3,32.,28.9,2600002260   06/25/75
     E.1,23.8,21.3,19.3,17.4,15.6,14.1,13.,11.9,11.1,10.8,10.5,10.5,10.500002270   06/25/75
     F,10.9,11.2,11.9,12.4,13.2,14.,15.,16.,17.,18.1,19.3,20.7,22.,23.5,00002280   06/25/75
     G25./                                                            00002290   06/25/75
      DATA AAB/39.,35.3,32.,28.9,26.1,23.8,21.3,19.3,17.4,15.8,14.1,13.,00002300   06/25/75
     111.9,11.1,10.8,10.5,10.5,10.9,11.2,11.5,12.5,13.2,14.2,15.3,16.7,100002310   06/25/75
     27.9,19.3,20.9,22.6,24.3,26.1,28.,30.,39.,35.3,32.,28.9,26.1,23.8,200002320   06/25/75
     31.3,19.3,17.4,15.8,14.1,13.,11.9,11.1,10.8,10.5,10.5,10.9,11.2,11.00002330   06/25/75
     49,12.7,13.7,14.9,16.1,17.7,19.1,20.9,22.6,24.7,26.8,28.9,31.,33.,400002340   06/25/75
     50.,36.3,32.7,29.6,26.4,24.,21.4,19.2,17.4,15.9,14.7,13.1,12.2,11.800002350   06/25/75
     6,11.1,10.8,10.8,10.9,11.1,11.4,12.,13.,13.5,14.3,15.2,16.1,17.2,1800002360   06/25/75
     7.2,19.4,20.7,22.,23.3,24.8,40.,36.3,32.7,29.6,26.4,24.,21.4,19.2,100002370   06/25/75
     87.4,15.9,14.7,13.1,12.2,11.8,11.1,10.8,10.8,10.9,11.1,11.7,12.4,1300002380   06/25/75
     9.6,14.8,16.,17.5,18.8,20.4,21.9,23.4,25.3,27.2,29.1,31.1,40.,36.3,00002390   06/25/75
     132.7,29.6,26.4,24.,21.4,19.2,17.1,15.6,13.9,12.7,11.5,10.9,10.2,1000002400   06/25/75
     A.,10.2,10.6,11.,11.9,13.,14.2,15.6,17.,18.7,20.3,22.1,24.,26.,28.200002410   06/25/75
     B,30.6,33.1,35.6,38.9,35.5,32.,28.6,25.6,22.9,20.5,18.2,16.2,14.5,100002420   06/25/75
     C3.,12.,11.3,11.,10.9,11.1,11.2,11.8,12.3,13.2,14.1,15.1,16.2,17.2,00002430   06/25/75
     D18.2,19.3,20.5,21.9,23.,24.3,25.6,27.,28.8,38.9,35.5,32.,28.6,25.600002440   06/25/75
     E,22.9,20.,17.5,15.1,13.2,11.9,11.,10.7,10.5,10.9,11.2,11.9,12.8,1300002450   06/25/75
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     F.8,15.,16.3,17.8,19.6,21.1,23.,24.8,26.6,28.5,30.3,32.2,34.4,36.5,    06/25/75
     G38.9/                                                                 06/25/75
      DATA AAC/38.9,35.5,32.,28.6,25.6,22.9,20.,17.5,15.1,13.2,11.9,11.,   06/25/75
     110.7,10.5,10.9,11.5,12.2,13.2,14.5,15.9,17.3,18.9,20.8,22.4,24.3,     06/25/75
     226.5,28.5,30.9,33.,35.4,37.9,40.2,43.,37.6,33.7,30.,26.5,23.4,21.,    06/25/75
     318.8,16.6,15.8,13.3,12.1,11.4,10.9,10.8,11.,11.5,12.4,13.3,14.6,      06/25/75
     415.8,16.9,18.2,19.5,20.9,22.1,23.4,24.4,26.2,27.4,28.8,30.1,31.6,     06/25/75
     532.9,37.6,33.7,30.,26.5,23.4,20.3,17.6,15.,12.8,11.1,10.2,9.9,10.1    06/25/75
     6,10.8,11.6,12.5,13.8,15.3,16.7,18.3,20.1,22.,23.9,25.9,28.,30.2,      06/25/75
     732.4,34.6,36.8,39.,41.1,43.3,45.3,37.6,33.7,30.,26.5,23.4,20.3,       06/25/75
     817.6,15.,12.8,11.1,10.2,9.9,10.1,10.8,11.8,13.,14.4,16.,17.6,19.5,    06/25/75
     921.4,23.4,25.7,27.9,30.2,32.6,35.1,37.5,40.,42.4,44.9,47.3,49.6,      06/25/75
     136.2,32.8,29.,25.4,22.3,19.7,17.2,15.2,13.5,12.1,11.1,10.7,10.7,      06/25/75
     A10.8,11.1,11.9,12.8,13.9,15.,16.3,17.9,19.2,20.8,22.4,24.,25.5,       06/25/75
     B27.2,28.9,30.7,32.2,34.,35.9,37.4,36.2,32.8,29.,25.4,22.,19.,16.4,    06/25/75
     C13.9,11.8,10.,9.,8.9,9.4,10.7,12.2,14.,15.8,17.7,19.7,21.6,23.8,      06/25/75
     D26.,28.2,30.4,32.7,35.1,37.4,39.9,42.2,44.7,47.1,49.9,52.2,36.2,      06/25/75
     E32.8,29.,25.4,21.7,18.7,15.6,13.,10.9,9.,8.1,8.3,9.3,11.,13.1,15.2    06/25/75
     F,17.4,19.5,21.7,23.9,26.2,28.6,31.,33.5,36.,38.5,41.1,43.9,46.3,      06/25/75
     G49.1,51.8,54.4,57.1/                                                  06/25/75
      IF (TEMPC-1080.)10,10,20                                              06/25/75
   10 K=1                                                                   06/25/75
      GO TO 30                                                              06/25/75
   20 K=3                                                                   06/25/75
   30 DO 40 I=1,33                                                          06/25/75
      S1(I)=SPEC(I,K,IDIR)                                                  06/25/75
   40 S2(I)=SPEC(I,2,IDIR)                                                  06/25/75
      DO 50 I=1,30                                                          06/25/75
      X=ALOG10(TERM*FREQ(I))                                                06/25/75
      CALL UNINT (33,XA,S2,X,Z1,L)                                          06/25/75
      IF (L.NE.0  .AND. ICIR.EQ.1) WRITE(NP,1000) FREQ(I)                   06/25/75
 1000 FORMAT (28H ***** CFF SPECTRUM CURVE AT,F8.1,3H HZ)                   06/25/75
      CALL UNINT (33,XA,S1,X,Z2,L)                                          06/25/75
   50 TOBC(I)=Z1+(Z2-Z1)*ABS(1080.-TEMPC)/540.                              06/25/75
      RETURN                                                                06/25/75
      END
```

Subroutines HELI, ROTOR, and BJSIGN

These three subroutines calculate the tones and broadband noise level of helicopter free-air main and tail rotors.

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RUN NO. 5717     DATE  04/14/76     TIME  1653          LISTING OF MODULE H894E                                PAGE   1

DESCRIPTION          HELI - HELICOPTER NOISE

MASTER FILE          LIBR.G04
ADDED TO MASTER      05/16/75
LAST DATE COPIED       NONE
LAST UPDATE          04/14/76  1653                *** TEMPORARY UPDATE ***

PASSWORD             MKWX
PROGRAMMER           F.W.BARRY
PROC PARAMETER       $NOJCL

      SUBROUTINE HELI                                                   00000010
C     CALCULATE HELICOPTER NOISE                                        00000020
C     HELI CALLS ROTOR, SHTR, GRBOXN; CALLED BY MAIN PROGRAM            00000040     10/02/75
      DIMENSION DATAIN(300)                                             00000050     09/11/75
      COMMON /DATAI/ DATAIM(3),BIGV,A(45),RCASE,RETA,RBIGB,RBIGR,ROMEGN,00000060
     1RSIC,RCHORD,RTHRUS,RTORQ,RBETA,RTWIST,CCRLCM,RNGOX,TCASE,TETA,    00000070
     2TBIGB,TBIGR,TOMEGN,TSIC,TCHORD,TTHRUS,TTORQ,TBETA,TTWIST,CORLCT,  00000080
     3TRCOR,TNGOX                                                       00000090
      COMMON /DATA/ ANGLE(15),BCFR(30),NR,NP,C,HOL(20),DATE(2),TIME(2), 00000100
     1 ATINT(30),SPLT(15,30),SPLTU(15,30),CBNU(7),XO(15),XD(15),ZO(15), 00000110
     2 PSI(15),DC(15),DDO(15),HPT,TR,VELFL,VM(15),PWLT(15,30),          00000120     08/22/75
     3 DIRIN(498),DIREX(498),BLF(31),CPWSP(15),RPMG,DHPT                00000130     08/22/75
      EQUIVALENCE (CATAIN(1),DATAIM(1))                                 00000140
C     REQUIRED INPUT VIA DATAIN FOR MAIN AND FREE-AIR TAIL ROTORS , LOC 00000150
C     MAIN TAIL      NAME  MEANING OF PARAMETER                         00000160
C       50   63      CASE  ROTOR AIRLOADING K FACTOR , DEFAULT = 1.44 - 00000170     10/02/75
C                          .0741667*TWIST - .0018056*TWIST**2           00000180     10/02/75
C                           LIMITS 1.55.LE.CASE.LE.2.22                 00000190     11/07/75
C       51   64       ETA  RADIAL LOADING STATION (.7 .LE. ETA .LE. .9) 00000200     11/07/75
C                          DEFAULT = 1.+.01667*TWIST                    00000210     10/07/75
C       52   65      BIGBR NUMBER OF ROTOR BLADES                       00000220
C       53   66      BIGR  ROTOR RADIUS , FT                            00000230
C       54   67     OMEGN  ROTOR ROTATIONAL SPEED , RPM                 00000240
C       55   68       SIC  ROTOR DISK INCIDENCE ANGLE , DEG             00000250
C       56   69    CHORDR  ROTOR BLADE CHORD , INCH                     00000260
C       57   70    THRUSR  ROTOR THRUST , LB                            00000270
C       58   71    TORQUE  ROTOR TORQUE , FT-LB                         00000280
C       59   72      BETA  ROTOR CONING ANGLE , DEG                     00000290
C       60   73     TWIST  BLADE TWIST , DEG , TYPICALLY NEGATIVE       00000300     10/02/75
C       61   74     CCNLC  CORRELATION LENGTH , DEFAULT = .7            00000310     10/02/75
C            75     TRCOR  NUMBER OF TAIL ROTOR HARMONICS               00000320
C                                                                       00000330
C     CALCULATE MAIN ROTOR NOISE                                        00000340
      HP     = RTORQ * ROMEGN / 5252.1131                               00000350     09/11/75
      I      = IFIX(CATAIN(36))                                         00000360     09/11/75
      RNGOX  = CATAIN(I)                                                00000370     02/11/76
      IF (I .LE. 0) RNGOX = 0.                                          00000380     10/02/75
C     DEFAULT OPTIONS                                                   00000390     11/07/75
      IF (RCASE .EQ. 0.) RCASE = AMAX1(1.55,AMIN1(2.22,1.44-RTWIST*(.07400000390
     11667+.0018056*RTWIST)))                                           00000400     11/07/75
```

```
      IF (RETA .LE. 0.) RETA = AMAX1(.7,AMIN1(.9,1.+.01666667*RTWIST))      11/07/75
      IF (CORLCM .LE. 0.) CCRLCM = .7                                       10/02/75
      WRITE (NP,10) HCL,DATE,TIME,RCASE,RBIGR,RTHRUS,RETA,RCHORD,RTORQ,
     1RBIGB,ROMEGN,HP,RNGCX,RSID,RTWIST,CATAIN(34),RBETA,CCRLCM
   10 FORMAT (1H1,30X,27HHELICOPTER MAIN ROTCR NCISE //1H ,20A4,2X,2A4,2
     1X,2A4 // 25H     AIRLOADING K FACTOR =,F4.2,7X,19HROTOR RADIUS  , FT
     2 =,F6.2,5X,13HTHRUST  , LB =,F7.0 / 25H RADIAL LOADING STATION =,F4
     3.2,7X,19HBLADE CHORD  , IN. =,F6.2,18H   TORQUE  , FT-LB =,F7.0 /25H
     4NUMBER OF ROTOR BLADES =,F4.0,26H  ROTATIONAL SPEED  , RPM =,F6.1,6
     5X,12HHORSEPOWER =,F7.1 / 4X,21HNUMBER OF GEARBOXES =,F4.0,4X,22HD1
     6SK INCIDENCE ANGLE =,F6.1,5X,13HTWIST  , DEG =,F7.3 / 7X,18HNUMBER
     7OF ROTORS =    ,F4.0,6X,20HCONING ANGLE  , DEG =,F6.1,10X,8HCORLCM =
     8,F7.3 /)
      IF (RETA.LT..7 .CR. RETA.GT..9 .OR. RBIGB.LT.2. .OR. RBIGR.LE.0.     11/07/75
     1.OR. ROMEGN.LE.0. .CR. RCHORD.LE.0. .OR. RTHRUS.LE.0. .OR. RTORQ.L   06/11/75
     2E.0. .CR. RCASE.LT.1.55 .OR. RCASE.GT.2.22) GO TO 100                 11/07/75
      HPT      = HP * DATAIN(34) + HPT                                      06/11/75
      CALL ROTOR (1)
      IF (CATAIN(36) .LE. 0.) GO TO 15                                      08/20/75
      CBN      = 0.                                                         08/20/75
      IF (CATAIN(34) .GT. 1.) DBN = DBNU(IFIX(DATAIN(34)-.9))               08/20/75
      CALL GRBOXN (IFIX(DATAIN(36)),HP,CATAIN(54),CBN,0.)                   09/25/75
   15 IF (CATAIN(38) .EQ. 0.) GO TO 3C                                      06/11/75
C     CALCULATE FREE-AIR TAIL ROTOR NOISE
C     DEFAULT OPTIONS                                                       10/02/75
      IF (TCASE .EQ. 0.) TCASE = AMAX1(1.55,AMIN1(2.22,1.44-TTWIST*(.C74   11/07/75
     11667+.0018056*TTWIST)))                                               11/07/75
      IF (TETA .LE. 0.) TETA = AMAX1(.7,AMIN1(.9,1.+.01666667*TTWIST))      11/07/75
      IF (CORLCT .LE. 0.) CORLCT = .7                                       10/02/75
      HP       = TTORQ * TCMEGN / 5252.1131
      I        = IFIX(CATAIN(40))                                           09/11/75
      TNGOX    = DATAIN(I)                                                  09/11/75
      IF (I .LE. 0) TNGOX = 0.                                              02/11/76
      WRITE (NP,20) HCL,DATE,TIME,TCASE,TBIGR,TTHRUS,TETA,TCHORD,TTORQ,
     1TBIGB,TOMEGN,HP,TNGOX,TSID,TTWIST,DATAIN(38),TBETA,CCRLCT,TRCOR
   20 FORMAT (1H1,26X,36HHELICOPTER FREE-AIR TAIL ROTOR NOISE//1H ,2CA4,
     12X,2A4,2X,2A4//25H     AIRLOADING K FACTCR =,F4.2,7X,19HROTOR RACIU
     2S  , FT =,F6.2,5X,13HTHRUST  , LB =,F7.0/25H RACIAL LOADING STATICN
     3=,F4.2,7X,19HBLADE CHORD  , IN. =,F6.2,18H   TORQUE  , FT-LB =,F7.0/2
     45H NUMBER CF ROTOR BLADES =,F4.0,26H  ROTATICNAL SPEED  , RPM =,F6.
     51,6X,12HHORSEPOWER =,F7.1/4X,21HNUMBER OF GEARBOXES =,F4.0,4X,22HD
     6ISK INCIDENCE ANGLE =,F6.1,5X,13HTWIST  , DEG =,F7.3/ 4X,21HNUMBER
     7OF ROTORS =    ,F4.0,6X,20HCONING ANGLE  , DEG =,F6.1,1CX,8HCORLCM =
     8,F7.3 / 4X,21HNUMBER OF HARMONICS =,F4.0 /)
      IF (TETA.LT..7 .OR. TETA.GT..9 .OR. TBIGB.LT.2. .OR. TBIGR.LE.0.     11/07/75
     1.OR. TOMEGN.LE.0. .OR. TCHORD.LE.0. .OR. TTHRUS.LE.0. .OR. TTORQ.L   06/11/75
     2E.0. .OR. TRCOR.LE.0..OR.TCASE.LT.1.55.OR.TCASE.GT.2.22)GO TO 120    11/07/75
      HPT      = HP * CATAIN(38) + HPT                                      06/11/75
      CALL ROTOR (2)
      IF (CATAIN(40) .LE. 0.) RETURN                                        08/20/75
      CALL GRBOXN (IFIX(DATAIN(40)),HP,CATAIN(67),0.,0.)                    09/25/75
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```
      RETURN                                                            00000920
   30 IF (DATAIN(42) .EQ. 0.) RETURN                                    00000930
      CALL SHTR                                                         00000940   08/16/75
      RETURN                                                            00000950
  100 WRITE (NP,110)                                                    00000960   06/11/75
  110 FORMAT (/53H MAIN ROTOR NOISE NOT CALCULATED BECAUSE OF ERROR IN 100000970   06/11/75
     1NPUT DATA)                                                        00000980   06/11/75
      GO TO 15                                                          00000990   06/11/75
  120 WRITE (NP,130)                                                    00001000   06/11/75
  130 FORMAT (/63H TAIL ROTOR NOISE NOT CALCULATED BECAUSE OF ERROR IN 100001010   06/11/75
     1NPUT DATA)                                                        00001020   06/11/75
      RETURN                                                            00001030   06/11/75
      END                                                               00001040
```

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DESCRIPTION        ROTOR - MAIN TAIL ROTOR NOISE

MASTER FILE        LIBR.G04
ADDED TO MASTER    05/16/75
LAST DATE COPIED    NONE
LAST UPDATE        04/14/76  1653          *** TEMPORARY UPDATE ***

PASSWORD           GTZD
PROGRAMMER         F.W.BARRY
PROC PARAMETER     $ACJCL

      SUBROUTINE ROTOR (IR)
C       IR = 1 FOR MAIN ROTOR , = 2 FOR TAIL ROTOR
C SOURCE: SUBROUTINES ARE BASICALLY TAKEN FROM DEPARTMENT OF
C         TRANSPORTATION REPORT DOT-TSC-OST-73-19, 'PREDICTION OF
C         V/STOL NOISE FOR APPLICATION TO COMMUNITY NOISE
C         EXPOSURE' BY C.L.MUNCH, MAY 1973.
C         MODIFIED BY F.BARRY OF HS , MAY 1975
C
C  TITLE:     ROTOR
C
C  PURPOSE:   TO CALCULATE THE ONE-THIRD OCTAVE NOISE SPECTRUM GENERATED
C             BY A HELICOPTER MAIN AND TAIL ROTOR
C
C  ABSTRACT: ROTOR ROTATIONAL NOISE IS CALCULATED USING THE CLOSED-FORM
C             SOLUTION MENTIONED BY LOWSON AND OLLERHEAD IN REFERENCE 1.
C             THIS IS COMBINED WITH A BROADBAND NOISE SPECTRUM THAT IS
C             CALCULATED FROM THE EMPIRICAL EQUATION PRESENTED IN REF. 2
C             BUT CORRECTED TO ACCOUNT FOR DIRECTIVITY.
C             REQUIRED INPUT (VIA COMMON):
C               RCASE (TCASE)....MAIN (TAIL) ROTOR AIRLOADING K FACTOR
C               RETA  (TETA).....MAIN (TAIL) ROTOR RADIAL LOADING STATION
C               RBIGB (TBIGB)....NUMBER OF MAIN (TAIL) ROTOR BLADES
C               RBIGR (TBIGR)....MAIN (TAIL) ROTOR RADIUS
C               ROMEGN(TOMEGN)...MAIN (TAIL) ROTOR ROTATIONAL SPEED
C               RSID  (TSID).....MAIN (TAIL) ROTOR DISK INCIDENCE ANGLE
C               RCHORD(TCHORD)...MAIN (TAIL) ROTOR BLADE CHORD
C               RTHRUS(TTHRUS)...MAIN (TAIL) ROTOR THRUST
C               RTORQ (TTORQ)....MAIN (TAIL) ROTOR TORQUE
C               RBETA (TBETA)....MAIN (TAIL) ROTOR CONING ANGLE
C               RTWIST(TTWIST)...MAIN (TAIL) ROTOR TWIST
C               CORLCM(CORLCT)...MAIN (TAIL)
C                     (TRCOR)....     (TAIL) ROTOR NUMBER OF HARMONICS
C             BIGV  FLIGHT SPEED , FPS
C                   NUMBER OF ROTORS
C      REQUIRED INPUT VIA COMMON /DATA/
C             SAZ  SPEED OF SOUND , FPS
C
C  SUBROUTINES CALLED:  BJSIGN   BESJH    PNLC                      08/15/75
C     CALLED BY HELI                                                08/15/75
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```
C
      DIMENSION PSCP(60),SFM(60),ALC(61),ALD(61),ALT(61),SCURVE(39),
     1 OLKP(15,30),TEMP2(30),TEMP3(30),CATAIN(76),ROLTP3(15,30),NAME(2)     02/10/76
      COMMON / JNX / BES(45C)
      COMMON /DATAI/ CATAIM(3),BIGV,A(45),KCASE,RETA,RHIGB,RBIGR,ROMEGN,
     1RSID,RCHORD,RTHRUS,RTORQ,RBETA,RTWIST,CCRLCM,RNGOX,TCASE,TETA,
     2TBIGB,THIGR,TCMEGN,TSID,TCHORC,TTHRUS,TTORQ,TBETA,TTWIST,CORLCT,
     3TRCOR,TNGOX
      COMMON /DATA/ ANGLE(15),FCK3(30),NR,NP,SAZ,HOL(20),DATE(2),TIME(2)
     1,ATTAT(30),SPLT(15,30),SPLTU(15,3C),DBNU(7),XO(15),XC(15),ZO(15),
     2 PSI(15),CO(15),DDO(15),HPI,TR,VELFL,VM(15),PWLT(15,30)            06/25/75
      EQUIVALENCE (CATAIN(1),DATAIN(1))
      CATA NAME / 4HMAIN,4HTAIL/                                         02/11/76
C
C 1/3-OCTAVE SPECTRUM SHAPE FOR BROADBAND NOISE CALCULATIONS IS ARRAY
C SCURVE.  SCURVE(17) IS THE BAND CONTAINING THE STRCUHAL FREQUENCY.
C CORRECTIONS ARE REFERENCED TO SPL IN BAND CONTAINING STROUHAL FREQUENC
      CATA  SCURVE          / -21.1, -20.0, -18.5, -17.1, -16.0,
     1     -14.5, -13.1, -12.C, -10.4, -9.1,  -7.9,  -6.5,  -5.1,
     2-4.., -2.8,  -1.1,  0.0,   -1.1,  -2.9,  -4.C,  -4.1,  -4.3,
     3     -4.5,  -6.0,  -7.4,  -9.0,  -9.3,  -9.7,  -10.0, -11.3,
     4     -12.7, -14.0, -15.3, -15.7, -18.0, -19.3, -20.7, -22.0,
     5     -23.3 /
C
C SET PROGRAM CONSTANTS
C
      DATA DTR,PI,HALFPI,PIO30,TWOPI,        TWO16,TWO13,TWO23 / .0174532   09/05/75
     1925,3.14159265,1.5707963,.104719755,6.2831853,          1.1224620     09/05/75
     25,1.25992105,1.58740105 /
      NPP=1
      MLIMIT = 2C
      XML     = 20.
      CHN     = C.
      IF (IR.EQ.1) GO TC 30
C     FREE-AIR TAIL ROTOR
   20 CASE=TCASE
      ETA=TETA
      BIGBR = TBIGB
      BIGR=TBIGR
      CMEGN=TCMEGN
      SID=TSID
      CHCROR = TCHORC
      THRUSR = TTHRUS
      TORCUE=TTORQ
      TWIST = ABS(TTWIST)
      CCNLC = CORLCT
      BETA=TBETA
      BIGY     = CATAIN(7)
      BIGZ     = -200.
      IF (CATAIN(38) .GT. 1.) CBN = CBNU(IFIX(DATAIN(38)-.9))
      GO TO 40
```

```
C     MAIN ROTOR
   30 CASE=RCASE
      ETA=RETA
      BIGBR = RBIGB
      BIGR=RBIGR
      OMEGA=ROMEGN
      SID=RSID
      CHCROR = RCHORD
      THRUSR = RTHRUS
      TORQUE=RTORQ
      CONLC = CORLCM
      TWIST = ABS(RTWIST)
      BETA=RBETA
      BIGY    = 200.
      BIGZ    = DATAIN(7)
      BIGMF=BIGV/SAZ
      BMFSQ=BIGMF*BIGMF
      IF (DATAIN(34) .GT. 1.) DBN = DBNU(IFIX(DATAIN(34)-.9))
   40 BIGM    = OMEGA*ETA*PIC30*BIGR/SAZ
      BPF     = OMEGN * BIGBR / 60.
C
C CALCULATE THE MAXIMUM NUMBER OF SOUND HARMONICS THAT CAN BE CALCULATED
C FROM 60 LOADING HARMONICS
C
      LLIMIT = XML * BIGBR * (1.0 + BIGM) + 0.5
      IF (LLIMIT.LT.60) GO TO 50
      LLIMIT=60
      MLIMIT = LLIMIT / ( BIGBR * (1.0 + BIGM) + 0.5)
   50 LI=LLIMIT+1
      XLL=LLIMIT
      K=1
      ETARN=1.0/(ETA*BIGR)
      ALT(1) = THRUSR
C CALCULATE STEADY AND FIRST HARMONIC LOADING
      ALD(1)=TORQUE*ETARN
      ALC(1) = THRUSR * SIN(BETA * DTR)
      ALT(2) = ALT(1)/4.0
      ALD(2) = ALD(1)/4.0
      ALC(2) = ALC(1) / 4.0
      DO 60 LK=3,61
      PWRK=CONLC/((LK-1)**CASE)
      ALT(LK)=ALT(1)*PWRK
      ALD(LK)=ALD(1)*PWRK
   60 ALC(LK)=ALC(1)*PWRK
      OMEGA   = PIO30 * OMEGN
      XX      = OMEGA * BIGBR / TWOPI
      OMEGR=OMEGA*BIGR
      CC      = 0.5 * XX / SAZ
      EXPK=2.0*CASE
      AL=2.0-EXPK
C
```

```
C CALCULATE VORTEX NOISE CONSTANT TERMS
C
      VTLG=20.0*ALOG10(CMEGR)
      TLG = 20. * ALOG10(THRUSR)
      BLG = 10. * ALCG10(BIG2R)
      RLG=10.0*ALOG10(BIGR)
      CLG = 10. * ALCG10(CHORCR/12.)
      FCKZ = 0.764 * CMEGR - 240. * ALOG10(THRUSR) + 786.C
       FCKZ1 = 1.0/(TWO16 * FCKZ)
       FCKZ2 = TWC16 / FCKZ
      RMT=CMEGR/SAZ
      XMACH=(1.0+RMT)**2
      XMACHM=(1.0-RMT)**2
C
C SFLVCO IS COMPCNENT CF 1/3-OCTAVE BANC CCNTAINING THE STROUHAL
C FREQUENCY. CONSTANT 16.73 IS COMPOSITE THAT HAS REFERENCE DISTANCE (R.
C ANC CBSERVATICN ANGLE (THETA=10DEG) AND TWIST(TWIST=6C=G) INCLUDED WIT
C BASE TERM K=41.5 FRCM CRIGINAL EQUATICN FOR OCTAVE SPL.
C
      SFLVCO = VTLG + TLG - BLG -RLG - CLG - .56*TWIST + 16.73
      NBIGB = BIGBR + 0.CCC1
C
C CALCULATE SMALL-X, SMALL-Y, PHI, X-PRIME, R-PRIME, AND SAMLL-R1
C
      DO 520 IA=1,15
      BIGX     = XO(IA)
      DUM      = (BIGX*BMFSQ+BIGMF*SQRT(BIGX**2+(1.-BMFSQ)*(BIGY**2+BIGZ*
     1*2))) / (1.-BMFSQ)
      BIGXP=BIGX+CUM
      COSINE=CCS(SID*DTR)
      SINE=SIN(SID*CTR)
      DUM1=BIGY
      DUM2=BIGXP*CGSINE+BIGZ*SINE
      IF (CUM1)70,70,110
   70 IF (CUM2)8C,9C,100
   80 PHI=ATAN(ABS(DUM1/DUM2))
      GC TO 150
   90 PHI=HALFPI
      GO TC 150
  100 PHI=ATAN(ABS(DUM1/DUM2))
      PHI=PI-PHI
      GO TC 150
  110 IF (DUM2)12C,13C,140
  120 PHI      = TWOPI - ATAN(ABS(DUM1/DUM2))
      GO TO 150
  130 PHI      = 4.71238898
      GO TO 150
  140 PHI=PI+ATAN(ABS(DUM1/DLM2))
  150 SX       = BIGXP*SINE - BIGZ-COSINE
      SY=-DUM2*CCS(PHI)-BIGY*SIN(PHI)
      SRP=SQRT(BIGXP**2+BIGY**2+BIGZ**2)
```

```
      BIGMZ=BIGMF*BIGXP/(SRP)
      XF=XX/(1.0-BIGMZ)
      SR=SRP*(1.0-BIGMZ)
      C1=CC/SR
      CCN2=SX/SR
      CCN4=SY/(2.0*SR)
      DARG=ABS(BIGZ/SRP)
C
C CALCULATE VORTEX DIRECTIVITY ANGLE AND CONSTANT TERMS
C
      THET = SQRT(ABS(1.-DARG**2))
      IF (THET.GT.DTR) GO TO 160
      EKAPPA=HALFPI
      GO TO 170
  160 TNUM = DARG / THET
      EKAPPA=ATAN(TNUM)
  170 ATHETA=EKAPPA-SID*DTR
      ALPHA=HALFPI-ATHETA
C
C THET AND THETLG ACCOUNT FOR DIRECTIONALITY AS PROPOSED BY OLLERHEAD
C AND LOWSON, 'PROBLEMS OF HELICOPTER NOISE ESTIMATION AND REDUCTION'
C AIAA PAPER NO. 69-195, FEBRUARY 1969. TERM 0.1 CORRECTS DISCONTINUITY.
C
      THET = COS(ALPHA) * COS(ALPHA)  +  0.1
      THETLG = 10.0 * ALOG10(THET)
      SRPLG=20.0*ALOG10(SRP)
      SPLVLG=SPLVCO+THETLG-SRPLG
      DO 9170 IV=1,60
 9170 PSQP(IV) = 0.0
C
C START SOUND HARMONIC LOOP
      DO 210 M=1,MLIMIT
      TSSQ=0.
      XM=FLOAT(M)
      SFM(M)=XF*XM
      N=M*NBIGB
      XN=FLOAT(N)
      CON1=C1*XM
      CCN3=1.0/(XN*BIGM)
      CCN5=CCN1*CCN2
      CCN6=CCN1*CCN3
      CCN7=CCN1*CCN4
      CALL BESJF (XN*BIGM*SY/SR,N+L1,BES,ER,450,NP)
C
C BEGIN LOADING HARMONIC LOOP
C
      DO 200 L=1,L1
      LL=L-1
      ARG=LL*PHI
      COSL=COS(ARG)
      SINL=SIN(ARG)
```

```
      K1=N+LL
      K2=N-LL
      K3=K1+1
      K4=K1-1
      K5=K2+1
      K6=K2-1
      EE=1.0
      IF(LL .NE. 2*(LL/2))EE=-1.0
C
C TRANSFORM LOADINGS FROM X,Y,Z SYSTEM TO SX,SY SYSTEM
C
      AT=ALT(L)*COSL
      AD=ALD(L)*COSL
      AC=ALC(L)*COSL
      BT=ALT(L)*SINL
      BD=ALD(L)*SINL
      BC=ALC(L)*SINL
C
C CALCULATE REQUIRED BESSEL FUNCTION VALUES
C
      CALL BJSIGN(K1,BJ1)
      CALL BJSIGN(K2,BJ2)
      CALL BJSIGN(K3,BJ3)
      CALL BJSIGN(K4,BJ4)
      CALL BJSIGN(K5,BJ5)
      CALL BJSIGN(K6,BJ6)
C
C CALCULATE TERM VALLES
C
      DUM1=(XN+LL)*BJ1
      DUM2=(XN-LL)*BJ2*EE
      DUM3=BJ3-BJ4
      DUM4=EE*(BJ5-BJ6)
      ANLT=CON5*AT*(BJ1+EE*BJ2)
      ANLD=CON6*AD*(DUM1+DUM2)
      ANLC=CON7*AC*(DUM3+DUM4)
      BNLT=CON5*BT*(BJ1-EE*BJ2)
      BNLD=CON6*BD*(DUM1-DUM2)
      BNLC=CON7*BC*(DUM3-DUM4)
      DUM5=ANLT-ANLC+BNLC
C
C DETERMINE IF N+LL IS OCC CR EVEN
C
      IF (K1.NE.2*(K1/2)) GC TO 180
C
C N+LL IS EVEN
C
      E1 = 1.0
      MX=K1/2
      IF(MX .NE. 2*(MX/2))E1=-1.0
      ANL = E1 * (BNLT - BNLD - ANLC)
```

```
      BAL = E1 * DUM5
      GO TO 190
C
C N+LL IS ODD
C
  180 E1=1.
      MK=K4/2
      IF(MK .NE. 2*(MK/2))E1=-1.C
      ANL = E1 * DUM5
      BNL = E1 * (-BNLT + BNLD + ANLC)
  190 SPSQ=ANL*ANL+BNL*BAL
  200 TSSQ=TSSQ+SPSQ
C
C ENC LOADING HARMONIC LOOP
C
      GGM=TSSQ+1.0E-20
      PM = 10.0 * ALCG10(GGM) + 124.58
  21C PSCP(M) = PM + DBN
C
C END OF SOUND HARMCNIC LOCP
C
C CALCULATE BIG K FOR HIGHER HARMCNICS
C
      XMB = MLIMIT * BIGBR
      XMB=XMB**AL
      BIGK = GGM/XMB
C
C CALCULATE SOUND HARMCNICS FROM MLIMIT TO 60
C
      RLGK=ALOG10(BIGK)+12.458
      MIN=MLIMIT+1
      DO 220 M=MIN,60
      F=XF*M
      XMB = M * BIGBR
      PM=10.0*(AL*ALOG10(XMB)+RLGK)
      SFM(M)=F
  220 PSCP(M) = PM + CBN
  235 IF(IX .NE. 2) GO TO 237
      ITRCOR = TRCCR + 1.0C01
      IF(ITRCOR .GE. 60) GO TO 237
      DC 236 M = ITRCOR,60
  236 PSQP(M) = 0.
  237 IF (DATAIN(6) .EQ. 3.) WRITE (NF,238) ANGLE(IA),BPF,PSQP
C     PRINT ROTCR HARMCNICS
  238 FCRMAT(/66H ROTOR HARMCNICS 1-60 WITHOLT ATMOSPHERIC ATTENUATION F
     1OR ANGLE CF,F6.1,31H ANC BLADE PASSING FREQUENCY OF,F6.1,7H HZ ARE
     2,3(/5X,20F6.1),3H DB)
C
C END OF SOUND HARMCNIC CALCULATION
C
C     ADD HARMCNIC NOISE TO PWLT
```

06/25/75

```
      JFC      = 1                                                        06/25/75
      F        = BPF                                                      06/25/75
      DO 239 J=1,30                                                       06/25/75
      IF (JFC.GT.60 .OR. PSQP(J).EQ.0. .OR. FCK3(J)/.794.LT.F) GO TO 239  06/25/75
      PWLT(IA,J) = PWLT(IA,J)+10.**((PSQP(JFC)+DBN-ATTNT(J)*ZO(IA))/10.)  06/25/75
      JFC      = JFC + 1                                                  06/25/75
      F        = F + BPF                                                  06/25/75
  239 CONTINUE                                                            06/25/75
C BEGIN CALCULATION OF ONE-THIRD OCTAVES OF ROTATIONAL NOISE BY
C COMPARING FREQUENCY OF THE 60-TH HARMONIC TO THE 1/3-OCTAVE CENTER
C FREQUENCIES TO DETERMINE THE BAND THAT CAN BE CALCULATED BY
C SUMMING HARMONIC LEVELS.  THE CENTER FREQUENCY OF THIS BAND IS
C CALLED FCC AND THE BAND NUMBER IS JFC.
C
      DUM = SFM(60) / 1.6
      DO 240 J=1,30
      IF (DUM.LT.FCK3(J)) GO TO 250
  240 CONTINUE
      J        = 31
  250 JFC = J - 1
      SMK=CASE
      DO 270 KL=1,30
      TEMP2(KL) = 0.0
      TEMP3(KL) = 0.0
  270 CLKP(IA,KL)  = 0.
C
C CALCULATE 1/3-OCTAVE LEVELS UP TO BAND JFC BY SUMMING HARMONICS.
C AFK VALUES ARE ATTENUATIONS DUE TO FILTER SHAPE ASSUMED
C
      DO 320 M=1,60
      PS=PSQP(M)
      F=SFM(M)
      DO 320 KL=1,JFC
      IF (F.GE.FCK3(KL)) GO TO 280
      DUM=133.0*ALOG10(F/FCK3(KL))
      AFK=DUM+3.65
      GO TO 290
  280 DUM=133.0*ALOG10(FCK3(KL)/F)
      AFK=DUM+3.65
  290 IF (AFK.LE.0) GO TO 320
      AFK=0.
  320 CLKP(IA,KL) = CLKP(IA,KL) + 10.**((PS+AFK)/10.)
      DO 350 KL=1,JFC
  350 GLKP(IA,KL) = 10.*ALOG10(AMAX1(1.E-20,CLKP(IA,KL))) + DBN
      MIN=JFC+1
      DXX=TWO16*SFM(1)
      DXX=1.0/DXX
C
C CALCULATE 1/3-OCTAVE BANDS ABOVE ONE AT FCC
C
      DO 380 KL=MIN,30
```

```
      FNN = FCK3(KL-1) * DXX
      NN = FNN
      NMIN=NN+1
      NMAX = TWO13 * FNN
      SUM=0.0
      DO 360 J=NMIN,NMAX
  360 SUM=SUM+J**AL
      XDEN = SUM
      SUM=0.0
      NMIN = TWO13 * FNN + 1.0001
      NMAX = TWO23 * FNN
      DO 370 J=NMIN,NMAX
  370 SUM=SUM+J**AL
  380 OLKP(IA,KL) = CLKP(IA,KL-1) + 10.*ALOG10(SUM/XDEN)
      DO 390 KL=MIN,30
  390 OLKP(IA,KL) = OLKP(IA,KL) + CBN
C
C
C END CALCULATION OF 1/3-OCTAVE BANDS OF ROTATIONAL NOISE
      IF (CATAIN(6) .NE. 3.) GO TO 395
      DO 394 IV=1,30
  394 TEMP3(IV)     = CLKP(IA,IV)
C
C BEGIN CALCULATION OF VORTEX NOISE
C
  395 IF (FCKZ .GT. 50.) GO TO 400
      INTVAL = 1                                                        06/25/75
      GO TO 420
  400 INTVAL = 30
      DO 410 I=1,30
      FLR = FCK3(I) / TWO16
      FUPR = FCK3(I) * TWO16
      IF (FCKZ.LT.FLR) GO TO 410
      IF (FCKZ.GT.FUPR) GO TO 410
      INTVAL = I
      GO TO 420
  410 CONTINUE
  420 IPTR = 17 - INTVAL
      DO 430 KL=1,30
      IPTRR = KL + IPTR
      IF(IPTRR.LT.1)IPTRR=1
      IF( IPTRR .GT. 39 ) IPTRR = 39
      TEMP2(KL)     = SPLVLG + SCURVE(IPTRR) + CBN
      OLKP(IA,KL) = 10.**(TEMP2(KL)/10.) + 10.**(OLKP(IA,KL)/10.) +
     1            10.**(-ATTNT(KL)*SRP)
C     ADD TO VEHICLE TOTAL NOISE
      SPLT(IA,KL)  = SPLT(IA,KL)  + OLKP(IA,KL)
      PWLT(IA,KL) = PWLT(IA,KL) +10.**((TEMP2(KL)-ATTNT(KL)*ZO(IA))/10.)
      IF (CATAIN(6) .EQ. 0.) GO TO 430                                  06/25/75
      CLKP(IA,KL) = 10.*ALOG10(AMAX1(1.E-20,OLKP(IA,KL)))
  430 CONTINUE
```

```
C
C END VCRTEX NOISE CALCULATICN
C
      IF (CATAIN(6) .NE. 3.) GO TO 520
      DC 50C KL=1,30
      TEMP2(KL) = TEMF2(KL) - ATTNT(KL) * SRP
  500 TEMP3(KL) = TEMP3(KL) - ATTNT(KL) * SRP
      WRITE (NP,510) ANGLE(IA),(FCK3(KL),TEMP3(KL),TEMP2(KL),KL=1,30)
  510 FCRMAT(/17X,87HHELICCPTER RCTCR ROTATICNAL ANC BRCADBAND NCISE IN
     11/3-OCTAVE BANDS AT AZIMUTH ANGLE OF ,F5.0,4H DEG / 130H FREQUENCY
     2 RGTATICNAL BRCACEAND   FRECUENCY RCTATIONAL ERCACBAND   FREQUENCY
     3 RCTATIONAL BROACBAND   FRECUENCY RCTATICNAL BROACBAND /,15(/,F10.
     41,2F9.1,F15.1,2F9.1,F15.1,2F9.1,F15.1,2F9.1)/)
  520 CCNTINUE
C     FINISHED RCTOR ROTATIONAL (TEMP3), BRCACBAND (TEMP2) AND TOTAL
C     (OLKP) NOISE FOR 30 FREQUENCIES ANC 15 AZIMUTH ANGLES
      IF (CATAIN(6) .EQ. 0.) RETURN
      IF (IR .EQ. 2) GO TO 540                                         02/10/76
      DO 530 J=1,30                                                    06/25/75
      DO 530 I=1,15                                                    06/25/75
  530 ROLTP3(I,J) = CLKP(I,J)
  540 WRITE (NP,545) NAPE(IR)                                          02/10/76
  545 FCRMAT (//,50X,11HHELICOPTER ,A4,12H RCTOR NOISE)                02/11/76
      CALL PNLC (CLKP)                                                 02/10/76
      IF (IR .EQ. 1) RETURA
      DO 550 J=1,30                                                    06/25/75
      CO 550 I=1,15                                                    06/25/75
  550 RCLTP3(I,J) = 10.*ALOG10(AMAX1(1.E-20,10.**(ROLTP3(I,J)/10.) +
     1 10.**(OLKP(I,J)/10.)))
      WRITE (NP,560)                                                   02/10/76
  560 FURMAT (1H1,40X,46HHELICOPTER MAIN PLUS FREE-AIR TAIL ROTOR NOISE)  02/10/76
      CALL PNLC (ROLTP3)
      RETURN
      END
```

```
DESCRIPTION         BJSIGN - SIGN OF BESSEL FCN. J

MASTER FILE         LIBR.G04
ADDED TO MASTER     05/16/75
LAST DATE COPIED      NONE
LAST UPDATE         04/14/76  1653            *** TEMPORARY UPDATE ***

PASSWORD            LLLK
PROC PARAMETER      $NOJCL

      SUBROUTINE BJSIGN(K,B)
C
C  TITLE:    BJSIGN
C
C  PURPOSE:  TO DETERMINE THE VALUE OF A BESSEL FUNCTION OF THE FIRST
C            KIND
C
C  ABSTRACT: THE VALUE OF THE K-TH ORDER BESSEL FUNCTION IS DETERMINED
C            FROM A PREVIOUSLY CALCULATED SET OF VALUES FOR A SPECIFIED
C            ARGUMENT.  THE ARITHMETIC SIGN OF THE FUNCTION IS
C            CALCULATED FROM THE SIGN OF THE ORDER VALUE.
C
C  USAGE:    ......(K,B)
C            K...INPUT VALUE OF THE BESSEL FUNCTION ORDER
C            B...BESSEL FUNCTION VALUE RETURNED
C
C
C  SUBROUTINES CALLED:  NONE
C     CALLED BY HELI                                                    08/15/75
C
      COMMON / JNX / BES(450)
      A=1.0
      IF (K.GE.0) GO TO 10
      K=IABS(K)
C
C IF THE ORDER (K) IS NEGATIVE AND ODD THEN THE FUNCTION VALUE IS
C MULTIPLIED BY -1.
C
      IF(K .NE. 2*(K/2)) A=-1.0
   10 B=A*BES(K+1)
      RETURN
      END
```

Subroutine FPFAN

This routine is used to calculate the noise of fixed-pitch fans. It also adjusts the fan noise spectra for acoustic treatment.

```
RUN NC. 5717     DATE  04/14/76     TIME  1653              LISTING OF MODULE H894H

DESCRIPTICN          FPFAN - FIXED-PITCH FAN NOISE

MASTER FILE          LIBR.G04
ACCED TO MASTER      05/16/75
LAST CATE COPIED       NCNE                    *** TEMPORARY UPCATE ***
LAST UPCATE          04/14/76   1653

PASSWCRC             FZNT
PROGRAMMER           F.W.BARRY
PROC PARAMETER       $NOJCL

                                                                         00000010       09/29/75
      SUBROUTINE FPFAN                                                   00000030       09/25/75
C     CALCULATES FIXED-PITCH FAN NOISE , REF. NASA CR-114649 ,SECT.5.2.400000030
C     FPFAN CALLS GAAFPF, PNLC, REVN, TREAT, COENG, GRBCXN, JETN;        00000040       09/25/75
C     CALLED BY MAIN                                                     00000050       09/25/75
      DIMENSION         CLF(4),YES(2),ATN150(30),SPL(15,30),DDB(15)      00000060       09/25/75
     1 ,Q1(15),Q2(15),FHOL(15,4),SPL34(15,30),SPL36(15,30),SPL38(15,30),C00000070      09/25/75
     2 SPL39(15,30),SPL40(15,30),PWLI(30),PWLE(30),SPL34D(15,30),        00000080       09/25/75
     3 SPL36D(15,3C),SPL38D(15,30),SPL39D(15,30),SPL40D(15,30),CI(15,30)C00000090      09/26/75
     4,CE(15,30),DENG(10),PRSTDS(3),BENG(6),TRSS(3),TB(3),PRSTOP(3)      00000100
      CCMMCN /CATA/ ANGLE(15),BCFR(30),NR,NP,C,HOL(20),DATE(2),TIME(2),  00000110
     1 ATTNT(30),SPLT(15,30),SPLTU(15,3C),DBNU(7),XO(15),XD(15),ZO(15),  00000120       09/25/75
     2 PSI(15),CO(15),DDO(15),HPT,TR,VELFL,VM(15),PWLT(15,30),           00000130       09/25/75
     3 DIRIN(498),DIREX(498),   F(31),DPWSP(15),RPMG,DHPT,RRPM,CSUM(15)  00000140       09/25/75
      CCMMCN /DATAI/CA(300)                                              00000150       09/25/75
      EQUIVALENCE (C,CA(78)),(VC,DA(80)),(VNSTG,DA(79)),(CA(218),DENG(1)00000160       09/25/75
     1),(CA(83),PRSTDS(1)),(DA(86),TRSS(1)),(DA(89),TB(1)),(DA(92),QIGV)C00000170       09/26/75
     2,(CA(77),TSDS),(CA(81),PCTTH),(DA(229),BENG(1))                    00000180
      DATA DLF / 0.,.16666666,.33333333,1./                              00000190
      DATA YES / 4H   NO,4HWITH/                                         00000200
C     ATMOSPHERIC ATTENUATICN FOR 59F, 70PCT REL.HUM. AND 150 FT         00000210
      CATA ATN150 / .00537,.00677,.00860,.01075,.01355,.01721,.02153,.02C00000220
     1692,.03449,.04316,.054C2,.06818,.C8679,.10877,.13751,.17545,.2205100000230
     2,.27753,.35867,.45683,.60332,.81539,1.14517,1.36199,1.90627,2.782200000240
     35,4.11427,5.84059,8.59953,12.44500 /                               00000250
      DATA FHOL /4HSHOR,4HT FA,4HN DU,4HCTS ,4H    ,4H    ,4H    ,4H     00000260
     1.    ,4H    ,4H    ,4H    ,4H    ,4H    ,4H    ,4H3/4-,4HLENG00000270
     2.    4HTH F,4HAN D,4HUCTS,4H    ,4H    ,4H    ,4H    ,4H    ,4H    00000280
     3.    4H    ,4H    ,4H    ,4H    ,4HLCNG,4H FAN,4H DUC,4HTS W,4HITH 00000290
     4.    4HCOPL,4HANAR,4H PRI,4HMARY,4H/SEC,4HCNDA,4HRY N,4HOZZL,4HE EX00000300
     5.    4HITS ,4HLCNG,4H FAN,4H DUC,4HTS W,4HITH ,4HA RE,4HTRAC,4HTED 00000310
     6.    4HPRIM,4HARY ,4HNOZZ,4HLE (,4HJT8D,4H)    ,4H    /              00000320
C        77 TSDS     DESIGN TIP SPEED , FPS                              00000330       09/25/75
C        78 D        FAN DIAMETER , FT                                   00000340       09/25/75
C        79 VNSTG    NUMBER OF FAN STAGES , 1. TO 3.                     00000350       09/25/75
C        80 VC       =1. FOR SHORT FAN DUCT                              00000360       09/25/75
C                    =2. FOR 3/4-LENGTH DUCT                             00000370       09/25/75
C                    =3. FOR LONG FAN DUCTS WITH COPLANAR PRIMARY /      00000380       09/25/75
C                             SECCNDARY NOZZLE EXITS                     00000390       09/25/75
C                    =4. FOR LONG FAN DUCTS WITH RETRACTEC PRIMARY NOZZLE 00000400       09/25/75
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C                    (JT8D)                                                   09/25/75
C     81 PCTTH  OPERATING THRUST / DESIGN THRUST                              09/25/75
C     82 HOT    HUB / TIP DIAMETER RATIO , DEFAULT = .4                       09/25/75
C     83 PRSTDS DESIGN PRESSURE RATIO OF FIRST STAGE , 1.1 TO 1.75            09/25/75
C     84        DESIGN PRESSURE RATIO OF SECOND STAGE (IF 79 = 2 OR 3)        09/25/75
C     85        DESIGN PRESSURE RATIO OF THIRD STAGE (IF 79 = 3.)             09/25/75
C     86 TRSS   ROTOR-STATOR SPACING IN PERCENT , STAGE 1                     09/25/75
C     87        ROTOR-STATOR SPACING IN PERCENT , STAGE 2                     09/25/75
C     88        ROTOR-STATOR SPACING IN PERCENT , STAGE 3                     09/25/75
C     89 TB     NUMBER OF BLADES IN STAGE 1                                   09/25/75
C     90        NUMBER OF BLADES IN STAGE 2                                   09/25/75
C     91        NUMBER OF BLADES IN STAGE 3                                   09/25/75
C     92 QIGV   =0. IF NO IGV , =1. IF IGV                                    09/25/75
C    152        MACH NUMBER IN NEAR SONIC INLET IF GT.4. LT.1                 09/25/75
C    211        INLET TREATMENT LENGTH , PERCENT OF DIAMETER                  09/25/75
C    212        EXHAUST TREATMENT LENGTH , PERCENT OF DIAMETER                09/25/75
C    213        DOF , 1. OR 2.                                                09/25/75
C    214        NUMBER OF INLET SPLITTERS                                     09/25/75
C    215        NUMBER OF EXHAUST SPLITTERS                                   09/25/75
C    216        = 0. IF SHAFT DRIVE , =1. IF INTEGRAL ENGINE                  09/25/75
C    217        =0. IF USE TYPICAL TURBOSHAFT ENGINE , =1. IF USE:            09/25/75
C    218 RPMC   COMPRESSOR RPM                                                09/25/75
C    219 D      COMPRESSOR DIAMETER , FT                                      09/25/75
C    220 FPR    COMPRESSOR FIRST-STAGE PRESSURE RATIO                         09/25/75
C    221 RSS    COMPRESSOR FIRST-STAGE ROTOR-STATOR SPACING IN PERCENT        09/25/75
C    222 BC     COMPRESSOR FIRST-STAGE NUMBER OF BLADES                       09/25/75
C    224 P3     COMBUSTOR INLET TOTAL PRESSURE , PSF                          09/25/75
C    225 T3     COMBUSTOR INLET TOTAL TEMPERATURE , DEG R                     09/25/75
C    226 T4     COMBUSTOR EXIT TOTAL TEMPERATURE , DEG R                      09/25/75
C    227 QMA    COMBUSTOR MASS FLOW RATE , LB/SEC                             
C    228 QMT    TURBINE MASS FLOW RATE , LB/SEC                               
C    229 VTR    RELATIVE TIP SPEED OF LAST TURBINE ROTOR , FPS                
C    230 CL     SPEED OF SOUND AT TURBINE EXIT , FPS                          09/25/75
C    231 SOC    LAST STAGE STATOR-ROTOR SPACING / STATOR CHORD                09/25/75
C    232 VK     =0. FOR COPLANAR EXHAUSTS , -10. FOR RECESSED EXHAUST         09/25/75
C    233 BT     NUMBER OF BLADES IN LAST TURBINE ROTOR                        09/25/75
C    234 RPMT   TURBINE RPM                                                   09/25/75
C    235 THRT   JET THRUST , LB                                               09/25/75
C    236 AREA   JET AREA , SQ FT                                              09/25/75
      IF (DA(77).LE.0. .OR. DA(78).LE.0. .OR. VASTG.LE.0. .OR. VNSTG.GT.      09/25/75
     13. .OR. DA(80).LE.0. .OR. DA(80).GT.4. .OR. DA(81).LE.0. .OR. DA(8      09/25/75
     23).LT.1.1 .OR. DA(83).GT.1.75 .OR. TB(1).LT.2. .OR. (VNSTG.GT.1.        09/25/75
     3.AND. (DA(84).LT.1.1.OR.DA(84).GT.1.75)) .OR. (VNSTG.EQ.3. .AND.        09/25/75
     4DA(85).LT.1.1.OR.DA(85).GT.1.75))) GO TO 1000                           09/25/75
C     DEFAULT OPTION                                                          09/25/75
      DA(82)  = AMAX1(.4,DA(82))                                              09/25/75
      DA(223) = 0.                                                            09/25/75
      CALL GAAFPF (DA(77),D,VNSTG,PRSTDS,DA(82),DA(125),DA(126),DA(124),      09/25/75
     1B,B,I,1,ERRA,SHPDS,TNETDS,ZM2,A,DA(81),VELFL/1.6878,DA(1),DA(3),        10/09/75
     2PRSTOP,WFAN,VTCP,ZMZCP,ZMSTE,SHP,TNETOP,FPRO,PRCP)                      09/26/75
      IF (ERRA .NE. 0.) GO TO 1000                                            09/25/75
```

COPY AVAILABLE TO DDC DOES NOT PERMIT FULLY LEGIBLE PRODUCTION

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      CALL GAAFPF (CA(77),C,VNSTG,PRSTDS,DA(82),DA(125),CA(126),DA(124),C0000920   09/25/75
     18,B,I,2,ERRA,SHPDS,TNETDS,ZM2,A,DA(81),VELFL/1.6878,DA(1),DA(3),  00000930   10/09/75
     2PRSTOP,WFAN,VTOP,ZMZOP,ZMSTE,SHP,TNETCP,FFRO,PROP)                00000940   09/26/75
      IF (ERRA .NE. 0.) GO TO 1000                                      00000950   09/25/75
      IF (A.LE.0. .OR. WFAN.LE.0. .OR. SHP.LE.0. .OR. SHPDS.LE.0.) GO TO00000960   09/25/75
     11000                                                              00000970   09/25/75
      IF (CA(216) .NE. 0.) GC TO 3                                      00000980   09/25/75
C     SHAFT DRIVE                                                       00000990   09/25/75
      BPR      = 11.                                                    00001000   09/25/75
      CHPT     = DHPT + SHPDS*DA(22)                                    00001010   09/25/75
      HPT      = HPT + SHP*DA(22)                                       00001020   09/25/75
      RRPM     = VTOP / TSDS                                            00001030   09/29/75
      GO TO 6                                                           00001040   09/25/75
C     INTEGRAL DRIVE                                                    00001050   09/25/75
    3 IF (CA(217) .NE. C.) WENG = CA(227) * 1.175                       00001060   09/25/75
      C2       = AMAX1(SHP/SHPDS,.28)                                   00001070   09/25/75
      IF (DA(217) .EQ. 0.) WENG = 50.3 * (SHPDS/5070.) * ((.8052-.18339*00001080   09/25/75
     1C2)*C2+.382163)                                                   00001090   09/25/75
      IF (WENG .LE. 0.) GO TO 1000                                      00001100   09/25/75
      BPR      = AMAX1(0.,(WFAN-WENG) / WENG)                           00001110   09/25/75
    6 RPM      = 19.098593 * VTOP / D                                   00001120   09/25/75
      DRPM     = 19.098593 * TSDS / D                                   00001130   09/25/75
      QMTR     = SQRT ((VTOP/C)**2 + ZMZOP**2)                          00001140   09/25/75
C     VMTR =0. IF FIRST STAGE IGV, OTHERWISE FIRST STAGE RELATIVE TIP   00001150   09/25/75
C     MACH NUMBER, IF GT 1. COMBINATION TONE NOISE TO BE INCLUDED       00001160   09/25/75
      VMTR     = QMTR                                                   00001170   09/25/75
      IF (QIGV .EQ. 1.) VMTR = 0.                                       00001180   09/25/75
      DO 10 IA=1,15                                                     00001190
      DDB(IA) = 20.*ALOG10(150./ZO(IA))                                 00001200
      Q1(IA)  = 20. * ALOG10(C/VM(IA)**2)                               00001210
   10 Q2(IA)  = 10. * ALOG10(A/VM(IA)**4)                               00001220
C     CORRECT FOR NUMBER OF FANS                                        00001230
      CBN      = 0.                                                     00001240
      IF (DA(22) .GT. 1.) CBN = DBNU(IFIX(CA(22)-.9))                   00001250   09/29/75
      IC       = IFIX(VC)                                               00001260
C     BYPASS RATIO AND DUCT LENGTH CORRECTION                           00001270
      DL       = 0.                                                     00001280
      IF (BPR.GE.10. .OR. VC.EQ.1.) GO TO 30                            00001290
      IF (BPR .GT. .5) GC TO 20                                         00001300
      DL       = -7.8 * DLF(IC)                                         00001310
      GO TO 30                                                          00001320
   20 DL       = 6. * DLF(IC) * ALOG10(BPR/10.)                         00001330
C     IGV = 1 IF NO IGVS , = 2 IF IGVS                                  00001340
   30 IGV      = IFIX (QIGV+1.1)                                        00001350   09/25/75
      NSTG     = IFIX(VNSTG)                                            00001360
      DO 40 IF=1,30                                                     00001370   09/25/75
      DO 40 IA=1,15                                                     00001380   09/25/75
      SPL(IA,IF) = 0.                                                   00001390   09/25/75
      SPL340(IA,IF) = 1.E-6                                             00001400   10/04/75
      SPL360(IA,IF) = 1.E-6                                             00001410   10/04/75
      SPL380(IA,IF) = 1.E-6                                             00001420   10/04/75
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      SPL39D(IA,IF) = 1.E-6                                             10/04/75
      SPL40D(IA,IF) = 1.E-6                                             10/04/75
      SPL34(IA,IF) = 1.E-6                                              10/04/75
      SPL36(IA,IF) = 1.E-6                                              10/04/75
      SPL38(IA,IF) = 1.E-6                                              10/04/75
      SPL39(IA,IF) = 1.E-6                                              10/04/75
   40 SPL40(IA,IF) = 1.E-6                                              10/04/75
      WRITE (NP,50) HOL,DATE,TIME, D,CA(82),A,NSTG, (FHOL(J,IC),J=1,15),  09/25/75
     1 SHPDS,TNETDS,TJDS,DRPM,ZM2, SHP,TNETOP,VTOP,RPM,ZMZCP, PCTTH,PROP  09/25/75
     2,WFAN,BPR,CA(8)                                                   02/10/76
   50 FORMAT (1H1,44X,21HFIXED-PITCH FAN NOISE //1H ,20A4,2X,2A4,2X,2A4
     1// 11H DIAMETER =,F6.2,30H FT , HUB/TIP DIAMETER RATIO =,F6.3,23H   09/25/75
     2, FAN DISCHARGE AREA =,F7.2,8H SQ FT ,,I2,7H STAGES / 1X,15A4 //   09/25/75
     318H DESIGN CONDITIONS / 6H SHP =,F7.0,11H , THRUST =,F7.0,17H LB , 09/25/75
     4 TIP SPEED =,F6.0,12H FPS , RPM =,F7.0,32H FIRST STAGE INLET MACH  09/25/75
     5NUMBER =,F6.3 /21H OPERATING CONDITIONS / 6H SHP =,F7.0,11H , THRU 09/25/75
     6ST =,F7.0,17H LB , TIP SPEED =,F6.0,12H FPS , RPM =,F7.0,32H FIRST 09/25/75
     7 STAGE INLET MACH NUMBER =,F6.3 / 35H OPERATING THRUST / DESIGN TH 09/25/75
     8RUST =,F5.2,27H , OVERALL PRESSURE RATIO =,F6.2,13H , FAN FLOW =,F 09/25/75
     96.1,24H LB/SEC , BYPASS RATIO =,F6.2 / 14H SHAFT ANGLE =,F5.0)     02/10/76
      IF (TNETDS.LE.0. .OR. TNETOP.LE.0. .OR. FPRO.LE.1.) GO TO 1000     09/25/75
C     CROSS-FLOW CORRECTION TO FUNDAMENTAL TONES                        11/05/75
      CDBT     = 0.                                                     11/05/75
      FDB      = 0.                                                     11/13/75
      IF (VELFL .EQ. 0.) GO TO 55                                       11/13/75
      VL34     = CA(8)*.0174532925 - ATAN2(DA(5),DA(4))                 11/13/75
      VKTAS    = VELFL / 1.6878                                         11/05/75
      IF (VL34.GT.1.5708 .AND. VL34.LT.4.7129) VKTAS = 0.               11/05/75
      VL39     = AMIN1(.2,VELFL*ABS(SIN(VL34))/VTOP)                    11/05/75
      IF (VL39.GT..001 .AND. (VL34.LT.1.5708.OR.VL34.GT.4.7129)) DDBT = 11/05/75
     110.**((((1133.89*VL39-642.248)*VL39+125.104)*VL39)/10.)           11/05/75
C     FORWARD FLIGHT EFFECT ON DISCRETE TONE NOISE (EQNS. 36&40)        09/25/75
      IF (VMTR.LE.0. .OR. VMTR.GT.1. .OR. VELFL.LT.16.878) GO TO 55     09/25/75
      FDB      = .81                                                    09/25/75
      IF (VELFL .LT. 135.) FDB = .9*ALOG10(VELFL/16.878)                09/25/75
      IF (VMTR .GT. .7) FDB = 3.33*FDB*(1.-VMTR)                        09/25/75
C     DO EACH STAGE , FROM 1 TO NSTG
   55 DO 750 J=1,NSTG                                                   09/25/75
      FPR      = PRSTOP(J)                                              09/25/75
      RSS      = TRSS(J)                                                09/25/75
      B        = TB(J)                                                  09/29/75
      BPF      = RPM * B / 60.
C     PRINT STAGE DATA
      WRITE (NP,60) J,B,RSS,PRSTDS(J),FPR,BPF                           09/25/75
   60 FORMAT (/ 6H STAGE,I2,2H ,,F4.0,32H BLADES , ROTOR/STATOR SPACING
     1=,F6.1,32H%, DESIGN STAGE PRESSURE RATIO =,F4.1,35H , OPERATING ST 10/01/75
     2AGE PRESSURE RATIO =,F6.3 / 26H BLADE PASSING FREQUENCY =,F6.0,3H 09/25/75
     3HZ)                                                               09/25/75
      IF (J .EQ. 1) WRITE (NP,70) VMTR,FPRC,YES(IGV)
   70 FORMAT (27H RELATIVE TIP MACH NUMBER =,F6.3,13X,31HCRITICAL STAGE
     1PRESSURE RATIO =,F7.4 / 1H ,A4,18H INLET GUIDE VANES )
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06/11/75

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      IF (J.EQ.1 .AND. VMTR.GT.1.) WRITE(NF,80)
   80 FORMAT (43H COMBINATION-TONE (BUZZ-SAW) NOISE INCLUDED)
      IF (FPR.LE.1. .OR. RSS.LE.0. .OR. B.LT.2.) GO TO 1020
C         F1 (FIG.57) TERM -  BROADBAND INLET AND DISCHARGE NOISE IN
C      EQUATIONS 34 AND 39
      VL39     = ALOG10(FPR-1.)
      VL34     = 83. + 17.*VL39
      VL39     = 93. + 20.*VL39
C     ADD F2 (FIG.61) TERM TO EQUATIONS 34 AND 39
      IF (RSS .GT. 25.) GO TO 90
      VL34     = VL34 + 5.396
      VL39     = VL39 + 5.396
      GO TO 110
   90 IF (RSS .GT. 400.) GO TO 100
      C1       = 5. * ALOG10(300./RSS)
      VL34     = VL34 + C1
      VL39     = VL39 + C1
      GO TO 110
  100 VL34     = VL34 - .6247
      VL39     = VL39 - .6247
C     F1 (FIG.58) TERM FOR DISCRETE TONE INLET AND DISCHARGE NOISE IN
C      EQUATIONS 36 AND 40
  110 VL40     = 96.+ 20.*ALOG10(FPR-1.)
      IF (J.EQ.1 .AND. VMTR.GT.1.) GO TO 130
      IF (FPR .GE. 1.4) GO TO 120
      VL36     = 88. + 15.*ALOG10(FPR-1.)
      GO TO 150
  120 VL36     = 82.
      GO TO 150
  130 IF (FPRO .GT. 1.4) GO TO 140
      VL36     = 88. + 15.*ALOG10(FPRO-1.) - 30.4*ALOG10((FPR-1.)/(FPRO-
     1 1.))
      GO TO 150
  140 VL36     = 82. - 30.4*ALOG10((FPR-1.)/(FPRO-1.))
C     ADD F2 (FIG.61) TERM TO EQUATIONS 36 AND 40
  150 IF (RSS .GT. 25.) GO TO 160
      VL36     = VL36 + 10.792
      VL40     = VL40 + 10.792
      GO TO 180
  160 IF (RSS .GT. 400.) GO TO 170
      C1       = C1*2.
      VL36     = VL36 + C1
      VL40     = VL40 + C1
      GO TO 180
  170 VL36     = VL36 - 1.249
      VL40     = VL40 - 1.249
C     ADD IGV AND BYPASS-RATIO AND DUCT LENGTH CORRECTIONS TO DISCHARGE
C      NOISE
  180 VL39     = VL39 + DL/2.
      VL40     = VL40 + DL
      IF (J.EQ.1 .AND. IGV.EQ.1) GO TO 190
```

```
      VL39    = VL39 + 3.
      VL40    = VL40 + 6.
C     START LOOP FOR 15 AZIMUTH ANGLES
  190 DO 740 IA=1,15
C     ACD DIRECTIVITY CORRECTIONS IN FIGS. 63&64 TO EQNS. 34,36,39 & 40
C     ALSC ADD SIZE-DOPPLER CORRECTICN
C     INLET BROADBAND NCISE
      VL34A   = VL34 + Q1(IA)
      IF (PSI(IA) .LE. 60.) GO TO 240
      IF (PSI(IA) .GT. 70.) GO TO 200
      VL34A   = VL34A + 12. - .2*PSI(IA)
      GO TO 240
  200 IF (PSI(IA) .CT. 80.) GC TC 210
      VL34A   = VL34A + 19. - .3*PSI(IA)
      GO TO 240
  210 IF (PSI(IA) .GT. 90.) GO TC 220
      VL34A   = VL34A + 35. - .5*PSI(IA)
      GC TC 240
  220 IF (PSI(IA) .GT. 120.) GO TO 230
      VL34A   = VL34A + 44. - .6*PSI(IA)
      GC TO 240
  230 VL34A   = VL34A - 28.
C     INLET DISCRETE TONE NOISE
  240 VL36A   = VL36 + Q1(IA) + 2.
      IF (PSI(IA) .LE. 20.) GO TO 330
      IF (PSI(IA) .GT. 30.) GC TC 250
      VL36A   = VL36A + .4 - .02*PSI(IA)
      GC TO 330
  250 IF (PSI(IA) .GT. 40.) GO TO 26C
      VL36A   = VL36A + .7 - .03*PSI(IA)
      GC TO 330
  260 IF (PSI(IA) .GT. 50.) GO TO 270
      VL36A   = VL36A + 1.5 - .05*PSI(IA)
      GC TC 330
  270 IF (PSI(TA) .GT. 60.) GO TO 280
      VL36A   = VL36A + 4.  - .1*PSI(IA)
      GC TC 330
  280 IF (PSI(IA) .GT. 70.) GO TO 290
      VL36A   = VL36A + 10. - .2*PSI(IA)
      GO TC 330
  290 IF (PSI(IA) .GT. 80.) GO TO 300
      VL36A   = VL36A + 17. - .3*PSI(IA)
      GO TO 330
  300 IF (PSI(IA) .GT. 90.) GO TO 310
      VL36A   = VL36A + 33. - .5*PSI(IA)
      GO TO 330
  310 IF (PSI(IA) .GT. 120.) GO TO 320
      VL36A   = VL36A + 42. - .6*PSI(IA)
      GO TO 330
  320 VL36A   = VL36A - 26.
C     DISCHARGE BROACBAND NCISE
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  330 VL39A   = VL39 + Q2(IA) - 22.
      IF (PSI(IA) .LE. 40.) GO TO 410
      IF (PSI(IA) .GT. 60.) GO TO 340
      VL39A   = VL39A - 24. + .6*PSI(IA)
      GO TO 410
  340 IF (PSI(IA) .GT. 70.) GO TO 350
      VL39A   = VL39A - 12. + .4*PSI(IA)
      GO TO 410
  350 IF (PSI(IA) .GT. 90.) GO TO 360
      VL39A   = VL39A + 2.  + .2*PSI(IA)
      GO TO 410
  360 IF (PSI(IA) .GT. 110.) GO TO 370
      VL39A   = VL39A + 11. + .1*PSI(IA)
      GO TO 410
  370 IF (PSI(IA) .GT. 120.) GO TO 380
      VL39A   = VL39A + 22.
      GO TO 410
  380 IF (PSI(IA) .GT. 140.) GO TO 390
      VL39A   = VL39A + 46. - .2*PSI(IA)
      GO TO 410
  390 IF (PSI(IA) .GT. 150.) GO TO 400
      VL39A   = VL39A + 60. - .3*PSI(IA)
      GO TO 410
  400 VL39A   = VL39A + 90. - .5*PSI(IA)
C     DISCHARGE DISCRETE TONE NOISE
  410 VL40A   = VL40 + Q2(IA) - 21.
      IF (PSI(IA) .LE. 40.) GO TO 480
      IF (PSI(IA) .GT. 60.) GO TO 420
      VL40A   = VL40A - 24. + .6*PSI(IA)
      GO TO 480
  420 IF (PSI(IA) .GT. 100.) GO TO 430
      VL40A   = VL40A + .2*PSI(IA)
      GO TO 480
  430 IF (PSI(IA) .GT. 110.) GO TO 440
      VL40A   = VL40A + 10. + .1*PSI(IA)
      GO TO 480
  440 IF (PSI(IA) .GT. 120.) GO TO 450
      VL40A   = VL40A + 21.
      GO TO 480
  450 IF (PSI(IA) .GT. 130.) GO TO 460
      VL40A   = VL40A + 33. - .1*PSI(IA)
      GO TO 480
  460 IF (PSI(IA) .GT. 150.) GO TO 470
      VL40A   = VL40A + 59. - .3*PSI(IA)
      GO TO 480
  470 VL40A   = VL40A + 74. - .4*PSI(IA)
  480 IF (J.NE.1 .OR. VMTR.LT.1.) GO TO 610
C     COMBINATION TONE NOISE , EQUATION 37 , FIGURE 63
      VL37A   = C1(IA)
      IF (PSI(IA) .GT. 50.) GO TO 490
      VL37A   = VL37A - 20. + .4*PSI(IA)
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          GC TO 520
      490 IF (PSI(IA) .LT. 70.) GO TO 520
          IF (PSI(IA) .GT. 8C.) GO TO 500
          VL37A    = VL37A + 14. - .2*PSI(IA)
          GC TO 520
      500 IF (PSI(IA) .GT. 120.) GO TO 510
          VL37A    = VL37A + 62. - .8*PSI(IA)
          GO TO 520
      510 VL37A    = VL37A - 34.
    C     ADD FIG.59 CORRECTION
    C     L1 , CURVE A
      520 IF (VMTR .GT. 1.09) GO TO 530
          VL37A1   = VL37A + 300.*VMTR - 245.
          GO TO 550
      530 IF (VMTR .GT. 1.20) GO TO 540
          VL37A1   = VL37A + 82.
          GC TO 550
      540 VL37A1   = VL37A + 106. - 20.*VMTR
    C     L2 , CURVE B
      550 IF (VMTR .GT. 1.132) GO TO 560
          VL37A2   = VL37A + 250.*VMTR - 195.
          GC TO 580
      560 IF (VMTR .GT. 1.200) GO TO 570
          VL37A2   = VL37A + 88.
          GO TO 580
      570 VL37A2   = VL37A + 112. - 20.*VMTR
    C     L3 , CURVE C
      580 IF (VMTR .GT. 1.25) GO TO 590
          VL37A3   = VL37A + 112.*VMTR - 57.
          GC TO 610
      590 IF (VMTR .GT. 1.30) GC TO 600
          VL37A3   = VL37A + 83.
          GO TO 610
      600 VL37A3   = VL37A + 109. - 20.*VMTR
    C     FUNDAMENTAL BLACE PASSAGE FREQUENCY IN HZ
      610 FO       = B * RPM / (60. * VM(IA))
          IPAL     = 0                                          06/26/75
          AOI      = (VL36A-3.) / 10. + .6
          AOC      = (VL4CA-3.) / 10. + .6
          IF (J.EQ.1 .ANC. IGV.EC.1) GO TO 62C
          AOI      = AOI - .6
          AOD      = AOD - .6
      620 NII      = IFIX(1. + F(1)/FO)
    C     START 1/3-OCTAVE BAND FREQUENCY LOOP
          DC 730 IF=1,30
    C     ADD BROADBAND FREQUENCY CORRECTION , EQUATICN 35 , FIGURE 56A
          C1       = BCFR(IF) / FC
          C2       = ALOG10(C1)
          IF (C1 .GT. 2.) GO TO 630
          FF       =  10.*C2 - 3.
          GC TO 640
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  630 FF        = -20.*C2 + 6.                                            00003980
  640 VL34AF    = VL34A + FF                                              00003990
      VL39AF    = VL39A + FF                                              00004000
C     SUM INLET AND DISCHARGE BROADBAND AND DISCRETE TONE NOISE ON AN    00004010
C      ENERGY BASIS                                                       00004020
      N2I       = IFIX(F(IF+1) / FO)                                      00004030
      PI        = 0.                                                      00004040
      IF (F(IF).LT.FO .AND. F(IF+1).GE.FO) PI = DDBT                      00004050     11/05/75
      PE        = PI                                                      00004060     11/05/75
      IF (N1I .GT. N2I) GO TO 670                                         00004070     06/26/75
      DO 660 K=N1I,N2I                                                    00004080
      IF (K .EQ. 1) GO TO 650                                             00004090
      C3        = .3 * FLOAT(K) + FOB/3.                                  00004100     09/25/75
      PI        = PI + 10.**(AOI-C3)                                      00004110     09/25/75
      PE        = PE + 10.**(AOC-C3)                                      00004120     09/25/75
      GO TO 660                                                           00004130
  650 PI        = PI + 10.**(VL36A/10.-FCB)                               00004140     09/25/75
      PE        = PE + 10.**(VL40A/10.-FCB)                               00004150     09/25/75
  660 CONTINUE                                                            00004160
  670 IF (IPWL .EQ. 0) GO TO 690                                          00004170     06/26/75
      SPL34(IA,IF) = 10.**(VL34AF/10.) + SPL34(IA,IF)                     00004180     09/25/75
      SPL36(IA,IF) = SPL36(IA,IF) + PI                                    00004190     09/25/75
      SPL39(IA,IF) = 10.**(VL39AF/10.) + SPL39(IA,IF)                     00004200     09/25/75
      SPL40(IA,IF) = SPL40(IA,IF) + PE                                    00004210     09/25/75
      GO TO 700                                                           00004220     06/26/75
  690 SPL34D(IA,IF) = 10.**(VL34AF/10.) + SPL34D(IA,IF)                   00004230     09/25/75
      SPL36D(IA,IF) = SPL36D(IA,IF) + PI                                  00004240     09/25/75
      SPL39D(IA,IF) = 10.**(VL39AF/10.) + SPL39D(IA,IF)                   00004250     09/25/75
      SPL40D(IA,IF) = SPL40D(IA,IF) + PE                                  00004260     09/25/75
  700 N1I       = N2I + 1                                                 00004270     06/26/75
      IF (J.NE.1 .OR. VMTR.LT.1.) GO TO 730                               00004280
C     COMBINATION-TONE NOISE SPECTRA , FIG.60                             00004290
C     PEAK LEVEL AT F=FO/2                                                00004300
      G1        = 30.*C2 + 9.                                             00004310
      IF (C1 .GT. .5) G1 = -G1                                            00004320
C     PEAK LEVEL AT F=FO/4                                                00004330
      G2        = 50.*C2 + 30.1                                           00004340
      IF (C1 .GT. .25) G2 = -G2                                           00004350
C     PEAK LEVEL AT F=FO/8                                                00004360
      IF (C1 .GT. .125) GO TO 710                                         00004370
      G3        = 50.*C2 + 45.1                                           00004380
      GO TO 720                                                           00004390
  710 G3        = -30.*C2 - 27.1                                          00004400
C     SUM 3 COMPONENTS , EQUATION 38                                      00004410
  720 IF (IPWL .EQ. 0) GO TO 725                                          00004420     06/26/75
      SPL38(IA,IF) = SPL38(IA,IF) + 10.**((VL37A1+G1)/10.) + 10.**((VL3700004430     09/25/75
     1A2+G2)/10.) + 10.**((VL37A3+G3)/10.)                                00004440     09/25/75
      GO TO 730                                                           00004450     06/26/75
  725 SPL38D(IA,IF) = SPL38D(IA,IF) + 10.**((VL37A1+G1)/10.) + 10.**((VL00004460     09/25/75
     137A2+G2)/10.) + 10.**((VL37A3+G3)/10.)                              00004470     09/25/75
  730 CONTINUE                                                            00004480
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      IF (IPWL .EQ. 1) GC TC 740                                       06/26/75
      IPWL      = 1                                                     06/26/75
      FO        = FC * VM(IA)                                           06/26/75
      GO TO 620                                                         06/26/75
C     END CF FRECUENCY LOOP
  740 CONTINUE
C     END OF AZIMUTH ANGLE LCOP
  75C CCNTINUE
C     END OF STAGE LCCP
C     HAVE NOISE AT 150-FT RADIUS FOR STANCARD CAY , NOW CCNVERT TO SPL,
C      ADD DBN TO ALLOW FOR NUMBER OF FANS, ADD ATN150(IF) TC REMOVE
C      STANDARD CAY ATMOSPHERIC ATTENUATICN TO 150FT , SUBTRACT ACTUAL
C      ATTENUATICN TC SIDELINE ATTNT(IF)*ZO(IA) , ANC ADD DDB(IA) TO
C      ACCOUNT FOR SPHERICAL SPREADING FROM 150FT TO SIDELINE
      DC 760 IF=1,30                                                    06/26/75
      DO 760 IA=1,15                                                    06/25/75
      C1        = CBN + ATN150(IF) - ATTNT(IF)*ZO(IA) + DDB(IA)         09/25/75
      SPL34(IA,IF) = 10.*ALOG10(SPL34(IA,IF)) + C1                      09/25/75
      SPL36(IA,IF) = 10.*ALCG10(SPL36(IA,IF)) + C1                      09/25/75
      SPL38(IA,IF) = 10.*ALOG10(SPL38(IA,IF)) + C1                      09/25/75
      SPL39(IA,IF) = 10.*ALOG10(SPL39(IA,IF)) + C1                      09/25/75
      SPL40(IA,IF) = 10.*ALCG10(SPL4C(IA,IF)) + C1                      09/25/75
      SPL34C(IA,IF) = 1C.*ALOG10(SPL34D(IA,IF)) + C1                    09/25/75
      SPL36D(IA,IF) = 10.*ALOG10(SPL36C(IA,IF)) + C1                    09/25/75
      SPL38D(IA,IF) = 10.*ALCG10(SPL38C(IA,IF)) + C1                    09/25/75
      SPL39D(IA,IF) = 10.*ALOG10(SPL39D(IA,IF)) + C1                    09/25/75
      SPL40D(IA,IF) = 10.*ALCG1C(SPL40C(IA,IF)) + C1                    09/25/75
  760 SPL(IA,IF) = 10.*ALOG10(10.**(SPL34C(IA,IF)/10.) + 10.**(SPL36D(IA 11/03/75
     1,IF)/10.) + 10.**(SPL38D(IA,IF)/10.) + 10.**(SPL39D(IA,IF)/10.) + 09/25/75
     210.**(SPL40D(IA,IF)/10.))                                         10/04/75
      IF (DA(6) .GT. 2.) CALL PNLC(SPL)                                 09/25/75
      IF (DA(25) .EQ. 0.) GC TO 840                                     09/25/75
      IF (CA(152).LE..4 .OR. CA(152).GT.1.) GO TO 805                   09/29/75
C     NOISE REDUCTICN DUE TC NEAR SCNIC INLET                           09/25/75
      IF (CA(152) .GT. .95) GO TC 770                                   09/25/75
      G2        = ALOG10(1.-DA(152))                                    09/25/75
      G1        = 37.*G2 + 8.                                           09/25/75
      G2        = 30.*G2 + 9.                                           09/25/75
      IF (DA(152) .LT. .5) G2 = 0.                                      09/25/75
      GO TO 780                                                         09/25/75
  770 G1        = - 40.                                                 09/25/75
      G2        = - 3C.                                                 09/25/75
  780 WRITE (NP,790) DA(152)                                            09/25/75
  790 FORMAT (33H1INLET WITH THROAT MACH NUMBER OF,F6.3,14H REDUCES NOIS09/25/75
     1E)                                                                09/25/75
      DC 800 IF=1,30                                                    09/25/75
      DO 800 IA=1,15                                                    09/25/75
      SPL34(IA,IF) = SPL34(IA,IF) + G2                                  09/25/75
      SPL36(IA,IF) = SPL36(IA,IF) + G1                                  09/25/75
      SPL38(IA,IF) = SPL38(IA,IF) + G1                                  09/25/75
      SPL34D(IA,IF) = SPL34D(IA,IF) + G2                                09/25/75
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      SPL36D(IA,IF) = SPL36D(IA,IF) + G1                                00005000   09/25/75
      SPL38D(IA,IF) = SPL38D(IA,IF) + G1                                00005010   09/25/75
  800 SPL(IA,IF) = 10.*ALOG10(10.**(SPL34D(IA,IF)/10.) + 10.**(SPL36D(IA00005020   09/25/75
     1,IF)/10.) + 10.**(SPL38D(IA,IF)/10.) + 10.**(SPL39D(IA,IF)/10.) + 00005030   09/25/75
     210.**(SPL40D(IA,IF)/10.))                                         00005040   10/01/75
      IF (DA(6) .GT. 2.) CALL PNLC(SPL)                                 00005050   09/25/75
  805 DO 830 IF=1,30                                                    00005060   09/25/75
      PWLI(IF) = 0.                                                     00005070   09/25/75
      PWLE(IF) = 0.                                                     00005080   09/25/75
      DO 810 IA=1,15                                                    00005090   09/25/75
      IF (DA(152) .GT. 0.) SPL(IA,IF)= 10.*ALOG10(10.**(SPL(IA,IF)/10.) 00005100   09/25/75
     1 - 10.**(SPL36D(IA,IF)/10.))                                      00005110   09/25/75
      PWLI(IF) = PWLI(IF) + CSUM(IA)*(10.**(SPL34D(IA,IF)/10.) + 10.**( 00005120   09/25/75
     1SPL38D(IA,IF)/10.) )                                              00005130   09/25/75
      IF (DA(152) .LE. 0.) PWLI(IF) = PWLI(IF) + CSUM(IA)*10.**(SPL36D(I00005140   09/29/75
     1A,IF)/10.)                                                        00005150   09/25/75
  810 PWLE(IF) = PWLE(IF) + CSUM(IA)*(10.**(SPL39D(IA,IF)/10.) + 10.**( 00005160   09/25/75
     1SPL40D(IA,IF)/10.) )                                              00005170   09/25/75
      PWLI(IF) = 10.*ALOG10(PWLI(IF))                                   00005180   09/25/75
      PWLE(IF) = 10.*ALOG10(PWLE(IF))                                   00005190   09/25/75
      C1      = PWLI(IF) - 3.0103                                       00005200   09/25/75
      C2      = PWLE(IF) - 3.0103                                       00005210   09/25/75
      DO 820 IA=1,15                                                    00005220   09/25/75
      DI(IA,IF) = SPL(IA,IF) - C1                                       00005230   09/25/75
  820 DE(IA,IF) = SPL(IA,IF) - C2                                       00005240   09/25/75
  830 CONTINUE                                                          00005250   09/25/75
      CALL TREAT (PWLI,PWLE,.01*D*DA(211),0.,.01*C*DA(212),D*(1.-DA(82))00005260   09/25/75
     1/2.,(ZMZOP+ZMSTE)/2.,4,DA(213),SPL,DI,DE,DA(214),DA(215))         00005270   09/25/75
      IF (DA(6) .NE. 0.) CALL PNLC (SPL)                                00005280   09/25/75
  840 DO 850 IF=1,30                                                    00005290   09/25/75
      DO 850 IA=1,15                                                    00005300   09/25/75
      C1      = 10.**(SPL(IA,IF)/10.)                                   00005310   09/25/75
      PWLT(IA,IF) = PWLT(IA,IF) + C1                                    00005320   09/25/75
  850 SPLT(IA,IF) = SPLT(IA,IF) + C1                                    00005330   09/25/75
      IF (DA(216) .EQ. 0.) GO TO 860                                    00005340   10/31/75
C     HAVE INTEGRAL ENGINE                                              00005350   09/25/75
      DA(223) = 0.                                                      00005360   09/25/75
      CALL COENG (0,SHPDS,SHP,DBN,IFIX(DA(217)),VTOP/TSDS,DENG,DA(228), 00005370   09/26/75
     1BENG,DA(23),DA(235),DA(236),WFAN,TNETOP*BPR/(1.+BPR),A)           00005380   09/26/75
  860 IF (DA(24) .GT. 0.) CALL GRBOXN (IFIX(DA(24)),SHP,RPM,DBN,DA(216))00005390   09/25/75
      IF (DA(23).LE.0. .OR. DA(216).GT.0.) GO TO 890                    00005400   10/01/75
      CALL JETN (WFAN,TNETOP,A ,0.,0.,0.,SPL34,SPL36)                   00005410   10/01/75
      DO 870 IF=1,30                                                    00005420   10/01/75
      DO 870 IA=1,15                                                    00005430   10/01/75
      SPL34(IA,IF) = SPL34(IA,IF) + DBN                                 00005440   10/01/75
      G1      = 10.**(SPL34(IA,IF)/10.)                                 00005450   10/01/75
      SPLT(IA,IF) = SPLT(IA,IF) + G1                                    00005460   10/01/75
  870 PWLT(IA,IF) = PWLT(IA,IF) + 10.**((SPL36(IA,IF)+DBN)/10.)         00005470   10/01/75
      IF (DA(6) .LT. 1) GO TO 890                                       00005480   10/01/75
      WRITE (NP,880)                                                    00005490   10/01/75
  880 FORMAT (1H1,9HJET NOISE)                                          00005500   10/01/75
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      CALL PNLC (SPL34)                                                  10/01/75
  890 IF (DA(116) .EC. 0.) RETURN                                        10/01/75
C     INCLUDE THRUST REVERSER                                            10/01/75
      CALL REVN (SPL34,CBN)                                              10/01/75
      DO 900 IF=1,3C                                                     10/01/75
      DC 900 IA=1,15                                                     10/01/75
      C1       = 1C.**(SPL34(IA,IF)/10.)                                 10/01/75
      IF (DA(6) .GT. 1.) SPL(IA,IF) = 1C.*ALOG10(10.**(SPL(IA,IF)/10.) + 10/01/75
     1 C1)                                                               10/01/75
      PWLT(IA,IF) = PWLT(IA,IF) + C1                                     10/01/75
  9C0 SPLT(IA,IF) = SPLT(IA,IF) + C1                                     11/05/75
      IF (DA(5) .GT. 1.) CALL PNLC (SPL)                                 10/01/75
      RETURN
 1CCC WRITE (NP,1010)                                                    06/11/75
 1C10 FORMAT (/68H FIXED-PITCH FAN NCISE NCT CALCULATED BECAUSE OF ERROR 06/11/75
     1 IN INPUT DATA)                                                    06/11/75
      DA(22)  = C.                                                       09/25/75
      RETURN                                                             06/11/75
 1020 WRITE (NP,1030)                                                    06/11/75
 1C3C FORMAT (/58H STAGE NCISE NCT CALCULATEC BECAUSE CF ERROR IN INPUT  06/11/75
     1DATA)                                                              06/11/75
      GO TO 750                                                          06/11/75
      END
```

Subroutine FAPROP

This subroutine calculates the geometry, aerodynamic performance, and noise of a free-air propeller. The noise components calculated include steady loading noise, unsteady loading noise (including flight effects), broadband noise and reverse thrust noise.

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DESCRIPTION          FAPROP - FREE-AIR PROPELLER

MASTER FILE          LIBR.G04
ADDED TO MASTER      05/30/75
LAST DATE COPIED       NONE
LAST UPDATE          04/14/76  1653          *** TEMPORARY UPDATE ***

PASSWORD             JRZT
PROGRAMMER           F.W.BARRY
PROC PARAMETER       $NOJCL

      SUBROUTINE FAPROP                                                 00000010
C     COMPUTES FREE-AIR PROPELLER GEOMETRY AND NOISE                    00000030
C     FAPROP CALLS BIQUAD, PNLC, BESJH, CCENG, GREOXN; CALLED BY MAIN   00000040   10/02/75
      DIMENSION BBOD(13), HOD(13),AFFB(13),FIG1(135),FIG2(135),SPICO(17)00000050   09/09/75
     1,AB1(13),AB2(13),SPL(15,30),ENG(10),PSC(100),PSUN(100),BNG(6)     00000060   09/25/75
     2,FIG3(207),FIG4(201),FIG5(17),RDI(15)                             00000070   11/07/75
      COMMON /DATA/ ANGLE(15),BCFR(30),NR,NP,C,HOL(20),DATE(2),TIME(2), 00000080
     1 ATTNT(30),SPLT(15,30),SPLTU(15,30),DBNU(7),XO(15),XC(15),ZC(15), 00000090
     2 PSI(15),DO(15),DDO(15),HPT,TR,VELFL,CM(15),PWLT(15,30),          00000100   08/22/75
     3 DIRIN(498),DIREX(498),BLF(31),DPASP(15),RPMG,DHPT,RRPM,CSUM(15)  00000110   11/10/75
      COMMON /DATAI/CA(400)                                             00000120   09/25/75
      COMMON / JNX / JJ(450)                                            00000130
      EQUIVALENCE (CA(94),SHP),(DA(95),THRUST),(CA(96),D),(DA(97),BLADN)00000140
     1,(DA(257),ENG(1)),(DA(268),BNG(1))                                00000150   09/26/75
C     CHORD/DIAMETER AT 80% RADIUS VERSUS AF                            00000160
      DATA BBOD / 1.,5.,0.,80.,86.,105.,141.,200.,.0534,.0588,.0749,    00000170
     1 .0974,.128 /                                                     00000180
C     THICKNESS/DIAMETER AT 70% RADIUS VERSUS AF                        00000190
      DATA HOD / 2.,5.,0.,80.,86.,105.,141.,200.,.0062725,.0065645,.00700000200
     1132,.0073750,.007552 /                                            00000210   10/09/75
C     ACTIVITY FACTOR VERSUS CHORD AT 80% RADIUS/DIAMETER               00000220
      DATA AFFB / 3.,5.,0.,.0534,.0588,.0749,.0974,.1280,80.,86.,105.,  00000230
     1 141.,200./                                                       00000240
C     CT/CP VS B AND CPE                                                00000250
      DATA FIG1 / 4.,.18,.6,..06,.08,.1,.12,.14,.16,.18,.2,.22,.24,.26,.200000260
     18,.3,.32,.34,.36,.38,.4, 2.,3.,4.,5.,6.,8.,     2.89,2.61,2.525,2.300000270
     265,2.23,2.01, 2.5,2.41,2.29,2.17,2.055,1.86, 2.2,2.15,2.08,1.95,1.00000280   09/05/75
     389,1.72, 1.955,1.925,1.88,1.83,1.76,1.59, 1.755,1.745,1.715,1.69,100000290
     4.63,1.49,2*1.58,1.565,1.55,1.51,1.39,4*1.45,1.4,1.3, 4*1.345,1.31500000300   09/05/75
     5,1.215, 4*1.25,1.23,1.15, 5*1.165,1.08, 5*1.095,1.02, 5*1.02,.96, 00000310
     65*.95,.91, 5*.905,.86, 5*.86,.81, 5*.81,.76, 5*.765,.72, 5*.72,.6800000320
     7 /                                                                00000330
C     T/TSTATIC VS CPE AND J                                            00000340
      DATA FIG2 / 5.,6.,18.,.0,.5,1.,1.5,2.,2.5, .06,.08,.1,.12,.14,.16,00000350
     1.18,.2,.22,.24,.26,.28,.3,.32,.34,.36,.38,.4, 18*1., .554,.617,.66C00000360
     23,.709,.752,.796,.828,.855,.878,.901,.917,.938,.95,.964,.972,.977,.900000370
     3.985,.995, .257,.366,.413,.457,.5,.535,.571,.61,.644,.686,.715,.75C00000380
     43,.786,.821,.856,.891,.920,.946, .172,.218,.269,.306,.339,.373,.400000390
     52,.435,.465,.501,.530,.567,.597,.628,.666,.7,.731,.762, .082,.126,00000400
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      6.173,.216,.242,.272,.299,.327,.356,.383,.407,.434,.466,.492,.523,.00000410
      7553,.582,.61, .01,.055,.106,.142,.169,.2,.224,.249,.273,.299,.32,.00000420
      8344,.369,.395,.421,.444,.47,.492 /                              00000430
C      CPE VS J AND CTE FOR NEGATIVE THRUST                            00000440    11/07/75
       DATA FIG3 / 9.,11.,0.,-.1241,-.1177,-.1096,-.0993,-.0872,-.0733,-.00000450    11/07/75
      1058,-.0414,-.0238,-.0056,.0,.2862,.2551,.223,.1905,.1583,.1289,.1300000460    11/07/75
      211,.0756,.0534,.0352,.031, 9.,12.,0.,-.1667,-.1591,-.1501,-.1392,-00000470    11/07/75
      3.1263,-.1109,-.0934,-.075,-.0567,-.0374,-.0174,.0,.3015,.2702,.23700000480    11/07/75
      44,.2039,.1706,.1387,.1088,.0816,.0578,.0385,.0248,.0195, 9.,14.,0.C0000490    11/07/75
      5,-.223,-.2124,-.2013,-.1892,-.1756,-.1597,-.142,-.1232,-.103,-.08100000500    11/07/75
      61,-.0589,-.0384,-.017,.0,.3353,.2995,.262,.2242,.187,.1522,.1196,.00000510    11/07/75
      70891,.0627,.0426,.0284,.0211,.0183,.016, 9.,17.,0.,-.2975,-.2835,-00000520    11/07/75
      E.2707,-.258,-.2445,-.2287,-.2113,-.1924,-.1725,-.1523,-.1316,-.11100000530    11/07/75
      92,-.0885,-.0623,-.0351,-.0063,.0,.3958,.3494,.3042,.2603,.2181,.1700000540    11/07/75
      A77,.1396,.1033,.0715,.0468,.0288,.0186,.0138,.0115,.0117,.0146,.0100000550    11/07/75
      B55, 9.,14.,0.,-.3885,-.379,-.3689,-.3582,-.3466,-.3335,-.3198,-.3000000560    11/07/75
      C04,-.2926,-.2778,-.2619,-.2468,-.2265,-.225,.4792,.4262,.372,.31730000570    11/07/75
      D.,2643,.2143,.1668,.1226,.0837,.0526,.0284,.0115,.0008,.0, 9.,13.,00000580    11/07/75
      E0.,-.5137,-.5054,-.4964,-.4866,-.4761,-.4652,-.4529,-.4384,-.4226,00000590    11/07/75
      F-.4066,-.3893,-.37,-.36,.5763,.5171,.4517,.3838,.317,.2572,.2016,.00000600    11/07/75
      G1481,.1008,.0639,.0339,.0092,.0, 9.,12.,0.,-.6345,-.6271,-.6199,-.00000610    11/07/75
      H6124,-.6042,-.595,-.5842,-.5712,-.5562,-.5394,-.5203,-.5,.5799,.5700000620    11/07/75
      I68,.523,.4513,.3824,.3141,.2478,.1831,.1241,.0761,.0352,.0 /    00000630    11/07/75
C      CTE VS J AND CPE FOR NEGATIVE THRUST                            00000640    11/07/75
       DATA FIG4 / 10.,11.,0.,.031,.0352,.0534,.0756,.1011,.1289,.1588,.100000650    11/07/75
      1905,.223,.2551,.2862,.0,-.0056,-.0238,-.0414,-.058,-.0733,-.0872,-00000660    11/07/75
      2.0993,-.1096,-.1179,-.1241, 10.,12.,0.,.0195,.0248,.0385,.0578,.0800000670    11/07/75
      316,.1088,.1387,.1706,.2039,.2374,.2702,.3015,.0,-.0174,-.0374,-.0500000680    11/07/75
      467,-.075,-.0934,-.1109,-.1263,-.1392,-.1501,-.1591,-.1667, 10.,14.,00000690    11/07/75
      5,0.,.016,.0183,.0211,.0284,.0426,.0627,.0891,.1196,.1522,.187,.22400000700    11/07/75
      62,.262,.2995,.3352,.0,-.017,-.0384,-.0589,-.0811,-.103,-.1232,-.1400000710    11/07/75
      72,-.1597,-.1756,-.1892,-.2013,-.2124,-.223, 10.,14.,0.,.0115,.013800000720    11/07/75
      8,.0186,.0288,.0468,.0715,.1033,.1396,.1777,.2181,.2603,.3042,.349400000730    11/07/75
      9,.3958,-.0623,-.0885,-.1112,-.1316,-.1523,-.1725,-.1924,-.2113,-.2000000740    11/07/75
      A287,-.2445,-.258,-.2707,-.2835,-.2975, 10.,14.,0.,0.,.0008,.0115,.00000750    11/07/75
      B0284,.0526,.0837,.1226,.1668,.2143,.2648,.3178,.372,.4262,.4792,-.00000760    11/07/75
      C225,-.2265,-.2468,-.2619,-.2778,-.2926,-.3064,-.3198,-.3335,-.346600000770    11/07/75
      D,-.3582,-.3689,-.379,-.3885, 10.,13.,0.,0.,.0092,.0339,.0639,.100800000780    11/07/75
      E,.1481,.2016,.2572,.317,.3838,.4517,.5171,.5763,-.36,-.37,-.3893,-00000790    11/07/75
      F.4066,-.4226,-.4384,-.4529,-.4652,-.4761,-.4866,-.4964,-.5054,-.5100000800    11/07/75
      G37, 10.,12.,0.,0.,.0352,.0761,.1241,.1831,.2478,.3141,.3824,.4513,00000810    11/07/75
      H.523,.5988,.6799,-.5,-.5203,-.5394,-.5562,-.5712,-.5842,-.595,-.600000820    11/07/75
      I42,-.6124,-.6199,-.6271,-.6345 /                                00000830    11/07/75
C      CPE OR CTE VS J                                                 00000840    11/07/75
       DATA FIG5 / 11.,7.,0.,0.,.2,.4,.6,.8,1.,1.2,7*0. /              00000850    11/07/75
       DATA RDI / -8.1,-4.6,-1.1,2.4,3.9,3.4,1.9,.4,-.8,-1.1,-1.6,-2.3,-400000860    11/07/75
      1.1,-6.6,-9.1 /                                                  00000870    11/07/75
C      SPINNER CUT-OFF RATIO VERSUS DIAMETER                           00000880
       DATA SPICO / 6.,7.,0.,5.,7.,8.,10.,15.,20.,24.,.284,.217,.195,.16700000890
      1,.132,.1175,.1075 /                                             00000900
       DATA ABI / 7.,5.,0.,80.,86.,105.,141.,200.,.03602,.036759,.039636,00000910
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      1.049554,.0640 /                                                  00000920
      DATA AB2 / 8.,5.,0.,80.,86.,105.,141.,200.,3*.04395,.05195,.0640 /00000930
C     INPUT DATA FOR FREE-AIR PROPELLER , IN DATAI                      00000940
C      94  SHP    PROPELLER HORSEPOWER                                  00000950
C      95  THRUST PROPELLER THRUST IF SHP=0. , POUNDS                   00000960
C      96  D      PROPELLER DIAMETER , FT                               00000970
C      97  BLADN  NUMBER OF BLADES (2 TO 8)                             00000980
C      98         PROPELLER TIP SPEED (FPS) IF GT 0. , RPM IF LT 0.     00000990
C      99         BLADE CHORD (FT) AT 80% RADIUS , AF IF LT 0.          00001000
C     145         PROPELLER HORSEPOWER FOR DESIGN (TAKEOFF) CONDITION   00001010    08/22/75
C     146         PROPELLER THRUST FOR DESIGN CONDITION IF HP=0., LB    00001020    08/22/75
C     153         =0. IF SHAFT DRIVE , =1. IF INTEGRAL ENGINE           00001030    09/25/75
C     154         =0. IF USE TYPICAL TURBOSHAFT ENGINE, =1. IF USE:     00001040    09/25/75
C     257  RPMC   COMPRESSOR RPM                                        00001050    09/26/75
C     258  D      COMPRESSOR DIAMETER , FT                              00001060    09/26/75
C     259  FPR    COMPRESSOR FIRST-STAGE PRESSURE RATIO                 00001070    09/26/75
C     260  RSS    COMPRESSOR FIRST-STAGE ROTOR-STATOR SPACING IN PERCENT00001080    09/26/75
C     261  BC     COMPRESSOR FIRST-STAGE NUMBER OF BLADES               00001090    09/26/75
C     262  CK     = 0.                                                  00001100    09/26/75
C     263  P3     COMBUSTOR INLET TOTAL PRESSURE , PSF                  00001110    09/26/75
C     264  T3     COMBUSTOR INLET TOTAL TEMPERATURE , DEG R             00001120    09/26/75
C     265  T4     COMBUSTOR EXIT  TOTAL TEMPERATURE , DEG R             00001130    09/26/75
C     266  QMA    COMBUSTOR MASS FLOW RATE , LB/SEC                     00001140    09/26/75
C     267  QMT    TURBINE MASS FLOW RATE , LB/SEC                       00001150    09/26/75
C     268  VTR    RELATIVE TIP SPEED OF LAST TURBINE ROTOR , FPS        00001160    09/26/75
C     269  CL     SPEED OF SOUND AT TURBINE EXIT , FPS                  00001170    09/26/75
C     270  SOC    LAST STAGE STATOR-ROTOR SPACING / STATOR CHORD        00001180    09/26/75
C     271  VK     =0. FOR COPLANAR EXHAUSTS , -10. FOR RECESSED EXHAUST 00001190    09/26/75
C     272  BT     NUMBER OF BLADES IN LAST TURBINE ROTOR                00001200    09/26/75
C     273  RPMT   TURBINE RPM                                           00001210    09/26/75
C     274         =1. IF JET NOISE , =0. IF NO JET NOISE                00001220    10/30/75
C     275  THRT   JET THRUST , LB                                       00001230    09/26/75
C     276  AREA   AREA OF JET , SQ FT                                   00001240    09/26/75
      IF ((SHP.EQ.0..AND.THRUST.EQ.0.) .OR. D.LE.0. .OR. BLADN.LT.2. .OR00001250    11/07/75
     1. BLADN.GT.8. .OR. DA(98).EQ.0. .OR. DA(99).EQ.0. .OR. (DA(145).LE00001260    08/22/75
     2.0..AND.DA(146).LE.0.)) GO TO 1000                                00001270    08/22/75
      VKTAS   = VELFL / 1.6878                                          00001280    08/16/75
      IF (DA(98) .LT. 0.) GO TO 10                                      00001290
      TS      = DA(98)                                                  00001300
      RPM     = TS * 19.098593 / D                                      00001310
      GO TO 20                                                          00001320
   10 RPM     = - DA(98)                                                00001330
      TS      = RPM * D / 19.098593                                     00001340
   20 VJ      = 101.4 * VKTAS / (RPM * D)                               00001350
      IF (DA(99) .LT. 0.) GO TO 30                                      00001360
      CALL BIQUAD (AFF8,1,DA(99)/D,0.,AF,IER)                           00001370
      M       = 3                                                       00001380
      IF (IER .NE. 0) WRITE (NP,25) M,IER                               00001390
   25 FORMAT (32H ERROR IN INTERPOLATION IN TABLE,I2,8H , IER =,I4)     00001400
      CHORD   = DA(99)                                                  00001410
      GO TO 40                                                          00001420
```

```
   30 AF        = - DA(99)
      CALL BIQUAD (BBOD,1,AF,0.,CHORD,IER)
      M         = 1
      IF (IER .NE. 0) WRITE (NP,25) M,IER
      CHORD     = CHORD * D
   40 C1        = 1.4166458E9 * TR / (RPM**3 *D**5 *DA(3))          06/25/75
      C2        = (4./BLADN)**.83 * (120./AF)**.8
      C3        = 33000. / (RPM * D)
      L         = 0                                                 11/07/75
      IF (SHP) 95, 43, 70                                           11/07/75
   43 IF (THRUST) 100,1000, 46                                      11/07/75
C     THRUST GIVEN , CALCULATE HORSEPOWER
   46 THR       = THRUST                                            11/07/75
      L         = 1                                                 11/07/75
   48 HP        = THR / 2.5                                         11/07/75
      DO 50 I=1,10
      CP        = C1 * HP                                           11/07/75
      CPE       = C2 * CP
      CALL BIQUAD (FIG1,1,CPE,BLADN,CTOCP,IER)
      M         = 4
      IF (IER .NE. 0) WRITE (NP,25) M,IER
      CALL BIQUAD (FIG2,1,VJ,CPE,TOTS,IER)
      M         = 5
      IF (IER .NE. 0) WRITE (NP,25) M,IER
      C4        = C3 * HP * CTOCP * TOTS                            11/07/75
      HP        = HP * THR / C4                                     11/07/75
      IF (ABS(THR-C4)/THR .LT. .01) GO TO 65                        11/07/75
   50 CONTINUE
      WRITE (NP,50) THRUST,SHP
   60 FORMAT (//40H DID NOT CONVERGE ON PROPELLER THRUST OF,F7.1,11H WITH
     1H SHP =,F7.1//)
      CA(10)    = 0.                                                08/22/75
      RETURN
   65 IF (L .EQ. 1) PHP = HP                                        11/07/75
      GO TO 80                                                      11/07/75
C     HORSEPOWER GIVEN , CALCULATE THRUST
   70 CP        = C1 * SHP                                          08/22/75
      CPE       = C2 * CP
      CALL BIQUAD (FIG1,1,CPE,BLADN,CTOCP,IER)
      M         = 4
      IF (IER .NE. 0) WRITE (NP,25) M, IER
      CALL BIQUAD (FIG2,1,VJ,CPE,TOTS,IER)
      M         = 5
      IF (IER .NE. 0) WRITE (NP,25) M,IER
      THRUST    = C3 * SHP * CTOCP * TOTS
      THR       = THRUST                                            11/07/75
      PHP       = SHP                                               11/07/75
      HP        = SHP                                               11/07/75
C     DESIGN (TAKEOFF) HORSEPOWER                                   08/22/75
   80 DHP       = CA(145)                                           08/22/75
      IF (DHP .GT. 0.) GO TO 110                                    08/22/75
```

```
C        THRUST GIVEN , CALCULATE HORSEPOWER                                          08/22/75
         C1       = 1.4166458E9 * (459.65+DA(125)) / (RPM**3 *D**5 *DA(126))          08/25/75
         DHP      = DA(146) / 2.5                                                     08/22/75
         VK       = 101.4 * DA(124) / (RPM * D)                                       08/22/75
         DO 90 I=1,10                                                                 08/22/75
         CPC      = C1 * DHP                                                          11/07/75
         CPED     = C2 * CPD                                                          11/07/75
         CALL BIQUAD (FIG1,1,CPED,BLADN,CTOCPC,IER)                                   11/07/75
         M        = 4                                                                 08/22/75
         IF (IER .NE. 0) WRITE (NP,25) M,IER                                          08/22/75
         CALL BIQUAD (FIG2,1,VK,CPED,TOTSC,IER)                                       11/07/75
         M        = 5                                                                 08/22/75
         IF (IER .NE. 0) WRITE (NP,25) M,IER                                          08/22/75
         C4       = C3 * CHP * CTOCPC * TOTSD                                         11/07/75
         CHP      = DHP * DA(146) / C4                                                08/22/75
         IF (ABS(DA(146)-C4)/DA(146) .LT. .01) GO TO 110                              08/22/75
   90    CONTINUE                                                                     08/22/75
         WRITE (NP,60) DA(146), DHP                                                   08/22/75
         DA(10)   = 0.                                                                08/22/75
         RETURN                                                                       08/22/75
C        REVERSE THRUST WITH HP GIVEN                                                 11/07/75
   55    PHP      = -SHP                                                              11/07/75
         CP       = C1 * PHP                                                          11/07/75
         CPE      = C2 * CP                                                           11/07/75
         M        = 10                                                                11/07/75
         CALL BIQUAD (FIG4,  1,CPE,0.,FIG5(11),IER)                                   11/07/75
         IF (IER .NE. 0) WRITE (NP,25) M,IER                                          11/07/75
         CALL BIQUAD (FIG4, 26,CPE,0.,FIG5(12),IER)                                   11/07/75
         IF (IER .NE. 0) WRITE (NP,25) M,IER                                          11/07/75
         CALL BIQUAD (FIG4, 53,CPE,0.,FIG5(13),IER)                                   11/07/75
         IF (IER .NE. 0) WRITE (NP,25) M,IER                                          11/07/75
         CALL BIQUAD (FIG4, 84,CPE,0.,FIG5(14),IER)                                   11/07/75
         IF (IER .NE. 0) WRITE (NP,25) M,IER                                          11/07/75
         CALL BIQUAD (FIG4,115,CPE,0.,FIG5(15),IER)                                   11/07/75
         IF (IER .NE. 0) WRITE (NP,25) M,IER                                          11/07/75
         CALL BIQUAD (FIG4,146,CPE,0.,FIG5(16),IER)                                   11/07/75
         IF (IER .NE. 0) WRITE (NP,25) M,IER                                          11/07/75
         CALL BIQUAD (FIG4,175,CPE,0.,FIG5(17),IER)                                   11/07/75
         IF (IER .NE. 0) WRITE (NP,25) M,IER                                          11/07/75
         M        = 11                                                                11/07/75
         CALL BIQUAD (FIG5,1,VJ,0.,CTE,IER)                                           11/07/75
         IF (IER .NE. 0) WRITE (NP,25) M,IER                                          11/07/75
         THRUST   = CTE / C2 * DA(3) / TR * (RPM*D**2)**2 / 41426.                    11/07/75
         THR      = -THRUST                                                           11/07/75
         VJ       = 0.                                                                11/07/75
         VKTAS    = 0.                                                                11/07/75
         GO TO 48                                                                     11/07/75
C        REVERSE THRUST WITH THRUST GIVEN                                             11/07/75
  100    CTE      = 41426. / DA(3) * C2 * TR * THRUST / (RPM*D**2)**2                 11/07/75
         M        = 5                                                                 11/07/75
         CALL BIQUAD (FIG3,  1,CTE,0.,FIG5(11),IER)                                   11/07/75
```

```
      IF (IER .NE. 0) WRITE (NP,25) M,IER                                11/07/75
      CALL BIQUAD (FIG3, 26,CTE,0.,FIG5(12),IER)                         11/07/75
      IF (IER .NE. 0) WRITE (NP,25) M,IER                                11/07/75
      CALL BIQUAD (FIG3, 53,CTE,0.,FIG5(13),IER)                         11/07/75
      IF (IER .NE. 0) WRITE (NP,25) M,IER                                11/07/75
      CALL BIQUAD (FIG3, 84,CTE,0.,FIG5(14),IER)                         11/07/75
      IF (IER .NE. 0) WRITE (NP,25) M,IER                                11/07/75
      CALL BIQUAD (FIG3,121,CTE,0.,FIG5(15),IER)                         11/07/75
      IF (IER .NE. 0) WRITE (NP,25) M,IER                                11/07/75
      CALL BIQUAD (FIG3,152,CTE,0.,FIG5(16),IER)                         11/07/75
      IF (IER .NE. 0) WRITE (NP,25) M,IER                                11/07/75
      CALL BIQUAD (FIG3,181,CTE,0.,FIG5(17),IER)                         11/07/75
      IF (IER .NE. 0) WRITE (NP,25) M,IER                                11/07/75
      M        = 11                                                      11/07/75
      CALL BIQUAD (FIG5,1,VJ,0.,CPE,IER)                                 11/07/75
      IF (IER .NE. 0) WRITE (NP,25) M,IER                                11/07/75
      CP       = CPE / C2                                                11/07/75
      PHP      = CP / C1                                                 11/07/75
      VJ       = 0.                                                      11/07/75
      VKTAS    = 0.                                                      11/07/75
      THR      = -THRUST                                                 11/07/75
      GO TO 43                                                           11/07/75
  110 IF (DA(153) .EQ. 0.) HPT = HPT + PHP*DA(10)                        11/07/75
      IF (DA(153) .EQ. 0.) DHPT = DHPT + DHP*DA(10)                      09/25/75
C     CALCULATE AREA OF ONE BLADE
      CALL BIQUAD (SPICO,1,D,0.,C1,IER)
      M        = 6
      IF (IER .NE. 0) WRITE (NP,25) M,IER
      CALL BIQUAD (AB1,1,AF,0.,C2,IER)
      M        = 7
      IF (IER .NE. 0) WRITE (NP,25) M,IER
      CALL BIQUAD (AB2,1,AF,0.,C3,IER)
      M        = 8
      IF (IER .NE. 0) WRITE (NP,25) M,IER
      AB       = (C2 - C1*C3) * D**2
      CALL BIQUAD (HOC,1,AF,0.,H,IER)
      M        = 2
      IF (IER .NE. 0) WRITE (NP,25) M,IER
      H        = H * C
      VMT      = TS / C
      BPF      = RPM * BLADN / 60.
      WRITE (NP,120) HOL,DATE,TIME,D,C1,BLADN,CHCRD,AF,AB,H  ,PHP,THRUST  11/07/75
     1,RPM,TS,VMT,VJ,CP,CPE,CTOCP,TOTS,BPF,CHP,DA(8)                     02/10/76
  120 FORMAT (1H1,45X,24HFREE-AIR PROPELLER NOISE //1H ,20A4,2X,2A4,2X,2C
     1A4// 24H PROPELLER CONFIGURATION /11H DIAMETER =,F6.2,34H FT , SPI
     2NNER/TIP DIAMETER RATIO =,F7.4,2H ,,F3.0,31H BLADES , CHORD AT 80%
     3 RADIUS =,F6.3,10H FT , AF =,F6.1 /13H BLADE AREA =,F7.3,40H SQ FT
     4 , BLADE THICKNESS AT 70% RADIUS =,F8.5,3H FT / 20H OPERATING COND
     5ITION / 6H SHP =,F7.1,11H , THRUST =,F7.1,12H LBS , RPM =,F8.2,14H
     6 , TIP SPEED =,F7.2, 24H FPS , TIP MACH NUMBER =,F6.3/4H J =,F6.3,
     77H , CP =,F6.3,8H , CPE =,F6.3,10H , CT/CP =,F6.3,14H , T/TSTATIC
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```
      8=,F6.3/25H BLADE PASSING FREQUENCY =,F6.1,3H HZ/ 6H SHP =,F7.1,46H00002960    02/10/76
      9 AT DESIGN (TAKEOFF) CONDITION , SHAFT ANGLE =,F5.0)               00002970    02/10/76
       IF (CA(153) .EQ. 0.) RPPM = 1.                                     00002980    09/25/75
C      CORRECTION FOR NUMBER OF PROPELLERS                                00002990
       DBN      = 0.                                                      00003000
       IF (CA(10) .GT. 1.) DBN = DBNU(IFIX(CA(10)-.5))                    00003010
C      CORRECTION FOR TILT EFFECT TO FUNDAMENTAL TONE                     00003020    09/08/75
       DDBT     = 0.                                                      00003030    09/08/75
       ALPHA    = C.                                                      00003040    11/26/75
       IF (VELFL .GT. 0.) ALPHA = DA(8) - ATAN2(DA(5),DA(4))/.0174532925 00003050    11/26/75
       IF (ALPHA.GT.90. .AND. ALPHA.LT.270.) VKTAS = 0.                   00003060    09/08/75
       C5       = AMIN1(.2,VELFL*ABS(SIN(.0174532925*ALPHA))/TS)          00003070    09/08/75
       IF (C5.GT..001 .AND. (ALPHA.LT.90..OR.ALPHA.GT.270.)) DDBT = 10.**00003080    09/08/75
      1((((1133.89*C5-642.248)*C5+125.104)*C5)/10.)                       00003090    09/08/75
C      BROADBAND NOISE , OPTION 3 IN AFAPL-TR-71-37                       00003100
       AB       = AB * BLADN                                              00003110
       DBTX     = -75.791 + 57000.*THR    /AB/TS**2 + 4.342945*ALOG(AB*TS**00003120    11/07/75
      16) + DBN                                                           00003130
       FREQM    = .06 * SQRT((.7*TS)**2+DA(4)**2) / H                     00003140
       DO 160 IA=1,15                                                     00003150
       C1       = DBTX - 8.68589*ALOG(ZO(IA)) - 3.3*SIN(.0174532925*(PSI(I00003160
      1A)+10.))**2                                                        00003170
       DO 160 IF=1,30                                                     00003180
       S        = ALOG10(BCFR(IF)/FREQM)                                  00003190
       IF (S .GT. -.1549) GO TO 130                                       00003200
       SPL(IA,IF) = C1 - 1.5 + 22.*S                                      00003210
       GO TO 160                                                          00003220
   130 IF (S .GT. .1461) GO TO 140                                        00003230
       SPL(IA,IF) = C1 - 3.4 + (2.23462-48.0894*S)*S                      00003240
       GO TO 160                                                          00003250
   140 IF (S .GT. .6021) GO TO 150                                        00003260
       SPL(IA,IF) = C1 - 2. - 15.*S                                       00003270
       GO TO 160                                                          00003280
   150 SPL(IA,IF) = C1 - 5.5 - 9.1*S                                      00003290
   160 SPL(IA,IF) = SPL(IA,IF) - ZO(IA)*ATTNT(IF)                         00003300
       IF (DA(6) .NE. 3. .OR. THRUST.LT.0.) GO TO 180                     00003310    11/07/75
       WRITE (NP,170)                                                     00003320
   170 FORMAT (//16H BROADBAND NOISE)                                     00003330
       CALL FNLC(SPL)                                                     00003340
   180 DO 190 IA=1,15                                                     00003350
       DO 190 IF=1,30                                                     00003360
   190 SPL(IA,IF) = 10.**((SPL(IA,IF)-DBN+ZO(IA)*ATTNT(IF))/10.)          00003370
       VMF      = VKTAS * 1.6878 / C                                      00003380
       XI2      = 1. - VMF**2                                             00003390
C      VELOCITY CORRECTION TO NON-STEADY HARMONIC LOADS                   00003400
       IF (VKTAS .GT. 2.) GO TO 200                                       00003410
       DDBNSV   = 10.**(-.31*VKTAS)                                       00003420
       GO TO 210                                                          00003430
   200 DDBNSV   = (1.+SQRT(1.+375.55883*THR    /(VKTAS*D)**2)) / (1.+SQRT(100003440    11/07/75
      1.+267.8375*THR    /D**2)) / 2.5118E644                              00003450    11/07/75
C      VARIOUS FACTORS                                                    00003460
```

```
  210 C1       = (54C178. * BLADN * VMT / D)**2
      C2       = THR / XI2                                                11/07/75
      C3       = .76 * HP / VMT**2                                        11/07/75
      C4       = .8 * BLACN * VMT
      C7       = 1.9876557E1C * (BLADN * VMT / D)**2
      IB       = IFIX(BLADN)
      MAX      = 20/IB + 1
      VMAX     = FLOAT(MAX)
      MMAX     = MIN1(100.,22400./BPF)
C     START LOOP OVER 15 AZIMUTH ANGLES
      DO 36C IA=1,15
      C5       = .0174537925 * PSI(IA)
      SINE     = SIN(C5)
      CCSINE   = COS(C5)
      C5       = C1 * ((C2*(VMF+COSINE/SQRT(1.-(VMF*SINE)**2)) - C3) / ZO
     1(IA))**2
      C6       = C4 * SINE
      C8       = THR * CCSINE                                             11/07/75
      C9       = C7 / ZO(IA)**2
      IF       = 1
      IS       = 1
      INS      = 1
      DO 300 M=1,MMAX
      PSC(M)   = 1.E-20
      PSCN(M)  = 1.E-20
      IF (IS.EQ.0 .AND. INS.EQ.0) GO TC 300
      VM       = FLOAT(M)
      IF (IS.EQ.0 .AND. M.GT.MAX) GO TO 250
      MB       = M * IB
      NORD     = MINC(4CC,MB)
C     CALCULATE BESSEL FUNCTION J ARRAY CJ OF ARGUMENT .8*M*BLADN*VMT*
C       SINE TO ORDER M*BLACN
      CALL BESJH(VM*C6,NORD,CJ,ER,450,NF)
      IF (ER .NE. 0.) NORD = IFIX(ER)
      IF (NORD .GE. MB) GO TC 230
      IF (DA(6) .EQ. 3.) WRITE(NP,22C) IA,M,NORD
  220 FORMAT (/24H BESSEL FUNCTION FOR IA=,I3,3H M=,I3,20H LIMITED TC OR
     1DER OF,I4/)
      IS       = 0
      GO TO 240
C     STEADY LOADING NOISE
  230 IF (IS .EQ. 1) PSC(M) = C5 * (VM * QJ(MB+1))**2
      IF (IS.EQ.1 .AND. PSC(M).LT.1.E-10) IS = 0
      IF (IS.EQ.0 .ANC. INS.EQ.0) GO TC 3CC
  240 IF (M .LE. MAX) GC TO 260
C     FOR MB GREATER THAN 20 USE SLCPE OF -3.67DB / DOUBLING OF M FOR
C      NCN-STEADY HARMONIC LOAD NCISE
  250 PSCN(M) = PSQN(MAX) * (VMAX/VM)**1.219
      GO TO 280
C     NCN-STEADY HARMCNIC LCADS , FIRST LIMITS CN LAMBDA
  260 VMB      = VM * BLADN
```

```
      LMIN     = MAX1(1.,VMB*(1.-VMT))                                  00003980
      LMAX     = IFIX(VMB*(1.+VMT)) + 1                                 00003990
      C10      = C9 * VM**2                                             00004000
      PSON(M) = C.                                                      00004010
      DO 270 L=LMIN,LMAX                                                00004020
      IF (ER.NE.O. .AND. IABS(MB-L).GT.NCRD) GO TO 270                  00004030
      VL       = FLOAT(L)                                               00004040
      PSON(M) = PSON(M) + ((C8 - C3*(VMB-VL)/VMB) * OJ(1+IABS(MB-L)) /  00004050
     1 VL**1.61)**2                                                     00004060
  270 CONTINUE                                                          00004070
      PSON(M) = PSON(M) * C10 * DDBNSV                                  00004080
C     FREQUENCY OF HARMONIC , HZ , ADD TO APPROPRIATE 1/3-OCTAVE BAND   00004090
  280 F        = VM * BPF                                               00004100
      IF (M .EQ. 1) PSQ(1) = PSQ(1) + CCBT                              00004110          09/08/75
      IF (M .EQ. 1) PSON(1) = PSON(1) + DDBT                            00004120          09/08/75
      IG       = IF                                                     00004130          09/05/75
      DO 290 IFF=IG,30                                                  00004140          09/05/75
      IF (F .LT. BLF(IFF) .OR. F .GT. BLF(IFF+1)) GO TO 290             00004150
      IF       = IFF                                                    00004160
      IF (PSQ(M)+PSON(M) .LT. SPL(IA,IFF)*.01) INS = 0                  00004170
      SPL(IA,IFF) = SPL(IA,IFF) + PSQ(M) + PSON(M)                      00004180
      GO TO 300                                                         00004190
  290 CONTINUE                                                          00004200
      GO TO 340                                                         00004210
  300 CONTINUE                                                          00004220
C     END OF HARMONIC ORDER LOOP ON M                                   00004230
      IF (DA(6) .NE. 3. .OR. THRUST.LT.0.) GO TO 340                    00004240          11/07/75
      DO 310 M=1,MMAX                                                   00004250
      PSQ (M) = 10.*ALOG10(PSQ(M)) + DBN                                00004260          11/26/75
  310 PSON(M) = 10.*ALOG10(PSON(M)) + DBN                               00004270          11/26/75
      WRITE (NP,320) MMAX,BPF,ANGLE(IA),(PSQ(M),M=1,MMAX)               00004280
  320 FORMAT (//I4,61H STEADY AND NON-STEADY HARMONICS WITH FUNDAMENTAL 00004290
     1FREQUENCY =,F6.1,23H HZ AT AZIMUTH ANGLE OF,F5.0,4H DEG/11H     ST00004300
     2EADY,20F6.1,4(/11X,20F6.1))                                       00004310
      WRITE (NP,330) (PSON(M),M=1,MMAX)                                 00004320
  330 FORMAT (11H NON-STEADY,20F6.1,4(/11X,20F6.1))                     00004330
C     CONVERT TO SPL , ADD CORRECTION FOR NUMBER OF PROPELLERS AND      00004340
C      SUBTRACT ATMOSPHERIC ATTENUATION                                 00004350
  340 DO 350 IF=1,30                                                    00004360
  350 SPL(IA,IF) = 10.*ALOG10(SPL(IA,IF)) + DBN - ZO(IA)*ATTNT(IF)      00004370
  360 CONTINUE                                                          00004380
C     END OF AZIMUTH ANGLE LOOP                                         00004390
      IF (THRUST .GT. 0.) GO TO 400                                     00004400          11/07/75
      DO 380 IF=1,30                                                    00004410          11/07/75
      PSQ(IF) = 0.                                                      00004420          11/07/75
      DO 370 IA=1,15                                                    00004430          11/07/75
  370 PSQ(IF) = PSQ(IF) + CSUM(IA)*10.**((SPL(IA,IF)+ZO(IA)*ATTNT(IF)+  00004440          11/07/75
     1DP*SP(IA))/10.)                                                   00004450          11/10/75
  380 PSQ(IF) = 10.*ALOG10(PSQ(IF)) + 7. - 3.0103                       00004460          11/07/75
      DO 390 IA=1,15                                                    00004470          11/07/75
      DO 390 IF=1,30                                                    00004480          11/07/75
```

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RUN NO. 5717     DATE  C4/14/76     TIME  1653          LISTING OF MODULE H5941

  390 SPL(IA,IF) = PSC(IF) - ZO(IA)*ATTNI(IF) - DPWSP(IA) + RDI(IA)        00004490          11/07/75
  4CC IF (DA(6) .EQ. 0.) GO TO 420                                          00004500          11/07/75
      WRITE (NP,410)                                                        00004510          11/07/75
  410 FORMAT (22HITOTAL PROPELLER NOISE)                                    00004520          11/07/75
      CALL ENLC (SPL)                                                       00004530          11/07/75
C     ADD TO TOTAL NOISE                                                    00004540
  420 DO 430 IF=1,30                                                        00004550          11/07/75
      DO 430 IA=1,15                                                        00004560          11/07/75
      C1        = 10.**(SPL(IA,IF)/10.)                                     00004570
      PWLT(IA,IF) = PWLT(IA,IF) + C1                                        00004580          06/25/75
  430 SPLT(IA,IF) = SPLT(IA,IF) + C1                                        00004590          11/07/75
      IF (DA(12) .GT. 0.) CALL GRHCXN (IFIX(DA(12)),PHP,RPM,DBN,DA(153))C00004600          11/07/75
      DA(262) = 0.                                                          00004610          09/23/75
      IF (DA(153).NE.0.) CALL CCENG (0,DHP,PHP,DBN,IFIX(DA(154)),1.,ENG,00004620          11/07/75
     1DA(267),ENG,DA(274),DA(275),DA(276),0.,0.,0.)                         00004630          09/26/75
      RETURN                                                                00004640
 1000 WRITE (NP,1010)                                                       00004650          06/11/75
 1010 FORMAT (/71H FREE-AIR PROPELLER NOISE NOT CALCULATED BECAUSE OF ER00004660          06/11/75
     1ROR IN INPUT DATA)                                                    00004670          06/11/75
      DA(10)  = 0.                                                          00004680          08/22/75
      RETURN                                                                00004690          06/11/75
      END                                                                   00004700
```

Subroutine COENG

This subroutine calculates the noise from the core engine sources. It includes generalized parameters which are scaled based on a given design SHP input, then further adjusted to off-design conditions. The noise sources calculated include the compressor, the combustor, the turbine, and the jet. Duct treatment corrections are also applied to the calculated engine noise levels by this subroutine. The turbine noise portion may be used to calculate the noise of lift fan tip turbines.

```
DESCRIPTION          CCENG - CORE ENGINE NOISE

MASTER FILE          LIBR.G04
ADDED TC MASTER      05/30/75
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PASSWORD             FJXP
PROGRAMMER           F.W.BARRY
PROC PARAMETER       $NCJCL

      SUBROUTINE CCENG (I,DHP,HP,DBN,J,RPM,DAT1,D1,DAT2,D2,D3,D4,D5,D6,  C0000010          11/11/75
     1D7)                                                                  00000020          09/26/75
C     COMPUTES CORE ENGINE (COMPRESSOR, COMBUSTOR & TURBINE) NOISE       C0000040
C     CCENG CALLS PNLC, JETN; CALLED BY MAIN, FFFAN, FAPROP, SHRP, VPFANC0000050          10/02/75
C     , VPLFAN, FPLFAN                                                     00000060          10/02/75
      DIMENSION SPL(15,30),SPLE(15,30),DCB(15),ATN150(30),DAT(23),       C0000070          09/08/75
     1 C1(15),ENG(3,2),DAT1(10),DAT2(6),DS(4,2)                           CC000080          02/10/76
      COMMON /DATA/ ANGLE(15),BCFR(30),NR,NP,C,FOL(20),DATE(2),TIME(2),  C000C090
     1 ATTNT(30),SPLT(15,30),SPLTU(15,30),CBNU(7),XC(15),XC(15),ZO(15),  00000100
     2 PSI(15),CO(15),DCC(15),HPT,TF,VELFL,VM(15),PWLT(15,30),           00000110          08/25/75
     3 DIRIN(498),DIREX(498),BLF(31),CPWSF(15),RPMG,DHPT,RRPM             CC000120          08/25/75
      COMMON / DATAI/DA(200)                                              CC000130
C     ATMOSPHERIC ATTENUATION FOR 59F, 70PCT REL.HUM. AND 150 FT         00000140
      DATA ATN150 / .00537,.00677,.CC860,.01C75,.01355,.01721,.02153,.02C0000150
     1692,.03449,.C4316,.05402,.06818,.C8679,.10877,.13751,.17545,.22051 CCCC0160
     2,.27753,.35367,.45683,.60332,.81539,1.14517,1.36199,1.90627,2.782200000170
     35,4.11427,5.84058,8.59953,12.465CC /                                C0000180
      DATA ENG /4HTURB,4HCSHA,4HFT E,4H  TU,4HRBCF,4HAN E/               00000190
      DATA DS / 4HGENE,4HRALI,4HZATI,4HCN  ,4HINPU,4HT DA,4HTA R,4HEAD /00000200          02/10/76
C     INPUT DATA IN ORDER :                                               C0000210          09/08/75
C           I    = 0 FOR COMPLETE ENGINE , =1 FOR TIP TURBINE            00000220          09/08/75
C           DHP  DESIGN HP                                                C0000230          09/08/75
C           HP   OPERATING HP                                             00000240          09/08/75
C           DBN  DB CORRECTION FOR NUMBER OF ENGINES                      00000250          09/08/75
C           J    = 0 IF USE TYPICAL TURBOSHAFT ENGINE GENERALIZATION     CC000260          09/08/75
C                = 1 IF USE FOLLOWING DETAILED DESCRIPTION                00000270          09/08/75
C           RPM  = OPERATING RPM / DESIGN RPM                            CCCC0280          09/08/75
C     INPUT DATA FOR CORE ENGINE COMPRESSOR NOISE                        CC000290
C      1    RPMC COMPRESSOR RPM                                           C0000300          09/08/75
C      2    D    COMPRESSOR DIAMETER , FT                                 CC000310          09/08/75
C      3    FPR  COMPRESSOR FIRST-STAGE PRESSURE RATIO                   CC0C0320          09/08/75
C      4    RSS  COMPRESSOR FIRST-STAGE ROTOR-STATOR SPACING IN PERCENT  C0000330          09/08/75
C      5    BC   COMPRESSOR FIRST-STAGE NUMBER OF BLADES                  C0000340          09/08/75
C     INPUT DATA FOR COMBUSTION NOISE                                     C0000350
C      6    CK   =0. FOR TURBOSHAFT ENGINE, =1. FOR TURBOFAN ENGINE      CC000360          09/08/75
C      7    P3   COMBUSTOR INLET TOTAL PRESSURE , PSF                     CC0C0370          09/08/75
C      8    T3   COMBUSTOR INLET TOTAL TEMPERATURE , DEG R                C0000380          09/08/75
C      9    T4   COMBUSTOR EXIT TOTAL TEMPERATURE , DEG R                 CC000390          09/08/75
C     10    QMA  MASS FLOW RATE , LBM / SEC                               CCCC0400          09/08/75
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C      INPUT DATA FOR CORE ENGINE TURBINE NOISE
C      11    QMT   MASS FLOW RATE , LBM / SEC                                  09/08/75
C      12    VTR   RELATIVE TIP SPEED OF LAST TURBINE ROTOR , FPS              09/08/75
C      13    CL    SPEED OF SOUND AT TURBINE EXIT , FPS                        09/08/75
C      14    SOC   LAST STAGE STATOR-ROTOR SPACING / STATOR CHORD              09/08/75
C      15    VK    =0. FOR CO-PLANAR EXHAUSTS , -10. FOR RECESSED EXHAUST      09/08/75
C      16    BT    NUMBER OF BLADES IN LAST TURBINE ROTOR                      09/08/75
C      17    RPMT  TURBINE RPM                                                 09/08/75
C      INPUT DATA FOR JET NOISE                                                08/25/75
C      18          = 1 IF JET NOISE , =0 IF NO JET NOISE                       10/29/75
C      19    THRT  THRUST OF JET , LB                                          09/08/75
C      20    AREA  AREA OF JET , SQ. FT                                        09/08/75
C      21          WEIGHT FLOW OF BYPASS JET , LB/SEC                          09/08/75
C      22          THRUST OF BYPASS JET , LB                                   09/08/75
C      23          AREA OF BYPASS JET , SQ FT                                  09/09/75
       DAT(1)  = DAT1(1)                                                       09/29/75
       DAT(2)  = DAT1(2)                                                       09/29/75
       DAT(3)  = DAT1(3)                                                       09/29/75
       DAT(4)  = DAT1(4)                                                       09/29/75
       DAT(5)  = DAT1(5)                                                       09/29/75
       DAT(6)  = DAT1(6)                                                       09/29/75
       DAT(7)  = DAT1(7)                                                       09/29/75
       DAT(8)  = DAT1(8)                                                       09/29/75
       DAT(9)  = DAT1(9)                                                       09/29/75
       DAT(10) = DAT1(10)                                                      09/29/75
       DAT(11) = D1                                                            09/29/75
       DAT(12) = DAT2(1)                                                       09/29/75
       DAT(13) = DAT2(2)                                                       09/29/75
       DAT(14) = DAT2(3)                                                       09/29/75
       DAT(15) = DAT2(4)                                                       09/29/75
       DAT(16) = DAT2(5)                                                       09/29/75
       DAT(17) = DAT2(6)                                                       09/29/75
       DAT(18) = D2                                                            09/29/75
       DAT(19) = D3                                                            09/29/75
       DAT(20) = D4                                                            09/29/75
       DAT(21) = D5                                                            09/29/75
       DAT(22) = D6                                                            09/29/75
       DAT(23) = D7                                                            09/29/75
       IF (J .EQ. 1) GO TO 5                                                   09/08/75
       J       = 0                                                             02/10/76
C      SCALE FROM TYPICAL TURBOSHAFT ENGINE DATA                               08/26/75
       IF (I .NE. 0) GO TO 3                                                   09/08/75
       C1      = SQRT(DHP)                                                     09/08/75
       C2      = AMAX1(HF/DHP,.28)                                             09/08/75
       RPMC    = 1417120. * ((.268181-.0800677*C2)*C2+.811652) / C1            09/08/75
       D       = .01855 * C1                                                   09/08/75
       FPR     = 1.36 * ((.197204-.00196713*C2)*C2+.80477)                     09/08/75
       RSS     = 10.                                                           09/08/75
       BC      = 29.                                                           09/08/75
       P3      = 2518.24 * DA(3) * ((.830581-.131166*C2)*C2+.300459)           09/08/75
       T3      = 1261. * ((.369162-.112953*C2)*C2+.743578)                     09/08/75
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      T4       = 2686. * ((.432965-.C561693*C2)*C2+.66278)                  09/08/75
    3 QMT      = 50.3 * (DHP/9070.) * ((.8052-.18739*C2)*C2+.382163) +      09/08/75
     1           (DHP/9070.)                                                09/08/75
      QMA      = .83 * QMT                                                  09/08/75
      VTR      = 91C. * ((.51792+.002C3551*C2)*C2+.480041) * RPM**.33333    09/08/75
      CL       = 49. * SCRT(1381.*((.137674+.0264726*C2)*C2+.835471))      09/08/75
      SCC      = .5714                                                      09/08/75
      BT       = 112.                                                       09/08/75
      RPMT     = 930C8C.*RPM/C1                                             11/07/75
      IF (DAT(18) .EQ. 0.) GO TO 7                                          09/08/75
      THRT     = (600.*((.76143-.100019*C2)*C2+.339376)-VELFL)*QMT/32.174   09/08/75
      AREA     = 3.10915E-4 * DHP                                           11/05/75
      IF (D5 .EC. 0.) GO TO 7                                               11/05/75
C     ABSOLUTE PRIMARY VELOCITY = 2 * ABSOLUTE BYPASS VELOCITY             11/05/75
      CK       = 2. * (VELFL + 32.17*DAT(22)/CAT(21))                       11/05/75
      AREA     = AREA * (VELFL + 32.17*THRT/CMT) / CK                       11/05/75
      THRT     = QMT * (CK - VELFL) / 32.17                                 09/08/75
      GO TO 7                                                               09/08/75
    5 IF (I .NE. 0) GC TO 6                                                 09/08/75
      RPMC     = DAT(1)                                                     09/08/75
      D        = CAT(2)                                                     09/08/75
      FPR      = CAT(3)                                                     09/08/75
      RSS      = CAT(4)                                                     09/08/75
      BC       = CAT(5)                                                     09/08/75
      P3       = CAT(7)                                                     09/08/75
      T3       = DAT(8)                                                     09/08/75
      T4       = CAT(9)                                                     09/08/75
      QMA      = DAT(10)                                                    09/08/75
    6 QMT      = CAT(11)                                                    09/08/75
      VTR      = DAT(12)                                                    09/08/75
      CL       = DAT(13)                                                    09/08/75
      SOC      = CAT(14)                                                    09/08/75
      BT       = CAT(16)                                                    09/08/75
      RPMT     = CAT(17)                                                    09/08/75
      THRT     = DAT(19)                                                    09/08/75
      AREA     = CAT(20)                                                    09/08/75
    7 IC       = IFIX(CAT(6)) + 1                                           09/08/75
      CK       = 43.7                                                       09/08/75
      IF (IC .EQ. 2) CK = 35.7                                              09/10/75
      VK       = CAT(15)
      DO 10 IA=1,15
      CCB(IA) = 8.6858896 * ALOG(ZO(IA))                                    04/25/75
      QI(IA)  = 8.6858896 * ALOG(D/VM(IA)**2)
      DO 10 IF=1,30                                                         09/08/75
      SPLE(IA,IF) = 0.
   10 SPL(IA,IF) = 0.                                                       09/08/75
      IF (I .NE. 0) GO TO 386
C     CCMPUTES CORE ENGINE CCMPRESSCR NCISE
      BPF      = RPMC * BC / 60.                                            02/10/76
      WRITE (NP,20) HCL,DATE,TIME,RPMC,C,BC,RSS,FPR,BPF,(DS(IA,J+1),IA=1    02/10/76
     1,4)
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   20 FORMAT (1H1,41X,28HCORE-ENGINE CCMPRESSOR NOISE // 1H ,2CA4,2X,2A400001430
     1,2X,2A4 // 6H RPM =,F7.0,25H , FIRST STAGE CIAMETER =,F6.2,5H FT ,00001440   11/11/75
     2F4.0,32H BLADES , ROTOR/STATOR SPACING =,F6.1,26H %, STAGE PRESSUR00001450
     3E RATIO =,F7.4 / 26H BLADE PASSING FREQUENCY =,F7.0,25H HZ , CCNFI00001460  02/10/76
     4GURATICN FROM ,4A4 )                                              00001470  02/10/76
      IF (RPMC.LE.0. .OR. C.LE.0. .OR. FPR.LE.1. .CR. RSS.LE.0. .OR. BC.00001480  06/11/75
     1LT.2.) GO TO 302                                                  00001490  06/11/75
C     EQUATICN 34 OF NASA CR-114649 FCR BRCADBAND NCISE - F1+F2         00001500
      VL34     = 83. + 17.*ALOG10(FPR-1.)                               00001510
      IF (RSS .GT. 25.) GO TC 30                                        00001520
      VL34     = VL34 + 5.396                                           00001530
      GC TO 50                                                          00001540
   30 IF (RSS .GT. 400.) GO TO 40                                       00001550
      C1       = 5. * ALOG10(300./RSS)                                  00001560
      VL34     = VL34 + C1                                              00001570
      GC TC 50                                                          00001580
   40 VL34     = VL34 - .6247                                           00001590
C     EQUATICN 36 FOR DISCRETE TCNE NOISE - F1(FIG.58) + F2(FIG.61)     00001600
   50 VL36     = 82.                                                    00001610
      IF (FPR .LT. 1.4) VL36 = 88. + 15.*ALOG10(FPR-1.)                 00001620
      IF (RSS .GT. 25.) GO TO 60                                        00001630
      VL36     = VL36 + 10.792                                          00001640
      GC TO 80                                                          00001650
   60 IF (RSS .GT. 4CC.) GO TO 70                                       00001660
      VL36     = VL36 + 2.*C1                                           00001670
      GC TO 80                                                          00001680
   70 VL36     = VL36 - 1.249                                           00001690
C     START LOOP FOR 15 AZIMUTH ANGLES                                  00001700
   80 DO 290 IA=1,15                                                    00001710
C     ADD DIRECTIVITY CORRECTICN F3 (FIG.63) ANC SIZE-DOPPLER CCRRECTICN00001720
      VL34A    = VL34 + Q1(IA)                                          00001730
      IF (PSI(IA) .LE. 60.) GC TC 130                                   00001740
      IF (PSI(IA) .GT. 70.) GO TC 90                                    00001750
      VL34A    = VL34A + 12. - .2*PSI(IA)                               00001760
      GO TO 130                                                         00001770
   90 IF (PSI(IA) .GT. 80.) GO TO 100                                   00001780
      VL34A    = VL34A + 19. - .3*PSI(IA)                               00001790
      GO TC 130                                                         00001800
  100 IF (PSI(IA) .GT. 90.) GO TC 110                                   00001810
      VL34A    = VL34A + 35. - .5*PSI(IA)                               00001820
      GO TC 130                                                         00001830
  110 IF (PSI(IA) .GT. 120.) GO TO 120                                  00001840
      VL34A    = VL34A + 44. - .6*PSI(IA)                               00001850
      GO TO 130                                                         00001860
  120 VL34A    = VL34A - 28.                                            00001870
  130 VL36A    = VL36 + Q1(IA) + 2.                                     00001880
      IF (PSI(IA) .LE. 2C.) GO TO 220                                   00001890
      IF (PSI(IA) .GT. 30.) GO TC 140                                   00001900
      VL36A    = VL36A + .4 - .02*PSI(IA)                               00001910
      GO TO 220                                                         00001920  09/08/75
  140 IF (PSI(IA) .GT. 40.) GO TC 150                                   00001930
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      VL36A    = VL36A + .7 - .03*PSI(IA)
      GO TO 220
  150 IF (PSI(IA) .GT. 50.) GO TO 160
      VL36A    = VL36A + 1.5 - .05*PSI(IA)
      GO TO 220
  160 IF (PSI(IA) .GT. 60.) GO TO 170
      VL36A    = VL36A + 4. - .1*PSI(IA)
      GO TO 220
  170 IF (PSI(IA) .GT. 70.) GO TO 180
      VL36A    = VL36A + 10. - .2*PSI(IA)
      GO TO 220
  180 IF (PSI(IA) .GT. 80.) GO TO 190
      VL36A    = VL36A + 17. - .3*PSI(IA)
      GO TO 220
  190 IF (PSI(IA) .GT. 90.) GO TO 200
      VL36A    = VL36A + 33. - .5*PSI(IA)
      GO TO 220
  200 IF (PSI(IA) .GT. 120.) GO TO 210
      VL36A    = VL36A + 42. - .6*PSI(IA)
      GO TO 220
  210 VL36A    = VL36A - 26.
C     FUNDAMENTAL BLADE PASSING FREQUENCY IN HZ
  220 FO       = BPF / VM(IA)                                        06/25/75
      AOI      = (VL36A - 3.) / 10.
      IPWL     = 0                                                   06/25/75
  225 NII      = IFIX(1. + BLF(1)/FO)                                08/25/75
C     START 1/3-OCTAVE BAND FREQUENCY LOOP
      DO 280 IF=1,30
C     ADD BROADBAND FREQUENCY CORRECTION , EQUATION 35 , FIGURE 56A
      C1       = 4.342944E * ALOG(BCFR(IF)/FO)
      IF (C1 .GT. 3.0103) GO TO 230
      VL34AF   = VL34A + C1 - 3.
      GO TO 240
  230 VL34AF   = VL34A - 2.*C1 + 6.
C     SUM BROADBAND AND DISCRETE TONE NOISE ON AN ENERGY BASIS
  240 N2I      = IFIX(BLF(IF+1) / FO)                                08/25/75
      PI       = 0.
      IF (NII .GT. N2I) GO TO 270
      DO 260 K=NII,N2I
      IF (K .EQ. 1) GO TO 250
      PI       = PI + 10.**(AOI-.3*K)
      GO TO 260
  250 PI       = PI + 10.**(VL36A/10.)
  260 CONTINUE
  270 PI       = PI + 10.**(VL34AF/10.)                              06/25/75
      NII      = N2I + 1
      IF (IPWL .EQ. 1) GO TO 275                                     06/25/75
      SPL(IA,IF) = SPL(IA,IF) + PI                                   07/08/75
      GO TO 280                                                      06/25/75
  275 SPLE(IA,IF) = SPLE(IA,IF) + PI                                 09/25/75
  280 CONTINUE
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      IF (IPWL .EQ. 1) GC TC 29C                                          06/25/75
      IPWL     = 1                                                        06/25/75
      FO       = BPF                                                      06/25/75
      GC TO 225                                                           06/25/75
C     END CF FREQUENCY LCOP
  290 CCNTINUE
C     END CF AZIMUTH ANGLE LOOP
C     HAVE NOISE AT 150-FT RADIUS FOR STANCARC CAY , NCW CCNVERT TO SPL,
C      ADD CBN TO ALLOW FOR NUMBER OF ENGINES, ADD ATN150(IF) TC REMCVE
C      STANCARD CAY ATMOSPHERIC ATTENUATICN TC 150FT , SUBTRACT ACTUAL
C      ATTENUATICN TO SIDELINE = ATTNT(IF)*ZO(IA) , ADD 43.5218-DDB(IA)
C      TC ACCOUNT FOR SPHERICAL SPREADING FROM 150FT TO SIDELINE
      DO 300 IF=1,30                                                      06/25/75
      DC 3C0 IA=1,15                                                      06/25/75
      PI       = DBN + ATN150(IF) - ATTNT(IF)*ZO(IA) + 43.5215 - DDB(IA)   09/26/75
      PWLT(IA,IF) = PWLT(IA,IF) + 10.**((10.*ALCG10(SPLE(IA,IF)) + PI) /  09/26/75
     110.)                                                                09/26/75
      SPL(IA,IF) = 1C.*ALOG10(SPL(IA,IF)) + PI                            09/26/75
  3C0 SPLE(IA,IF) = 10.**(SPL(IA,IF)/10.)
      IF (DA(6) .NE. 0.) CALL PNLC (SPL)
      GO TO 308                                                           06/11/75
  302 WRITE (NP,304)                                                      06/11/75
  304 FORMAT (/63H CCMPRESSOR NOISE NOT CALCULATEC BECAUSE CF ERROR IN 1  06/11/75
     INPUT DATA)                                                          06/11/75
C     CCMPUTES CCRE ENGINE CCMBUSTCR NCISE
  308 WRITE (NP,310) HOL,DATE,TIME,P3,T3,T4,QMA,(ENG(IF,IC),IF=1,3)       06/11/75
     1,(DS(IF,J+1),IF=1,4)                                                02/10/76
  310 FCRMAT (1H1,41X,28HCORE-ENGINE CCMBUSTICN NCISE // 1H ,20A4,2X,2A4
     1,2X,2A4 // 23H INLET TOTAL PRESSURE =,F8.0,32H PSF , INLET TOTAL T
     2EMPERATURE =,F6.0,29H R , EXIT TCTAL TEMPERATURE =,F6.0,2H R / 17H
     3 MASS FLOW RATE =,F6.1,10H LB/SEC , ,3A4,27HNGINE , CONFIGURATION   02/10/76
     4FRCM ,4A4)                                                          02/10/76
      IF (IC.LT.1 .OR. IC.GT.2 .OR. P3.LE.C. .OR. T3.LE.0. .OR. T4.LE.T3  06/11/75
     1 .OR. QMA.LE.O.) GO TO 382                                          06/11/75
      C1       = QMA * ((T4-T3) * P3/(144.*DA(3)) * (459.69+DA(1))/T3)**2
      FP       = 76.767656 * SORT(P3 / (QMA * SORT(T4)))
      IF (FP.LT.300. .OR. FP.GT.1000.) FP = 400.
C     START AZIMUTH ANGLE LOOP , 20DEG TO 16CDEG , INCEX IA
      DO 380 IA=1,15
      IF (PSI(IA) .GT. 117.) GO TO 320
      F2       = .24*PSI(IA) - 28.08
      GO TO 340
  320 IF (PSI(IA) .GT. 126.) GC TO 33C
      F2       = C.
      GO TO 340
  33C F2       = 34.02 - .27*PSI(IA)
  34C C2       = 4.3425448 * ALOG(C1/ VM(IA)**2) - DDB(IA) + F2 + CK +CBN  06/25/75
C     START LOOP FOR 1/3-O.B.C.F. FROM 25 TO 20C00 HZ , INCEX IF
      DC 370 IF=1,3C
      F1       = ABS(ALCG(BCFR(IF)/FP))                                   06/25/75
      IF (F1 .GT. .3855) GO TO 350
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      F1       = -4.2429448 * F1
      GC TO 360
  350 F1       = -10.423068 * F1 + 2.3
  360 SPL(IA,IF) = C2 + F1 - ATTNT(IF)*ZO(IA)
      F1       = 10.**(SPL(IA,IF)/10.)                              06/25/75
      PWLT(IA,IF) = PWLT(IA,IF) + F1                                06/25/75
  370 SPLE(IA,IF) = SPLE(IA,IF) + F1                                06/25/75
C     ENC CF FREQUENCY LOOP , INCEX IF
  380 CCNTINUE
C     END OF AZIMUTH ANGLE LOOP , INCEX IA
      IF (DA(6) .NE. 0.) CALL PNLC (SPL)
      GC TO 386                                                     06/11/75
  382 WRITE (NP,384)                                                06/11/75
  384 FORMAT (/62H COMBUSTCR NOISE NOT CALCULATEC BECAUSE OF ERROR IN I 06/11/75
     1PUT DATA)                                                     06/11/75
C     COMPUTES CCRE ENGINE TURBINE NCISE
  386 BPF      = RPMT * BT / 60.                                    06/11/75
      WRITE (NP,390) HOL,DATE,TIME,BT,SCC,VK,RPMT,BPF,VTR,CL,QMT,DHP,HP 09/26/75
     1,(DS(IF,J+1),IF=1,4)                                          02/10/76
  390 FORMAT (1H1,42X,25HCORE-ENGINE TURBINE NOISE // 1H ,2CA4,2X,2A4,2X
     1,2A4 // 21H LAST ROTOR STACE HAS,F5.0,45H BLADES , STATOR-RCTCR SP 08/28/75
     2ACING/STATOR CHORD =,2PF6.1,25H % , EXHAUST CORRECTION =,0PF5.C,3H
     3 DB/ 6H RPM =,F7.0,28H , BLADE PASSING FRECUENCY =,F5.0,37H HZ , L 08/28/75
     4AST ROTOR RELATIVE TIP SPEED =,F6.0,28H FPS , EXIT SPEED OF SOUND
     5=,F6.0,4H FPS/ 17H MASS FLOW RATE =,F5.1,39H LB/SEC , CESIGN (TAKE 11/13/75
     6OFF) HORSEPOWER =,F7.0,17H , OPERATING HP =,F7.0,22H , CONFIGURATI 02/10/76
     7CN FROM ,4A4)                                                 02/10/76
      IF (QMT.LE.0. .OR. VTR.LE.C. .CR. CL.LE.0. .OR. SOC.LE.0. .CR. BT. 08/26/75
     1LT.2. .OR. RPMT.LE.0.) GO TO 510                              06/11/75
      C1       = QMT * (VTR/CL)**3                                  08/26/75
      C2       = QMT * VTR**.6 / CL**3 / SOC                        08/26/75
      DO 500 IA=1,15
      FJ       = BPF                                                06/25/75
      IF (PSI(IA) .GT. 60.) GO TO 400
      F1       = .4*PSI(IA) - 37.2
      GC TO 440
  400 IF (PSI(IA) .GT. 100.) GO TO 410
      F1       = .3*PSI(IA) - 31.2
      GO TO 440
  410 IF (PSI(IA) .GT. 120.) GO TO 420
      F1       = -.12 * ABS(PSI(IA)-11C.)
      GO TO 440
  420 IF (PSI(IA) .GT. 14C.) GC TO 430
      F1       = -.38*PSI(IA) + 44.4
      GO TO 440
  430 F1       = -.50*PSI(IA) + 61.2
  440 IF (PSI(IA) .GT. 100.) GO TO 450
      F3       = .4*PSI(IA) - 42.5
      GC TO 480
  450 IF (PSI(IA) .GT. 110.) GO TO 460
      F3       = .25*PSI(IA) - 27.5
```

```
      GO TO 480
  460 IF (PSI(IA) .GT. 120.) GO TO 470
      F3      = -.2*PSI(IA) + 22.
      GO TO 480
  470 F3      = -.5*PSI(IA) + 70
C     BROADBAND NOISE
  480 F1      = 4.3429448 * ALOG(C1/ VM(IA)**4) - COB(IA) + F1+124.9+DBN     06/25/75
C     TONE NOISE
      F3      = 4.3425448 * ALOG(C2/ VM(IA)**4) - COB(IA) + F3+150.9 +VK     06/25/75
      FP      = F0
      DO 490 IF=1,30
      F2      = 4.3429448 * ALOG(BCFR(IF)/F0)
      IF (F2 .GT. 0.) F2 = -2. * F2
      SPL(IA,IF) = F1 + F2 - ATTNT(IF)*ZO(IA)
      IF (BLF(IF+1) .LT. FP) GO TO 485                                      08/25/75
C     ONE OF 4 HARMONICS IN 1/3-O.B. , ADD TO BROADBAND NOISE
      SPL(IA,IF) = 10. * ALOG10(10.**(SPL(IA,IF)/10.) + 10.**(F3/10.))
      F3      = F3 - 10.
      FP      = FP + F0
      IF (FP .GT. 4.5*F0) FP = 23000.
  485 F2      = 10.**(SPL(IA,IF)/10.)                                       06/25/75
      PWLT(IA,IF) = PWLT(IA,IF) + F2                                        06/25/75
  490 SPLE(IA,IF) = SPLE(IA,IF) + F2                                        06/25/75
C     END OF FREQUENCY LOOP , INDEX IF
  500 CONTINUE
C     END OF AZIMUTH ANGLE LOOP , INDEX IA
      IF (DA(6) .NE. 0.) CALL PNLC (SPL)
      GO TO 530                                                             06/11/75
  510 WRITE (NP,520)                                                        06/11/75
  520 FORMAT (/60H TURBINE NOISE NOT CALCULATED BECAUSE OF ERROR IN INPU    06/11/75
     1T DATA)                                                               06/11/75
  530 DO 540 IF=1,30                                                        05/25/75
      DO 540 IA=1,15                                                        06/25/75
  540 SPLT(IA,IF) = SPLT(IA,IF) + SPLE(IA,IF)                               11/11/75
      IF (DA(6) .LT. 2.) GO TO 570                                          08/26/75
      IF (I .NE. 0) GO TO 570                                               09/08/75
      DO 550 IF=1,30                                                        06/25/75
      DO 550 IA=1,15                                                        06/25/75
  550 SPLE(IA,IF) = 10. * ALOG10(SPLE(IA,IF))                               06/11/75
      WRITE (NP,560) HOL,DATE,TIME                                          06/11/75
  560 FORMAT (1H1,44X,23HTOTAL CORE ENGINE NOISE // 1H ,20A4,2X,2A4,2X,2    06/11/75
     1A4 //)
      CALL PNLC (SPLE)
  570 IF (DAT(18) .EQ. 0.) RETURN                                           10/29/75
      CALL JETN (QMT,THRT,AREA,DAT(21),DAT(22),DAT(23),SPL,SPLE)            09/08/75
      DO 590 IF=1,30                                                        08/26/75
      DO 580 IA=1,15                                                        08/26/75
      SPL(IA,IF)  = SPL(IA,IF) + DBN                                        08/26/75
      SPLE(IA,IF) = SPLE(IA,IF) + DBN                                       08/26/75
      F2      = 10.**(SPL(IA,IF)/10.)                                       08/26/75
      PWLT(IA,IF)  = PWLT(IA,IF) + 10.**(SPLE(IA,IF)/10.)                   09/08/75
```

```
  580 SPLT(IA,IF)  = SPLT(IA,IF) + F2                                      00003980      11/05/75
      WRITE (NP,590) HOL,CATE,TIME,QPT,THRT,AREA                           00003990      08/29/75
  590 FORMAT (1H1,45X,21HCORE ENGINE JET NOISE//1H ,20A4,2X,2A4,2X,2A4/   00004000      08/29/75
     116H JET FLOW RATE =,F5.1,18H LB/SEC , THRUST =,F7.0,12H LB , AREA   00004010      08/29/75
     2=,F5.1,6H SQ.FT)                                                     00004020      08/29/75
      IF (DA(6) .NE. 0.) CALL PNLC (SPL)                                   00004030      11/05/75
      RETURN                                                               00004040
      END                                                                  00004050
```

Subroutine RVINT

This subroutine is used to calculate the rotor-stator interaction noise of variable-pitch fans with outlet guide vanes and the stator-rotor interaction noise of variable pitch fans with inlet guide vanes. It is used for propulsion fans, lift fans, and shrouded helicopter tail rotors.

```
DESCRIPTICN         RVINT - SHRCUDED PROP + VP FAN

MASTER FILE         LIBR.G04
ADDED TC MASTER     06/25/75
LAST DATE COPIED      NCNE
LAST UPCATE         04/14/76  1653          *** TEMPORARY UPCATE ***

PASSWCRD            VXPT
PROGRAMMER          F.W.BARRY
PRCC PARAMETER      $NCJCL


      SUBROUTINE RVINT (PWLT,PWLB,MMAX,VK,IGCG,B,V,RE,H,D,VT,BPF,VMT,BE,00000010
     1 CM,CU,CD,CUP,CDN,STLD,SIGF,DCLDA,SIGA,SIGP)                      00000020
C     CALCULATES TCNE ANC BROADBAND SCUNC PCWER LEVELS DUE TO ROTOR-IGV 00000040   08/16/75
C      (VARIABLE-PITCH FAN WITH IGV, V-P LIFT FAN, SHROUDED TAIL ROTOR) 00000050   10/28/75
C       CR CGV-ROTOR (V-P FAN WITH CGV) INTERACTICN                     00000060   10/28/75
C     RVINT CALLS BESJH, RVINTS ; CALLED BY SHRP, VPFAN, VPLFAN, SHTR   00000070   10/28/75
      DIMENSION PWLT(20),PWLB(30),ETA(200),AK(101)                      00000080
      CCMMCN /DATA/ ANGLE(15),RCFR(3C),NR,NP,C                          00000090
      CCMMCN / JNX / BES(450)                                           00000100
C                                                                       00000110
C     EXPLANATICN CF ARGUMENTS IN SUBROUTINE STATEMENT                  00000120
C      NAME   1     2    = IGCG                                         00000130
C      PWLT                SOUNC POWER CF MMAX HARMONICS CF BPF RE 10E-13 W 00000140
C      PWLB                BROADBAND SOUNC POWER IN 30 1/3-OCTAVE BANDS 00000150
C      MMAX                NUMBER OF TCNE HARMCNICS TO CALCULATE , INITIALLY 00000160
C                          20, 70DB CUTOFF MAY REDUCE NUMBER CALCULATED 00000170
C        VK                K = CCEFFICIENT IN POWER FCRMULAE            00000180
C      IGCG                =1 FCR IGV-RCTCR CASES                       00000190   10/28/75
C                          =2 FOR RUTOR-OGV (VARIABLE-FITCH FAN) CASE   00000200
C         B                NUMBER CF BLADES ON ROTOR                    00000210
C         V   IGV   OGV    NUMBER OF VANES                              00000220
C        RE                EFFECTIVE RADIUS RATIO .0. LT RE LE 1.)      00000230
C         H                HUB / TIP DIAMETER RATIO                     00000240
C         D                TIP CIAMETER , FT                            00000250
C        VT                RCTCR TIP RCTATICNAL VELOCITY , FPS          00000260
C       BPF                ROTOR BLADE PASSING FRECUENCY , HZ , VT*B/(PI*D) 00000270
C       VMT                ROTOR TIP ROTATICNAL MACH NUMBER , VT/C      00000280
C        BE ROTOR OGV      BLACE (VANE) STAGGER ANGLE , DEG             00000290
C        CM                AXIAL VELOCITY , FPS                         00000300
C        CU                HALF SWIRL VELOCITY BETWEEN RCWS , FPS       00000310
C        CD IGV ROTOR      DRAG CCEFFICIENT                             00000320
C       CUP IGV RCTCR      CHORD , FT                                   00000330
C       CDN ROTOR OGV      CHCRD , FT                                   00000340
C      STLD                STACKING LINE CISTANCE , FT                  00000350
C      SIGF ROTOR CGV      SOLIDITY                                     00000360
C     DCLDA ROTOR OGV      LIFT CURVE SLOPE , /RACIAN                   00000370
C      SIGA                STANDARD CEVIATICN CF PAM , STD.=.5,1.       00000380   08/15/75
C      SIGP                STANDARD DEVIATICN CF PPM , STD.=.01,.02     00000390   08/16/75
C                                                                       00000400
```

```
      IF (IGOG .EQ. 2) GO TO 10
C     IGOG = 1 FOR IGV-ROTOR CASES                                       10/28/75
      C3       = 6.2831853 * V * SIGP
      UBAR     = SQRT (1. + (CU/CM)**2)
      UREL     = SQRT (CM**2 + (RE*VT + CU)**2)
      C7       = 19.739209 * BPF * CDN * V / (B * UREL)
      GO TO 20
C     IGOG = 2 FOR ROTOR-OGV (VARIABLE-PITCH FAN) CASE
   10 C3       = 5.0265482 * B * SIGP                                    01/29/76
      UBAR     = SQRT (1. + ((RE*VT - CU)/CM)**2)
      UREL     = SQRT (CM**2 + CU**2)
      C7       = 19.739209 * BPF * CDN / UREL
   20 BER      = .017453293 * BE
      FWW      = UBAR * (STLD - .25*CDN*COS(BER))/CUP
      FVD      = 1.21 * SQRT(CD) / (FWW-.2)
      FWW      = .4329*V*UBAR*CUP*SQRT((FWW-.35)*CD) / (RE*D)
      C1       = .032724923*VK*((1.-H**2)*SIGF*VMT*B)**2
      IF (IGOG .EQ. 2) FWW = FWW * B / V                                 01/29/76
      IF (IGOG .EQ. 2) C1 = C1 / EXP(C3**2)                              01/29/76
      C2       = 2. * B * RE * VMT
      C4       = 24. * SIN(BER)**2
      C5       = 24. - C4
      C6       = .5 * RE * VT * CM * DCLDA * FVD / C**2
C     CALCULATE TONE POWERS , MMAX HARMONICS OF BPF RE 1CE-13 WATTS
      PWLTM    = - 10C.
      KMAX     = C
      AM       = 1.
      DO 150 M=1,MMAX
C     COMPUTE MODAL EFFICIENCY ETA()
      DO 30 I=1,200
   30 ETA(I)   = C.
      VM       = FLOAT(M)
      Z        = VM * C2
      MJ       = 420
      IF (Z.GE.50.) MJ = MINO(420,MAX1(35.*Z**.33333333,42.+1.17*Z))
      CALL BESJH (Z,MJ,BES,ER,450,NP)
      IF (ER .NE. 0.) MJ = IFIX(ER) - 1
      C8       = VM * B
      V1       = C4 / Z**2
      V2       = C5 / Z**3
      IF (IGOG .EQ. 2) GO TO 160
      SUM      = 0.
      DO 130 K=1,10C
      VKK      = FLOAT(K)                                                10/04/75
      MBKV     = IFIX(C8 + VKK*V + .1)                                   10/28/75
      DSUM     = 0.
      IF (MBKV .GT. 200) GO TO 90                                        10/28/75
C     SUM OVER I USING CONVERGENCE TOLERANCE
      CALL RVINTS (MBKV,ETA,V1,V2,MJ,Z)                                  10/28/75
      DSUM     = ETA(MBKV+1)                                             10/28/75
   90 MBKV     = IFIX(ABS(C8-VKK*V)+.1)
```

```
      IF (MBKV .GT. 200) GO TO 140
      IF (ETA(MBKV+1) .NE. 0.) GO TO 100
      CALL RVINTS (MBKV,ETA,V1,V2,MJ,Z)                                10/28/75
  100 IF (K .LE. KMAX) GO TO 120
C     CALCULATE BLADE HARMONIC LOAD FACTOR A SUB K
      AK(K+1) = (C6 / SQRT(1.+C7*VKK) * SIN(3.1415927*VKK*FWW) / (3.1415
     1927*VKK*(1.-(VKK*FWW)**2)))**2
      KMAX    = KMAX + 1
  120 IF (C3*VKK .GT. 13.21) GO TO 140                                 01/29/76
      DSUM    = AK(K+1) * (DSUM+ETA(MBKV+1)) / EXP((C3*VKK)**2)        01/29/76
      SUM     = SUM + DSUM
      IF (ABS(DSUM) .LT. .005*ABS(SUM)) GO TO 140
  130 CONTINUE
  140 SUM     = C1 * SUM * AM * VM**2
C     FINISHED SUM OVER K USING CONVERGENCE TOLERANCE
      PWLT(M) = 1.E-70
      IF (SUM .LE. C.) GO TO 150
      PWLT(M) = SUM
      C10     = ALOG10(SUM)
      PWLTM   = AMAX1(PWLTM,C10)
C     CHECK IF DONT NEED 20 HARMONICS
      IF (C10 .LT. PWLTM-4.) GO TO 200
  150 CONTINUE
      GO TO 210
C     TONE POWER FOR VARIABLE-PITCH FANS , IGOG=2
  160 AM      = (C5 / SQRT(1.+C7*VM) * SIN(3.1415927*VM*FWW) / (3.141592
     17*VM*(1.-(VM*FWW)**2)))**2                                       01/29/76
      MBKV    = C8
      CALL RVINTS (MBKV,ETA,V1,V2,MJ,Z)                                10/28/75
      SUM     = ETA(MBKV+1)                                            10/28/75
      DO 190 K=1,100
      VKK     = FLOAT(K)                                               10/04/75
      MBKV    = IFIX(C8 + VKK*V + .1)                                  10/28/75
      DSUM    = C.                                                     10/28/75
      IF (MBKV .GT. 200) GO TO 174                                     10/28/75
C     SUM OVER I USING CONVERGENCE TOLERANCE                           10/28/75
      CALL RVINTS (MBKV,ETA,V1,V2,MJ,Z)                                10/28/75
      DSUM    = ETA(MBKV+1)                                            10/28/75
  174 MBKV    = IFIX(ABS(C8-VKK*V)+.1)
      IF (MBKV .GT. 200) GO TO 140
      CALL RVINTS (MBKV,ETA,V1,V2,MJ,Z)                                10/28/75
      DSUM    = DSUM + ETA(MBKV+1)                                     10/29/75
      SUM     = SUM + DSUM
      IF (ABS(DSUM) .LT. .005*ABS(SUM)) GO TO 140
  190 CONTINUE
C     FINISHED SUM OVER K USING CONVERGENCE TOLERANCE
      GO TO 140
C     FINISHED MMAX TONE HARMONICS
  200 MMAX    = M
C     CALCULATE POWER OF BROADBAND NOISE IN 30 1/3-OCTAVE BANDS
  210 FRCT    = BPF / B
```

```
      C1      = C1 / BPF**3 * .72256631 * RE * FWW / (1.-H)
      C2      = C2 / BPF
      C3      = (6.2831853*SIGP)**2
      C6      = C6 / 3.1415927
      C10     = 1. + SIGA**2
      IF (IGOG .EQ. 2) GO TO 220
      C7      = C7 / V
      C8      = 3.1415927 * FWW / V
      C9      = (FWW/V)**2
      DO 215 I=1,200
  215 ETA(I)  = C.
      GO TO 230
  220 C1      = C1 * B / V
      C3      = C3 / FRCT**2
      C6      = C6 * FRCT
      C7      = C7 / BPF
      C8      = 3.1415927 * FWW / B / FROT
      C9      = (FWW / BPF)**2
  230 DO 310 M=1,30
      IF (IGOG .EQ. 2) GO TO 290
C     BROADBAND NOISE POWER FOR SHROUDED PROPELLERS WITH IGV
      C15     = BCFR(M) / FRCT
      Z       = C2 * BCFR(M)
      MJ      = 420
      IF (Z.GE.50.) MJ = MINO(420,MAX1(39.*Z**.33333333,42.+1.17*Z))
      CALL BESJH (Z,MJ,BES,ER,450,NP)
      IF (ER .NE. 0.) MJ = IFIX(ER) - 1
      MBKV    = 0
      V1      = C4 / Z**2
      V2      = C5 / Z**3
      CALL RVINTS (MBKV,ETA,V1,V2,MJ,Z)                                  10/28/75
C     SUM OVER N , STARTING WITH N=0, UNTIL CONVERGED TO TOLERANCE       10/28/75
      C14     = C10                                                      01/29/76
      IF (C3*C15**2 .LT. 18.) C14 = C14 - EXP(-C3*C15**2)                01/29/76
      SUM     = ETA(1) * C14 * (C5 / SQRT(1.+C7*C15) * SIN(C8*C15) /     01/29/76
     1 (C15*(1.-C9*C15**2)))**2                                          01/29/76
      DO 250 MBKV=1,159                                                  10/28/75
      VN      = FLOAT(MBKV)                                              12/30/75
      CALL RVINTS (MBKV,ETA,V1,V2,MJ,Z)                                  10/23/75
      C11     = C15 + VN                                                 10/28/75
      C12     = ABS(C15-VN)
      C13     = -C3 * (C15+6.2831853*VN)**2
      C14     = C10
      IF (C13 .GT. -7.) C14 = C10 - EXP(C13)
      DSUM    = C14 * (SIN(C8*C11) / (SQRT(1.+C7*C11) * C11 * (1.-C9*C11
     1**2)))**2
      C13     = -C3 * (C15-6.2831853*VN)**2
      C14     = C10
      IF (C13 .GT. -7.) C14 = C10 - EXP(C13)
      IF (C12 .LT. .001) GO TO 260
      DSUM    = C14 * (SIN(C8*C12) / (SQRT(1.+C7*C12) * C12 * (1.-C9*C12
```

```
     1**2)))**2 + DSUM
      GC TO 270
  260 DSUM     = DSUM + C14 * C8**2
  27C DSUM     = CSUM * ETA(MBKV+1) * C6**2
      SUM      = SUM + DSUM
      IF (ABS(DSUM) .LT. .C05*ABS(SUM)) GO TO 300
  28C CCNTINUE
C     FINISHED SUM CVER N USING CCNVERGENCE TOLERANCE
      GC TO 300
C     BRCADBAND NCISE POWER FOR VARIABLE-PITCH FANS WITH OGV
  290 C14      = C10                                                       01/29/76
      IF (C3*BCFR(M)**2 .LT. 18.) C14 = C14 - EXP(-C3*BCFR(M)**2)          01/29/76
      SUM      = C14 * (C6 / SQRT(1.+C7*BCFR(M)) * SIN(C8*BCFR(M)) /       01/29/76
     1 (BCFR(M) * (1.-C9*BCFR(M)**2)))**2                                  01/29/76
  300 SUM      = SUM * C1 * BCFR(M)**3
      PWLB(M) = 1.E-70
      IF (SUM .GT. 0.) PWLB(M) = SUM
  310 CCNTINUE
C     FINISHED 30 1/3-OCTAVE BANDS
      RETURN
      END                                                                  10/28/75
      SUBRCUTINE RVINTS (MBKV,ETA,V1,V2,MJ,Z)                              10/28/75
      DIMENSION ETA(200)                                                   10/28/75
      CCMMCN / JNX / BES(450)                                              10/28/75
C     RVINTS CALLED BY RVINT                                               10/28/75
      VN       = FLOAT(MBKV)                                               10/28/75
      VNSC     = VN**2                                                     10/28/75
      J        = MBKV + MBKV + 1                                           10/28/75
      C11      = VN + VN + 1.                                              10/28/75
      C12      = C11                                                       10/28/75
      C13      = VN + 1.                                                   10/28/75
      C14      = 1.                                                        10/28/75
      ETA(MBKV+1) = 0.                                                     10/28/75
   60 ETA1     = V1/C11*C12/(C11+2.)*C13*C14*BES(J+2) + V2*VNSQ*BES(J+1)   10/28/75
      ETA(MBKV+1) = ETA(MBKV+1) + ETA1                                     10/28/75
      IF (J+2 .GT. MJ) GO TO 70                                            10/28/75
      IF (C11.GT.Z .AND. ABS(ETA1).LE..005*ABS(ETA(MBKV+1))) GO TO 7C      10/28/75
      J        = J + 2                                                     10/28/75
      C11      = C11 + 2.                                                  10/28/75
      C12      = C12 + 1.                                                  10/28/75
      C13      = C13 + 1.                                                  10/28/75
      C14      = C14 + 1.                                                  10/28/75
      GO TO 60                                                             10/28/75
C     CCMPLETED SUM CVER I                                                 10/28/75
   70 RETURN                                                               10/28/75
      END
```

Subroutine REVN

This routine calculates the broadband noise spectra for target and cascade fixed-pitch fan thrust reversers.

```
DESCRIPTION         REVN - THRUST REVERSER FP FAN

MASTER FILE         LIER.G04
ADDED TO MASTER     06/25/75
LAST DATE COPIED      NONE
LAST UPDATE         04/14/76  1653          *** TEMPORARY UPDATE ***

PASSWORD            CCVW
PROGRAMMER          F.W.BARRY
PROC PARAMETER      $NCJCL

      SUBROUTINE REVN (SPLR,CBN)                                         00000010     10/01/75
C     CALCULATE NOISE DUE TO THRUST REVERSER FOR FIXED-PITCH FAN         00000030
C     REVN CALLS PNLC ; CALLED BY FPFAN                                  00000040     08/16/75
      DIMENSION SPLR(15,30),HOLR(29)                                     00000050     10/01/75
      COMMON /DATA/ ANGLE(15),BCFR(30),NR,NP,C,HOL(20),DATE(2),TIME(2),  00000060
     1 ATTNT(30),SPLT(15,30),SPLTU(15,30),DBNU(7),XO(15),XC(15),ZO(15),  00000070
     2 PSI(15),DO(15),DDO(15),HPT,TR,VELFL,VM(15),PWLT(15,30)            00000080
      COMMON /DATAI/DA(200)                                              00000090
      EQUIVALENCE (DA(116),RT),(DA(117),AJ),(DA(118),TJ),(DA(119),VJ),   00000100
     1 (DA(120),RHOJ),(DA(121),DE),(DA(122),DHODE),(DA(123),AEOAT)       00000110
C     INPUT DATA FOR FIXED-PITCH FAN REVERSER                            00000120
C     116  =-2. FOR V-GUTTER TARGET TYPE                                 00000130
C          =-1. FOR SEMICYLINDRICAL TARGET TYPE                          00000140
C          = 0. IF NO REVERSER                                           00000150
C          = 1. FOR CASCADE TYPE WITH CONSTANT-THICKNESS VANES , NO      00000160
C               INTERNAL FLOW DEFLECTOR (BLOCKER)                        00000170
C          = 2. FOR CASCADE TYPE WITH CONSTANT-THICKNESS VANES AND       00000180
C               BLOCKER                                                  00000190
C          = 3. FOR CASCADE TYPE WITH AIRFOIL-SHAPED VANES , NO BLOCKER  00000200
C          = 4. FOR CASCADE TYPE WITH AIRFOIL-SHAPED VANES AND BLOCKER   00000210
C     117  = FULLY-EXPANDED JET AREA , SQ FT                             00000220
C     118  = TOTAL TEMPERATURE OF JET , DEG R                            00000230
C     119  = FULLY-EXPANDED JET VELOCITY , FPS                           00000240
C     120  = FULLY-EXPANDED JET DENSITY , LB SEC**2 / FT**4              00000250
C     121  = EFFECTIVE DIAMETER , DE , FT                                00000260
C     122  = DH / DE                                                     00000270
C     123  = CASCADE-EXIT-TO-TAILPIPE AREA (AHEAD OF REVERSER) RATIO ,   00000280
C            FOR CASCADE REVERSERS ONLY                                  00000290
      DATA HOLR /4H SEM,4HICYL,4HINDR,4HICAL,4H TAR,4HGET ,4HTYPE,4HREVE00000300
     1,   4HRSER,4HV-GU,4HTTER,4HCASC,4HADE ,4HWITH,4HAIRF,4HOIL-,4HSHAP00000310
     2,   4HED V,4HANES,4H AND,4H BLO,4HCKER,4HCONS,4HTANT,4H THI,4HCKNE00000320
     3,   4HSS V,4H NOI,4HSE  /                                          00000330
      IF (AJ.GT.0. .AND. TJ.GT.0. .AND. VJ.GT.0. .AND. DE.GT.0. .AND.    00000340
     1DHODE.GE.1. .AND. RHOJ.GT.0.) GO TO 30                             00000350
   10 WRITE (NP,20)                                                      00000360
   20 FORMAT (/68H THRUST REVERSER NOISE NOT CALCULATED BECAUSE OF ERROR00000370
     1 IN INPUT DATA)                                                    00000380
      RETURN                                                             00000390
   30 C1      = 10. * ALOG10(AJ*RHOJ*DA(3)*C**4 / TR)                    00000400
```

```
      IF (RT .GT. 0.) GO TO 120
      IF (RT.LT.-2.) GO TO 10
C     V-GUTTER OR SEMICYLINDRICAL TARGET TYPE REVERSER
      COSP    = 0.
      IF (DA(7) .GT. 0.) COSP = ((DA(7)/COS(.0174532925*DA(8)))**2) /
     1 (((DA(7)/COS(.0174532925*DA(8)))**2) + 40000.)
      PHI     = ARCOS(SQRT(COSP)) / .0174532925
      IF (RT .EQ. -1.) GO TO 50
C     V-GUTTER TARGET TYPE REVERSER , RT = -2.
      VKR     = 75.0528
      WRITE (NP,40) HOLR(10),HOLR(11),(HOLR(J),J=5,9),HOLR(28),HOLR(29)
   40 FORMAT (1H1,36X,5A4,1X,4A4)
      GO TO 70
C     SEMICYLINDRICAL TARGET TYPE REVERSER , RT = -1.
   50 VKR     = 70.0528
      WRITE (NP,60) (HOLR(J),J=1,9),HOLR(28),HOLR(29)
   60 FORMAT (1H1,32X,7A4,1X,4A4)
   70 WRITE (NP,80) HOL,DATE,TIME, AJ,DE,DHODE,TJ,VJ,RHOJ,PHI
   80 FORMAT (//1H ,20A4,2X,2A4,2X,2A4 // 11H JET AREA =,F6.1,34H SQ FT
     1, EFFECTIVE DIAMETER (DE) =,F7.3,13H FT , DH/DE =,F6.3,26H , JET T
     2OTAL TEMPERATURE =,F6.0,2H R / 15H JET VELOCITY =,F7.1,20H FPS , J
     3ET DENSITY =,F9.6,24H LB*SEC**2/FT**4 , PHI =,F6.1,4H DEG)
      C2      = C1 + 10.*COSP*ALOG10(DHODE) + 10.*ALOG10((VJ/C)**5.5/(1.
     1+.01*(VJ/C)**2.5)) + CBN + VKR
      DO 110 IA=1,15
      C3      = C2 + 20.*ALOG10(COS(PSI(IA)*.00581776421)) - 20.*ALOG10(Z
     1D(IA))
      C4      = DE * DHODE**.4 * (TJ/TR)**(.4*(1.+COS(PSI(IA)*.01745329
     15*(VJ/C)**.1))) / VJ
      DO 110 IF=1,30
      S       = C4 * BCFR(IF)
      IF (S .GE. .5) GO TO 90
      SPLR(IA,IF) = -3.4 + 22.*ALOG10(S)
      GO TO 105
   90 IF (S .GT. 2.5) GO TO 100
      SPLR(IA,IF) = -10.
      GO TO 105
  100 SPLR(IA,IF) = -2. - 20.*ALOG10(S)
  105 SPLR(IA,IF) = SPLR(IA,IF) - ATTNT(IF)*ZC(IA) + C3
  110 CONTINUE
      IF (DA(6) .GT. 1.) CALL PNLC(SPLR)
      RETURN
C     CASCADE REVERSER NOISE
  120 IF (RT .GT. 4.) GO TO 10
      J       = IFIX(RT)
      GO TO (130,150,170,190),J
C     CASCADE REVERSER WITH CONSTANT-THICKNESS VANES AND NO INTERNAL
C      FLOW DEFLECTOR (BLOCKER) , RT=1.
  130 VKR     = 66.8034
      WRITE (NP,140) HOLR(12),HOLR(13),(HOLR(J),J=7,9),HOLR(14),(HOLR(J)
     1,J=23,27),HOLR(19),HOLR(28),HOLR(29)
```

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  140 FORMAT (1H1,26X,3A4,1X,2A4,1X,A4,1X,8A4)
      GO TO 210
C     CASCADE REVERSER WITH CONSTANT-THICKNESS VANES AND BLOCKER , RT=2.
  150 VKR     = 61.8034
      WRITE (NP,160) HOLR(12),HOLR(13),(HOLR(J),J=7,9),HOLR(14),(HOLR(J)
     1,J=23,27),(HOLR(J),J=19,22),HOLR(28),HOLR(29)
  160 FORMAT (1H1,23X,3A4,1X,2A4,1X,A4,1X,11A4)
      GO TO 210
C     CASCADE REVERSER WITH AIRFOIL-SHAPED VANES AND NO BLOCKER , RT=3.
  170 VKR     = 60.8034
      WRITE (NP,180) HOLR(12),HOLR(13),(HOLR(J),J=7,9),(HOLR(J),J=14,19)
     1,HOLR(28),HOLR(29)
  180 FORMAT (1H1,27X,3A4,1X,2A4,1X,A4,1X,7A4)
      GO TO 210
C     CASCADE REVERSER WITH AIRFOIL-SHAPED VANES AND BLOCKER , RT=4.
  190 VKR     = 55.8034
      WRITE (NP,200) HOLR(12),HOLR(13),(HOLR(J),J=7,9),(HOLR(J),J=14,22)
     1,HOLR(28),HOLR(29)
  200 FORMAT (1H1,21X,3A4,1X,2A4,1X,A4,1X,10A4)
  210 WRITE (NP,220) HOL,DATE,TIME,AJ,DE,DHODE,TJ,VJ,RHOJ,AECAT
  220 FORMAT (//1H ,2C34,2X,2A4,2X,2A4 // 11H JET AREA =,F6.1,34H SQ FT
     1, EFFECTIVE DIAMETER (DE) =,F7.3,13H FT , DH/DE =,F6.3,26H , JET TO
     2OTAL TEMPERATURE =,F6.0,2H R / 15H JET VELOCITY =,F7.1,20H FPS , JE
     3ET DENSITY =,F9.6,56H LB*SEC**2/FT**4 , CASCADE-EXIT-TO-TAILPIPE A
     4REA RATIO =,F6.3)
      C2      = 10.*ALOG10(10.**((VKR + C1 + 7.2*AECAT + 10.*ALOG10((VJ/
     1C)**5/(1.+.01*(VJ/C)**2)))/10.) + 10.**((60.8034 +C1+10.*ALOG10((V
     2J/C)**7.5/(1.+.01*(VJ/C)**4.5)) + 30.*(VJ/C)**3.5/(.6+(VJ/C)**3.5)
     3*ALOG10(RHOJ*TR*11.92011/DA(3)))/10.)) + DBN
      DO 260 IA=1,15
      C3      = C2 - 20.*ALOG10(ZO(IA)) + 20.*ALOG10(1.+.5*SIN(.0349065
     15*PSI(IA)))
      C4      = DE * DHODE**.4 * (TJ/(459.69+DA(1)))**(.4*(1.+COS(PSI(IA
     1)*.0174532925*(VJ/C)**.1))) / VJ
      DO 260 IF=1,30
      S       = C4 * BCFR(IF)
      IF (S .GE. .5) GO TO 230
      SPLR(IA,IF) = -3.4 + 22.*ALOG10(S)
      GO TO 250
  230 IF (S .GT. 2.5) GO TO 240
      SPLR(IA,IF) = -10.
      GO TO 250
  240 SPLR(IA,IF) = -2. - 20.*ALOG10(S)
  250 SPLR(IA,IF) = SPLR(IA,IF) - ATTNT(IF)*ZO(IA) + C3
  260 CONTINUE
      IF (DA(6) .GT. 1.) CALL PNLC(SPLR)
      RETURN
      END
```

10/01/75

Subroutine SHRP

This subroutine is a second level main routine which manages the calculation of aerodynamic performance and all noise sources for a variable pitch fan with inlet guide vanes. It also adjusts the performance and noise for partly sonic inlets and duct treatment.

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DESCRIPTION         SHRP - SHROUDED PROPELLER NOI.

MASTER FILE         LIBR.G04
ADDED TO MASTER     08/16/75
LAST DATE COPIED      NONE
LAST UPDATE         04/14/76  1653        *** TEMPORARY UPDATE ***

PASSWORD            ZPPC
PROGRAMMER          F.W.BARRY
PROC PARAMETER      $NOJCL

      SUBROUTINE SHRP                                                  00000010
C     VARIABLE-PITCH FAN WITH IGV PERFORMANCE AND NOISE                00000030    10/03/75
C     SHRP CALLS GAAVPF, TREAT, BIQUAC, RVINT, BESJF, PNLC, GRBOXN,    00000040    10/02/75
C      COENG ; CALLED BY MAIN                                          00000050    10/02/75
      COMMON /DATA/ ANGLE(15),BCFR(30),NR,NP,C,HOL(20),DATE(2),TIME(2), 00000060
     1 ATTNT(30),SPLT(15,30),SPLTU(15,30),CBNU(7),XO(15),XD(15),ZO(15), 00000070
     2 PSI(15),CC(15),DDD(15),HPT,TR,VELFL,WM(15),PWLT(15,30),         00000080    08/20/75
     3 DIRIN(498),DIREX(498),BLF(31),CPHSP(15),RPMG,DHPT,RRPM          00000090    08/28/75
      COMMON /DATAI/DA(400)                                            00000100    09/26/75
      COMMON / JNX / JJ(450)                                           00000110
      DIMENSION TPWL(20),PWLB(30),SPL(15,30),PSCN(100),FDIRI(15,30),   00000120    08/20/75
     1FDIRE(15,30),DENG(10),BENG(6),SPLC(15,30),SPLD(15,30)            00000130    02/10/76
      EQUIVALENCE (DA(238),DENG(1)),(DA(249),BENG(1))                  00000140    09/26/75
C     127  = DESIGN (TAKE OFF) NET THRUST , LB, USED IF GT 0.          00000150    08/20/75
C     128  = DESIGN (TAKE OFF) SHP, USED IF 127 LE 0.                  00000160    08/20/75
C     129  = DESIGN (TAKE OFF) TIP SPEED (FPS), USED IF GT MINIMUM     00000170    08/20/75
C     130  = DESIGN (TAKE OFF) PRESSURE RATIO, 1.0 TO 1.75, USED IF    00000180    09/04/75
C               132 = 0.                                               00000190    08/20/75
C     131  = HUB / TIP DIAMETER RATIO, USE IF GT MINIMUM. MINIMUM OF .4 00000200   09/04/75
C     132  = TIP DIAMETER (FT), USED IF GT 0.                          00000210    08/20/75
C     133  = NUMBER OF BLADES                                          00000220
C     134  = NUMBER OF IGVS                                            00000230
C     135  = NET THRUST , LB, USED IF GT 0.                            00000240    08/20/75
C     136  = SHP, USED IF 135 LE 0.                                    00000250    08/20/75
C     137  = STACKING LINE DISTANCE , FT, IF GT 0., -BVGAP IF LT 0.,   00000260    08/20/75
C               IF = 0. BVGAP = 2. USED                                00000270    08/20/75
C     138  = STANDARD DEVIATION OF PAM , 0. REPLACED BY 0.5            00000280
C     139  = STANDARD DEVIATION OF PPM , 0. REPLACED BY 0.01           00000290
C     141  = INLET TREATMENT LENGTH , PERCENT OF DIAMETER              00000300    08/20/75
C     142  = EXHAUST TREATMENT LENGTH , PERCENT OF DIAMETER            00000310    08/20/75
C     143  = DOF , 1. OR 2.                                            00000320
C     151  = 0. IF SHAFT DRIVE , =1. IF INTEGRAL ENGINE                00000330    09/25/75
C     198  = NUMBER OF INLET SPLITTERS                                 00000340    09/08/75
C     199  = NUMBER OF EXHAUST SPLITTERS                               00000350    09/08/75
C     237  = 0. IF USE TYPICAL TURBOSHAFT ENGINE , =1. IF USE:         00000360    09/25/75
C     238  RPMC COMPRESSOR RPM                                         00000370    09/25/75
C     239  D    COMPRESSOR DIAMETER , FT                               00000380    09/25/75
C     240  FPR  COMPRESSOR FIRST-STAGE PRESSURE RATIO                  00000390    09/25/75
C     241  RSS  COMPRESSOR FIRST-STAGE ROTOR-STATOR SPACING IN PERCENT 00000400    09/25/75
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C      242  BC    COMPRESSOR FIRST-STAGE NUMBER OF BLADES                 C0000410      09/25/75
C      243  CK    = 0.                                                    C0000420      09/25/75
C      244  P3    COMBUSTOR INLET TOTAL PRESSURE , PSF                    C0000430      09/25/75
C      245  T3    COMBUSTOR INLET TOTAL TEMPERATURE , DEG R               C0000440      09/25/75
C      246  T4    COMBUSTOR EXIT  TOTAL TEMPERATURE , DEG R               C0000450      09/25/75
C      247  QMA   COMBUSTOR MASS FLOW RATE , LB/SEC                       C0000460      09/25/75
C      248  QMT   TURBINE MASS FLOW RATE , LB / SEC                       C0000470      09/25/75
C      249  VTR   RELATIVE TIP SPEED OF LAST TURBINE ROTOR , FT/SEC       C0000480      09/25/75
C      250  CL    SPEED OF SOUND AT TURBINE EXIT , FPS                    C0000490      09/25/75
C      251  SOC   LAST STAGE STATOR-ROTOR SPACING / STATOR CHORD          C0000500      09/25/75
C      252  VK    =0. FOR COPLANAR EXHAUSTS , -10. FOR RECESSED EXHAUST   C0000510      09/25/75
C      253  BT    NUMBER OF BLADES IN LAST TURBINE ROTOR                  C0000520      09/25/75
C      254  RPMT  TURBINE RPM                                             C0000530      09/25/75
C      255  THRT  JET THRUST , LB                                         C0000540      09/25/75
C      256  AREA  JET AREA , SQ FT                                        C0000550      09/25/75
       IF ((DA(127).GT.0..OR.DA(128).GT.0.) .AND. DA(133).GT.1. .AND.     C0000560
      1DA(134).GT.1. .AND. (DA(135).GT.0..OR.DA(136).GT.0.)) GO TO 20     C0000570
     5 WRITE (NP,10)                                                      C0000580      08/20/75
    10 FORMAT (83H1NOISE OF VARIABLE-PITCH FAN WITH IGV NOT CALCULATED BEC0000590      10/08/75
      1CAUSE OF ERROR IN INPUT DATA)                                      C0000600      10/08/75
       DA(14)  = 0.                                                       C0000610
       RETURN                                                             C0000620
C      DEFAULT OPTIONS                                                    C0000630
    20 IF (DA(138) .EQ. 0.) DA(138) = .5                                  C0000640      08/22/75
       IF (DA(139) .EQ. 0.) DA(139) = .01                                 C0000650
       DA(131) = AMAX1(.4,DA(131))                                        C0000660      09/04/75
C      DBN    CORRECTION FOR NUMBER OF UNITS                              C0000670
       DBN     = 0.                                                       C0000680
       IF (DA(14) .GT. 1.) DBN = DBNU(IFIX(DA(14)-.9))                    C0000690
       TS      = 0.                                                       C0000700      09/05/75
       CALL GAAVPF(DA(124),DA(125),DA(126),DA(127),DA(128),DA(129),DA(130C0000710
      1),DA(131),DA(132),DA(133),DA(134),A2,AR,DA(135),DA(136),TS,PR,CM,  C0000720
      2CU,CUP,CDN,SIGF,DCLDA,BE,RE,1,VELFL/C,W,1,ERRA,DA(137),THRUST,QM,  C0000730      08/20/75
      3CD,SIGR)                                                           C0000740      09/05/75
       IF (ERRA .NE. 0.) GO TO 5                                          C0000750      08/20/75
       DHPT    = DHPT + DA(14)*DA(128)                                    C0000760      08/22/75
       CALL GAAVPF(DA(124),DA(125),DA(126),DA(127),DA(128),DA(129),DA(130C0000770      08/20/75
      1),DA(131),DA(132),DA(133),DA(134),A2,AR,DA(135),DA(136),TS,PR,CM,  C0000780      08/20/75
      2CU,CUP,CDN,SIGF,DCLDA,BE,RE,1,VELFL/C,W,2,ERRA,DA(137),THRUST,QM,  C0000790      08/29/75
      3CD,SIGR)                                                           C0000800      09/05/75
       IF (ERRA .NE. 0.) GO TO 5                                          C0000810      08/20/75
       HPT     = HPT + DA(14)*DA(136)                                     C0000820
       WRITE (NP,30) HOL,DATE,TIME, DA(132),DA(131),DA(134),DA(133),AR,DAC0000830
      1(137),(DA(I),I=124,130),DA(135),DA(136),TS,PR,DA(8)                C0000840      02/10/76
    30 FORMAT (1H1,40X,33HVARIABLE-PITCH FAN WITH IGV NOISE //            C0000850      10/08/75
      1                                     1H ,20A4,2X,2A4,2X,2C0000860      10/08/75
      1A4// 14H CONFIGURATION /11H DIAMETER =,F6.2,30H FT , HUB/TIP DIAMEC0000870      08/20/75
      2TER RATIO =,F7.4,2H ,,F3.0, 7H IGVS ,,F3.0,22H BLADES , AREA RATIOC0000880
      3 =,F5.2,27H , STACKING LINE DISTANCE =,F6.3 /18H TAKEOFF CONDITIONC0000890
      4 / F6.1,8H KNOTS ,F4.0,8H DEG F ,F7.3,20H PSIA , NET THRUST =,F7.1C0000900
      5,11H LBS , HP =,F7.1,14H , TIP SPEED =,F7.2,23H FPS , PRESSURE RATC0000910
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     6IG =,F5.2 / 20H OPERATING CONDITION / 13H NET THRUST =,F7.1,11H LB
     7S , HP =,F7.1,14H , TIP SPEED =,F7.2,23H FPS , PRESSURE RATIO =,F5
     8.2,16H , SHAFT ANGLE =,F5.0)                                              02/10/76
      IF (DA(6) .EQ. 3.) WRITE(NP,35) BE,CUP,CDN,SIGF,A2,W,CM,QM,CU,CD,          08/20/75
     1THRUST,DA(138),DA(139)                                                    08/20/75
   35 FORMAT (/22H BLADE STAGGER ANGLE =,F4.0,18H DEG , IGV CHORD =,F6.3
     1,16H , ROTOR CHORD =,F6.3,22H FT , ROTOR SOLIDITY =,F6.3,7H , A2 =
     2,F6.2,7H SQ.FT. /10H AIRFLOW =,F7.2,25H LB/SEC, AXIAL VELOCITY =,F
     37.1,16H FPS , AXIAL M =,F6.3,19H , 1/2 SWIRL VEL. =,F7.1,15H FPS ,
     4 IGV CD =,F7.4 /15H ROTOR THRUST =,F7.1,24H LB , STD. DEV. OF PAM
     5=,F5.2,21H , STD. DEV. OF PPM =,F6.3)
      RRPM     = TS / DA(129)                                                   08/28/75
      MMAX     = 20
C     TONE AND BROADBAND POWERS DUE TO IGV-ROTOR INTERACTION
      CALL RVINT (TPWL,PWLB,MMAX,1.9679E18*DA(132)**2*SQRT(TR),1,DA(133)        08/20/75
     1,DA(134),RE,DA(131),DA(132),TS,TS*DA(133)/(3.1415927*DA(132)),TS/C
     2,BE,CM,CU,CD      ,CUP,CDN,DA(137),SIGF,CCLDA,DA(138),DA(139))            08/20/75
C     NON-STEADY HARMONIC LOADING AS IN FAFROP
C     VELOCITY CORRECTION
      VKTAS    = VELFL / 1.6878
      IF (VKTAS .GT. 2.) GO TO 40
      DDBNSV   = -3.1 * VKTAS                                                   11/10/75
      GO TO 50
   40 DDBNSV = 10.*ALOG10((1.+SQRT(1.+375.99883*THRUST/(VKTAS*DA(132))*         08/28/75
     1*2)) / (1.+SQRT(1.+267.8375*THRUST/DA(132)**2)) ) - 4.                    08/28/75
   50 VMT      = TS / C
      BPF      = TS * DA(133) * .31830988 / DA(132)
      C1       = 9943.77 * (DA(133)     /DA(132))**2                            08/28/75
      C2       = .03125 * (THRUST/(DA(133)))**2                                 08/28/75
      C3       = .722 * DA(136)**2 / (DA(133)*VMT)**3
      C4       = 44.7 - 10.*ALOG10(DA(3)/C) + DBN + DDBNSV
      C6       = 1.6 * DA(133) * VMT
      IB       = IFIX(DA(133))                                                  08/20/75
      MAX      = 20/IB + 1
      VMAX     = FLOAT(MAX)
      NMAX     = MIN1(100.,22400./BPF)
      DO 130 M=1,NMAX
      VM       = FLOAT(M)
      IF (M .GT. MAX) GO TO 80
      SUM      = 0.
      C5       = C3 / VM
      PSON(M)  = 0.
      MB       = M * IB
      NORD     = MINO(400,MB)
      CALL BESJH(VM*C6,NORD,CJ,RR,450,NP)
      IF (RR .NE. 0.) NORD = IFIX(RR)
      IF (NORD .GE. MB) GO TO 90
      IF (DA(6) .EQ. 3.) WRITE (NP,70) IA,M,NORD
   70 FORMAT (/24H BESSEL FUNCTION FOR IA=,I3,3H M=,I3,20H LIMITED TO OR
     1DER OF,I4/)
      GO TO 90
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   80 PSCN(M) = PSQN(MAX) * (VMAX/VM)**1.219
      GO TO 130
   90 VMB      = VM * CA(133)
      LMIN     = MAX1(1.,VMB*(1.-VMT))
      LMAX     = IFIX(VMB*(1.+VMT)) + 1
      DO 120 L=LMIN,LMAX
      VL       = FLCAT(L)**3.22
      MBL      = MB - L
      VN       = FLOAT(MBL)
      VNSQ     = VN**2                                              08/28/75
      J        = MBL + MBL + 1
      C11      = VN + VN + 1.
      C12      = C11
      C13      = VN + 1.
      C14      = 1.
      ETA      = 0.
  100 DETA     = C2/C11*C12/(C11+2.)*C13*C14*CJ(J+2) + C5*VNSQ*QJ(J+1)
      ETA      = ETA + DETA
      IF (J+2 .GT. NORD) GO TO 110
      IF (C11.GT.VM*C6 .AND. ABS(DETA).LE..005*ABS(ETA)) GO TO 110
      J        = J + 2
      C11      = C11 + 2.
      C12      = C12 + 1.
      C13      = C13 + 1.
      C14      = C14 + 1.
      GO TO 100
C     COMPLETED SUM OVER K STARTING AT 0
  110 DSUM     = ETA / VL
  120 SUM      = SUM + DSUM
  130 PSQN(M) = 10. * ALCG10(C1*SUM) + C4
      DO 140 I=1,30
  140 PWLB(I) = 10.*ALOG10(PWLB(I)) + CBN
      DO 150 I=1,MMAX
  150 TPWL(I) = 10.*ALOG10(TPWL(I)) + DBN                           08/20/75
C     ADD CROSS-FLOW CORRECTION TO FUNDAMENTAL TONES                11/05/75
      C11      = 0.                                                 11/05/75
      IF (VELFL .EQ. 0.) GO TO 155                                  02/11/76
      C12      = DA(8)*.0174532925 - ATAN2(CA(5),DA(4))             02/11/76
      IF (C12.GT.1.5708 .AND. C12.LT.4.7129) VKTAS = 0.             11/05/75
      C13      = AMIN1(.2,VELFL*ABS(SIN(C12))/TS)                   11/05/75
      IF (C13.GT..001 .AND. (C12.LT.1.5708.OR.C12.GT.4.7129)) C11 =10.**   11/05/75
     1((((1133.89*C13-642.248)*C13+125.104)*C13)/10.)               11/05/75
      PSQN(1) = PSQN(1) + C11                                       11/05/75
      TPWL(1) = TPWL(1) + C11                                       11/05/75
  155 IF (DA(6) .NE. 3.) GO TO 180                                  02/11/76
      WRITE (NP,160) PWLB,MMAX,BPF,(TPWL(I),I=1,MMAX)               08/20/75
  160 FORMAT (/57H 30 PWL'S OF BROADBAND NOISE DUE TO IGV-ROTOR INTERAC
     1TON/ 1X,20F6.1 / 1X,10F6.1 // I3,78H PWL'S OF TONE NOISE DUE TO I
     2V-ROTOR INTERACTION WITH FUNDAMENTAL FREQUENCY =,F6.1,3H HZ / 1X,
     32CF6.1 )
      WRITE (NP,170) NMAX,(PSQN(I),I=1,NMAX)
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  170 FORMAT (/ I4,30H PWL'S DUE TO NON-STEADY LOADS / 5(1X,20F6.1/))          08/28/75
C     FAN DIRECTIVITY FACTORS
  180 FCOR      = DA(132) / 3.
      DO 190 IA=1,15
      DO 190 IF=1,30
      CALL BIQUAD (DIRIN,1,PSI(IA),BCFR(IF)*FCOR,FDIPI(IA,IF),K)               02/10/76
      CALL BIQUAD (DIREX,1,PSI(IA),BCFR(IF)*FCOR,FDIRE(IA,IF),K)               02/10/76
  190 CONTINUE
C     COMBINE TPWL,PSON & FWLB INTO PWLB AND GET SPL                           08/20/75
      VL        = BPF
      I         = 1
      DO 230 IF=1,30
      PWLB(IF) = 10.**(PWLB(IF)/10.)
  200 IF (VL .GT. BLF(IF+1)) GO TO 210
      IF (I.LE.MMAX) PWLB(IF) = PWLB(IF) + 10.**(TPWL(I)/10.)                  08/20/75
      IF (I.LE.NMAX) PWLB(IF) = PWLB(IF) + 10.**(PSON(I)/10.)
      VL        = VL + BPF
      I         = I + 1
      GO TO 200
  210 PWLB(IF) = 10.*ALOG10(PWLB(IF))
      DO 220 IA=1,15
  220 SPL(IA,IF) = 10.*ALOG10(10.**((PWLB(IF)+FDIRI(IA,IF))/10.) + 10.**     11/05/75
     1((PWLB(IF)+FDIRE(IA,IF))/10.)) - CPWSP(IA) -ATTNT(IF)*ZO(IA)
  230 CONTINUE
      IF (DA(6) .GT. 1.) CALL PNLC(SPL)                                        11/05/75
      IF (DA(15).EQ.0. .OR. DA(151).NE.0.) GO TO 236                           11/05/75
C     JET NOISE                                                                11/05/75
      C11       = 0.                                                           02/12/76
      CALL JETN (W,DA(135),A2,C1),C11,C11,SPLC,SPLD)                           11/05/75
      DO 232 IF=1,30                                                           11/05/75
      DO 232 IA=1,15                                                           02/10/76
      SPLC(IA,IF) = SPLC(IA,IF) + DBN                                          02/10/76
      SPLT(IA,IF) = SPLT(IA,IF) + 10.**(SPLC(IA,IF)/10.)                       11/05/75
  232 PWLT(IA,IF) = PWLT(IA,IF) + 10.**((SPLC(IA,IF)+DBN)/10.)                 11/05/75
      WRITE (NP,234)                                                           11/05/75
  234 FORMAT (10HIJET NOISE)                                                   02/10/76
      IF (DA(6) .NE. 0.) CALL PNLC (SPLC)                                      11/05/75
  236 IF (DA(17).GT.0.) CALL TREAT (FWLB,PWLB,DA(141)*.01*DA(132),0.,          09/08/75
     1DA(142)*.01*DA(132),DA(132)*(1.-DA(131))/2.,CM,3,DA(143),SPL,FDIRI       09/03/75
     2,FDIRE,DA(198),DA(199))
      DO 240 IF=1,30
      DO 240 IA=1,15                                                           08/23/75
      C1        = 10.**(SPL(IA,IF)/10.)                                        08/28/75
      PWLT(IA,IF) = PWLT(IA,IF) + C1                                           08/28/75
  240 SPLT(IA,IF) = SPLT(IA,IF) + C1                                           09/25/75
      DA(243) = 0.                                                             09/26/75
      IF (DA(151) .NE. 0.) CALL COENG (0,DA(128),DA(136),DBN,IFIX(DA(237     09/23/75
     1)),TS/DA(129),DENG,DA(248),BENG,DA(15),DA(255),DA(256),W,DA(135)-        09/26/75
     2THRUST,A2)                                                               09/23/75
      IF (DA(16) .EQ. 0.) RETURN
      CALL GRBOXN (IFIX(DA(16)),DA(136),19.098593*TS/DA(132),DBN,DA(151)       09/25/75
```

```
      1)                                                    00002450    09/25/75
       RETURN                                               00002460
       END                                                  00002470
```

Subroutine VPFAN

This subroutine is used to calculate the aerodynamic performance and noise of variable pitch fans with outlet guide vanes, including reverse thrust noise. Adjustments are also made in this subroutine for duct acoustic treatment.

```
DESCRIPTION        VPFAN - VARIABLE-PITCH FAN NO.

MASTER FILE        LIBR.G04
ADDED TO MASTER    08/16/75
LAST DATE COPIED     NONE
LAST UPDATE        04/14/76  1653          *** TEMPORARY UPDATE ***

PASSWORD           ZXHW
PROGRAMMER         F.W.BARRY
PROC PARAMETER     $NOJCL

      SUBROUTINE VPFAN
C     VARIABLE-PITCH FAN WITH OGV PERFORMANCE AND NOISE                       10/08/75
C     VPFAN CALLS GAAVPF, BIQUAD, JETN, TREAT, COENG, GRECXN, PNLC,          11/05/75
C     RVINT ; CALLED BY MAIN                                                 11/05/75
      COMMON /DATA/ ANGLE(15),BCFR(30),NR,NP,C,HOL(20),DATE(2),TIME(2),
     1 ATTNT(30),SPLT(15,30),SPLTU(15,30),DBAL(7),XC(15),XD(15),ZO(15),
     2 PSI(15),DO(15),DDO(15),HPT,TR,VELFL,WM(15),PWLT(15,30),                09/09/75
     3 DIRIN(498),DIREX(498),BLF(31),DPWSP(15),RPMG,DHPT,RRPM,CSUM(15)        09/08/75
      COMMON /DATA1/ DA(300)                                                  09/08/75
      COMMON / JNX / JJ(450)                                                  09/??/75
      DIMENSION TPWL(20),PWLP(30),SPL(15,30),PSCN(100),FDIRI(15,30),          ??/??/75
     1FDIRE(15,30),BPWL(30),RHOL(6),BBCBC(59),RDIRIN(41),RDIREX(41),          09/09/75
     2CPWL(30),SPLD(15,30),RPWL(30),SPWL(30),CENG(10),RENG(6)                 09/26/75
      EQUIVALENCE (DA(179),CENG(1)),(DA(190),RENG(1))                         09/25/75
      DATA RHOL /4H FLA,4HT PI,4HTCH ,4H   F,4HFEATH,4HER  /                  09/08/75
      DATA BBCBC / 16*6.5,11.,15.,18.2,13.8,12.,11.4,9.3,7.6,3.7,4.5,3.5,     09/08/75
     1,3.9,6.8,8.3,9.7,9.5,9.5,11.1,11.9,10.3,10.8,9.6,9.4,9.4,10.2,9.7,      09/08/75
     2?.2,8.,15*8.7 /                                                         ??/??/75
      DATA RDIRIN / 1.,19.,0., 0.,10.,20.,30.,40.,50.,60.,70.,80.,90.,100.,   09/09/75
     10.,110.,120.,130.,140.,150.,160.,170.,180.,-2.,3.,4.8,4.7,3.5,2.3,      09/08/75
     21.6,.4,-2.8,-5.,-9.,-13.,-17.,-20.8,-24.6,-28.6,-33.,-35.,-37. /        09/08/75
      DATA RDIREX / 1.,19.,0., 0.,10.,20.,30.,40.,50.,60.,70.,80.,90.,10      09/09/75
     10.,110.,120.,130.,140.,150.,160.,170.,180., -32.,-31.2,-30.,-28.4,      09/08/75
     2-26.3,-25.,-22.5,-20.,-16.8,-13.,-9.,-5.6,-2.3,.5,2.1,3.1,3.5,2.1,      09/08/75
     31. /                                                                    09/08/75
C     155  = DESIGN (TAKEOFF) NET THRUST , LB , USED IF GT 0.                 09/08/75
C     156  = DESIGN (TAKEOFF) SHP, USED IF 155 LE 0.                          09/08/75
C     157  = DESIGN (TAKEOFF) TIP SPEED (FPS), USED IF GT MINIMUM             09/08/75
C     158  = DESIGN (TAKEOFF) PRESSURE RATIO, 1.0 TO 1.75, USED IF            09/08/75
C            160 = 0.                                                         09/08/75
C     159  = HUB / TIP DIAMETER RATIO, USE IF GT MINIMUM                      09/08/75
C     160  = TIP DIAMETER , FT , USED IF GT 0.                                09/08/75
C     161  = NUMBER OF BLADES                                                 09/08/75
C     162  = NUMBER OF OGVS                                                   09/08/75
C     163  = NET THRUST , LB , USED IF NE 0. , REVERSE IF LT 0.               09/08/75
C     164  = SHP , USED IF 163 EQ 0.                                          09/08/75
C     165  = STACKING LINE DISTANCE , FT , IF GT 0., -BVGAP IF LT 0.,         09/08/75
C            IF = 0. BVGAP = 2. USED                                          09/08/75
C     166  = STANDARD DEVIATION OF PAM , 0. REPLACED BY 1.0                   09/08/75
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C       167  = STANDARD DEVIATION OF PPM , C. REPLACED BY C.C2               C0000410        09/08/75
C       168  = INLET TREATMENT LENGTH , PERCENT OF DIAMETER                  C0000420        09/26/75
C       169  = MID TREATMENT LENGTH , PERCENT OF DIAMETER                    C0000430        09/08/75
C       170  = EXHAUST TREATMENT LENGTH , PERCENT OF DIAMETER                C0000440        09/08/75
C       171  = DOF , 1. OR 2.                                                C0000450        09/08/75
C       172  = INLET SPLITTERS                                               C0000460        09/08/75
C       173  = EXHAUST SPLITTERS                                             C0000470        09/08/75
C       174  = THROAT MACH NUMBER OF NEAR-SONIC INLET (NONE IF LE .4)        C0000480        09/08/75
C       175  =0 IF REVERSE THROUGH FLAT PITCH, =1 IF THROUGH FEATHER         C0000490        09/08/75
C       176  =0 IF SHAFT DRIVE , =1. IF INTEGRAL ENGINE                      C0000500        09/08/75
C       177  = REVERSE TIP SPEED / DESIGN TIP SPEED , .75 TO 1.              C0000510        09/08/75
C       178  = 0. IF USE TYPICAL TURBOSHAFT ENGINE , =1. IF USE :            C0000520        09/08/75
C       INPUT DATA FOR CORE ENGINE COMPRESSOR NOISE                          C0000530        09/08/75
C       179  RPMC COMPRESSOR RPM                                             C0000540        09/08/75
C       180  C    COMPRESSOR DIAMETER , FT                                   C0000550        09/08/75
C       181  FPR  COMPRESSOR FIRST-STAGE PRESSURE RATIO                      C0000560        09/08/75
C       182  RSS  COMPRESSOR FIRST-STAGE ROTOR-STATOR SPACING IN PERCENT     C0000570        09/08/75
C       183  BC   COMPRESSOR FIRST-STAGE NUMBER OF BLADES                    C0000580        09/08/75
C       INPUT DATA FOR COMBUSTION NOISE                                      C0000590        09/08/75
C       184  CK   =0.                                                        C0000600        09/08/75
C       185  P3   COMBUSTOR INLET TOTAL PRESSURE , PSF                       C0000610        09/08/75
C       186  T3   COMBUSTOR INLET TOTAL TEMPERATURE , DEG R                  C0000620        09/08/75
C       187  T4   COMBUSTOR EXIT  TOTAL TEMPERATURE , DEG R                  C0000630        09/08/75
C       188  QMA  COMBUSTOR MASS FLOW RATE , LB/SEC                          C0000640        09/08/75
C       INPUT DATA FOR CORE ENGINE TURBINE NOISE                             C0000650        09/08/75
C       189  CMT  TURBINE MASS FLOW RATE , LB/SEC                            C0000660        09/08/75
C       190  VTR  RELATIVE TIP SPEED OF LAST TURBINE ROTOR , FPS             C0000670        09/08/75
C       191  CL   SPEED OF SOUND AT TURBINE EXIT , FPS                       C0000680        09/08/75
C       192  SOC  LAST STAGE STATOR-ROTOR SPACING / STATOR CHORD             C0000690        09/08/75
C       193  VK   =0. FOR COPLANAR EXHAUSTS , -10. FOR RECESSED EXHAUST      C0000700        09/08/75
C       194  BT   NUMBER OF BLADES IN LAST TURBINE ROTOR                     C0000710        09/08/75
C       195  RPMT TURBINE RPM                                                C0000720        09/08/75
C       INPUT DATA FOR JET NOISE                                             C0000730        09/08/75
C       196  THRT JET THRUST , LB                                            C0000740        09/08/75
C       197  AREA    AREA OF JET , SQ FT                                     C0000750        09/26/75
        IF ((DA(155).GT.0..OR.DA(156).GT.0.) .AND. DA(161).GT.1. .AND.      C0000760        09/08/75
       1DA(162).GT.1. .AND. (DA(163).NE.0..OR.DA(164).GT.0.)) GO TO 20       C0000770        09/08/75
    5 WRITE (NP,10)                                                          C0000780        09/08/75
   10 FORMAT (83H1NOISE OF VARIABLE-PITCH FAN WITH OGV NOT CALCULATED BEC0000790        10/08/75
      1CAUSE OF ERROR IN INPUT DATA)                                         C0000800        10/08/75
        DA(18)   = 0.                                                        C0000810        09/26/75
        RETURN                                                               C0000820        09/08/75
C       DEFAULT OPTIONS                                                      C0000830        09/08/75
   20 IF (DA(159) .LT. .4) DA(159) = .4                                      C0000840        09/08/75
      IF (DA(166) .LE. 0.) DA(166) = 1.                                      C0000850        09/08/75
      IF (DA(167) .LE. 0.) DA(167) = .02                                     C0000860        09/08/75
C       CBN    CORRECTION FOR NUMBER OF UNITS                                C0000870        09/08/75
        CBN      = 0.                                                        C0000880        09/08/75
        IF (DA(18) .GT. 1.) CBN = CBNU(IFIX(DA(18)-.9))                      C0000890        09/29/75
        VKTAS    = VELFL / 1.6878                                            C0000900        09/08/75
        ALPHA    = 0.                                                        C0000910        11/26/75
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      IF (VELFL .GT. 0.) ALPHA = CA(8) - ATAN2(CA(5),DA(4))/.0174532925 00000920     11/26/75
      IF (ALPHA.GT.90. .AND. ALPHA.LT.270.) VKTAS = 0.                  00000930     09/08/75
      CALL GAAVPF (CA(124),DA(125),CA(126),DA(155),DA(156),DA(157),DA(1500000940     09/08/75
     18),CA(159),CA(160),DA(161),DA(162),A2,AR,CA(163),CA(164),TS,PR,CM,00000950     09/08/75
     2CU,CUP,CDN,SIGF,DCLDA,BE,RE,0,VELFL/C,W,1,ERRA,CA(165),THRUST,CM, 00000960     09/08/75
     3CC,SIGR)                                                          00000970     09/08/75
      IF (ERRA .NE. 0.) GO TO 5                                         00000980     09/08/75
      IF (CA(176) .EQ. 0.) DHPT = DHPT + DA(18)*DA(156)                 00000990     09/26/75
      TS       = C.                                                     00001000     09/08/75
      IF (DA(163) .LT. 0.) GO TO 1000                                   00001010     09/08/75
      CALL GAAVPF (CA(124),CA(125),DA(126),DA(155),CA(156),DA(157),DA(1500001020     09/08/75
     13),DA(159),CA(160),DA(161),CA(162),A2,AR,CA(163),CA(164),TS,PR,CM,00001030     09/08/75
     2CU,CUP,CDN,SIGF,DCLDA,BE,RE,0,VELFL/C,W,2,ERRA,CA(165),THRUST,CM, 00001040     09/08/75
     3CD,SIGR)                                                          00001050     09/08/75
   25 IF (ERRA .NE. 0.) GO TO 5                                         00001060     09/08/75
      IF (DA(176) .EQ. 0.) HPT = HPT + CA(18)*CA(164)                   00001070     09/26/75
      WRITE (NP,30) FCL,DATE,TIME, DA(160),CA(159),DA(162),DA(161),AR,DA00001080     09/08/75
     1(165),DA(124),DA(125),CA(126),(CA(I),I=155,158),DA(163),DA(164),TSC00001090     09/08/75
     2,PR,DA(8)                                                         00001100     02/10/76
   30 FORMAT (1H1,40X,33HVARIABLE-PITCH FAN WITH OGV NOISE //           00001110     10/08/75
     1                                              1H ,20A4,2X,2A4,2X,200001120     10/08/75
     1A4// 14H CONFIGURATION /11H DIAMETER =,F6.2,30H FT , HUB/TIP DIAME00001130     09/08/75
     2TER RATIO =,F7.4,2H ,,F3.0, 7H OGVS ,,F3.0,22H BLADES , AREA RATI00001140     09/08/75
     3 =,F5.2,27H , STACKING LINE DISTANCE =,F6.3 /18H TAKEOFF CONDITION00001150     09/08/75
     4 / F6.1,8H KNOTS ,F4.0,8H DEG F ,F7.3,20H PSIA , NET THRUST =,F7.100001160     09/08/75
     5,11H LBS , HP =,F7.1,14H , TIP SPEED =,F7.2,23H FPS , PRESSURE RAT00001170     09/08/75
     6IO =,F5.2 / 20H OPERATING CONDITION / 13H NET THRUST =,F7.1,11H LB00001180     09/08/75
     7S , HP =,F7.1,14H , TIP SPEED =,F7.2,23H FPS , PRESSURE RATIO =,F500001190     09/08/75
     8.2,16H , SHAFT ANGLE =,F5.0 )                                     00001200     02/10/76
      IF (DA(163) .LT. C.) WRITE (NP,32) (RHCL(I+IA),I=1,3),TSTAT       00001210     09/08/75
   32 FORMAT (/21H FAN REVERSED THROUGH,3A4,23H , USE STATIC THRUST OF,F00001220     09/08/75
     17.1,13H LB FOR NOISE)                                             00001230     09/08/75
      IF (DA(6) .EQ. 3.) WRITE(NP,35) BE,CUP,CDN,SIGF,A2,W,CM,QM,CU,CD, 00001240     09/08/75
     1THRUST,DA(166),CA(167)                                            00001250     09/08/75
   35 FORMAT (/22H BLADE STAGGER ANGLE =,F4.0,20H DEG , BLADE CHORD =,F600001260     09/08/75
     1.3,14H , OGV CHORD =,F6.3,20H FT , OGV SOLIDITY =,F6.3,  7H , A2 =00001270     09/08/75
     2,F6.2,7H SQ.FT. /10H AIRFLOW =,F7.2,25H LB/SEC, AXIAL VELOCITY =,F00001280     09/08/75
     37.1,16H FPS , AXIAL M =,F6.3,19H , 1/2 SWIRL VEL. =,F7.1,16H FPS, 00001290     11/07/75
     4ROTOR CD =,F7.4/15H ROTOR THRUST =,F7.1,24H LB , STD. DEV. OF FAM 00001300     11/07/75
     5=,F5.2,21H , STD. DEV. OF PPM =,F6.3)                             00001310     09/08/75
      IF (DA(176) .EQ. 0.) RRPM = TS / CA(157)                          00001320     09/29/75
      MMAX     = 20                                                     00001330     09/08/75
C     TONE AND BROADBAND POWERS DUE TO ROTOR-OGV INTERACTION            00001340     11/07/75
      CALL RVINT (TPWL,PWLB,MMAX,1.9679E18*DA(160)**2*SQRT(TR),2,DA(161)00001350     09/09/75
     1,DA(162),RE,DA(159),DA(160),TS,TS*CA(161)/(3.1415927*DA(160)),TS/C00001360     09/09/75
     2,BE,CM,CU,CD,CUP,CDN,DA(165),SIGF,DCLDA,DA(166),DA(167))          00001370     09/08/75
C     NON-STEADY HARMONIC LOADING AS IN FAFRCP                          00001380     09/08/75
C     VELOCITY CORRECTION                                               00001390     09/08/75
      IF (VKTAS .GT. 2.) GO TO 40                                       00001400     09/08/75
      DCBNSV   = -3.1 * VKTAS                                           00001410     09/29/75
      GO TO 50                                                          00001420     09/08/75
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 40 DDBNSV = 10.*ALOG10((1.+SQRT(1.+375.55883*THRUST/(VKTAS*DA(160))*  00001430   09/08/75
   1*2)) / (1.+SQRT(1.+267.8375*THRUST/DA(160)**2)) ) - 4.             00001440   09/08/75
 50 VMT    = TS / C                                                    00001450   09/08/75
    BPF    = TS * DA(161) * .31830988 / DA(160)                        00001460   09/08/75
    C1     = 5943.77 * (DA(161)     /DA(160))**2                       00001470   09/08/75
    C2     = .03125 * (THRUST/(DA(161)))**2                            00001480   09/08/75
    C3     = .722 * DA(164)**2 / (DA(161)*VMT)**3                      00001490   09/08/75
    C4     = 44.7 - 10.*ALOG10(DA(3)/C) + CBN + DDBNSV                 00001500   09/08/75
    C6     = 1.6 * DA(161) * VMT                                       00001510   09/08/75
    IB     = IFIX(DA(161))                                             00001520   09/08/75
    MAX    = 20/IB + 1                                                 00001530   09/08/75
    VMAX   = FLOAT(MAX)                                                00001540   09/08/75
    NMAX   = MIN1(100.,22400./BPF)                                     00001550   09/08/75
    DO 130 M=1,NMAX                                                    00001560   09/08/75
    VM     = FLOAT(M)                                                  00001570   09/08/75
    IF (M .GT. MAX) GO TO 80                                           00001580   09/08/75
    SUM    = 0.                                                        00001590   09/08/75
    C5     = C3 / VM                                                   00001600   09/08/75
    PSQN(M) = 0.                                                       00001610   09/08/75
    MB     = M * IB                                                    00001620   09/08/75
    NORD   = MINO(400,MB)                                              00001630   09/08/75
    CALL BESJH(VM*C6,NORD,QJ,RR,450,NP)                                00001640   09/08/75
    IF (RR .NE. 0.) NORD = IFIX(RR)                                    00001650   09/08/75
    IF (NORD .GE. MB) GO TO 90                                         00001660   09/08/75
    IF (DA(6) .EQ. 3.) WRITE (NP,70) IA,M,NORD                         00001670   09/08/75
 70 FORMAT (/24H BESSEL FUNCTION FOR IA=,I3,3H M=,I3,20H LIMITED TO OR00001680   09/08/75
   1DER OF,I4/)                                                        00001690   09/08/75
    GO TO 90                                                           00001700   09/08/75
 80 PSQN(M) = 10. * ALOG10(PSQNM / VM**1.219)                          00001710   11/26/75
    GO TO 130                                                          00001720   09/08/75
 90 VMB    = VM * DA(161)                                              00001730   09/08/75
    LMIN   = MAX1(1.,VMB*(1.-VMT))                                     00001740   09/08/75
    LMAX   = IFIX(VMB*(1.+VMT)) + 1                                    00001750   09/08/75
    DO 120 L=LMIN,LMAX                                                 00001760   09/08/75
    VL     = FLOAT(L)**3.22                                            00001770   09/08/75
    MBL    = MB - L                                                    00001780   09/08/75
    VN     = FLOAT(MBL)                                                00001790   09/08/75
    VNSQ   = VN**2                                                     00001800   09/08/75
    J      = MBL + MBL + 1                                             00001810   09/08/75
    C11    = VN + VN + 1.                                              00001820   09/08/75
    C12    = C11                                                       00001830   09/08/75
    C13    = VN + 1.                                                   00001840   09/08/75
    C14    = 1.                                                        00001850   09/08/75
    ETA    = 0.                                                        00001860   09/08/75
100 DETA   = C2/C11*C12/(C11+2.)*C13*C14*QJ(J+2) + C5*VNSQ*QJ(J+1)     00001870   09/08/75
    ETA    = ETA + DETA                                                00001880   09/08/75
    IF (J+2 .GT. NORD) GO TO 110                                       00001890   09/08/75
    IF (C11.GT.VM*C6 .AND. ABS(DETA).LE..005*ABS(ETA)) GO TO 110       00001900   09/08/75
    J      = J + 2                                                     00001910   09/08/75
    C11    = C11 + 2.                                                  00001920   09/08/75
    C12    = C12 + 1.                                                  00001930   09/08/75
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      C13      = C13 + 1.                                               09/08/75
      C14      = C14 + 1.                                               09/08/75
      GO TO 100                                                         09/08/75
C     COMPLETED SUM OVER K STARTING AT 0                                09/08/75
  110 DSUM     = ETA / VL                                               09/08/75
  120 SUM      = SUM + DSUM                                             09/08/75
      PSON(M) = 10. * ALOG10(C1*SUM) + C4                               11/26/75
      IF (M .EQ. MAX) PSONM = 10.**(PSON(M)/10.) * VMAX**1.219          11/26/75
  130 CONTINUE                                                          11/26/75
      DO 140 I=1,30                                                     09/08/75
  140 PWLB(I) = 10.*ALOG10(PWLB(I)) + C8N                               09/08/75
      DO 150 I=1,MMAX                                                   09/08/75
  150 TPWL(I) = 10.*ALOG10(TPWL(I)) + C8N                               09/08/75
      IF (DA(163) .GT. 0.) GO TO 158                                    09/08/75
C     APPLY CORRECTIONS FOR REVERSE THRUST TO TONE AND BROADBAND NOISE  09/08/75
      SUM      = 10.                                                    09/08/75
      IF (TS .GT. 650.) SUM = AMIN1(25.,.075*TS-38.75)                  09/08/75
      PSON(1) = PSON(1) + SUM                                           09/08/75
      PSON(2) = PSON(2) + 9.                                            09/08/75
      PSON(3) = PSON(3) + 6.                                            09/08/75
      PSON(4) = PSON(4) + 4.                                            09/08/75
      PSON(5) = PSON(5) + 3.                                            09/08/75
      PSON(6) = PSON(6) + 2.                                            09/08/75
      PSON(7) = PSON(7) + 1.                                            09/08/75
      TPWL(1) = TPWL(1) + SUM                                           09/08/75
      TPWL(2) = TPWL(2) + 9.                                            09/08/75
      TPWL(3) = TPWL(3) + 6.                                            09/08/75
      TPWL(4) = TPWL(4) + 4.                                            09/08/75
      TPWL(5) = TPWL(5) + 3.                                            09/08/75
      TPWL(6) = TPWL(6) + 2.                                            09/08/75
      TPWL(7) = TPWL(7) + 1.                                            09/08/75
      DO 152 IF=1,30                                                    09/08/75
      IFC      = IF                                                     09/08/75
      IF (BPF .LT. BLF(IF+1)) GO TO 154                                 09/08/75
  152 CONTINUE                                                          09/08/75
  154 DO 156 IA=1,30                                                    09/08/75
  156 PWLB(IA) = PWLB(IA) + BBDBC(IA-IFC+30)                            09/08/75
  158 IF (DA(6) .NE. 3.) GO TO 180                                      09/08/75
      WRITE (NP,160) PWLB,MMAX,BPF,(TPWL(I),I=1,MMAX)                   09/08/75
  160 FORMAT (/57H 30 PWL'S OF BROADBAND NOISE DUE TO ROTOR-OGV INTERACT 09/08/75
     1ION/ 1X,20F6.1 / 1X,10F6.1 // I3,78H PWL'S OF TONE NOISE DUE TO RO 11/07/75
     2TOR-OGV INTERACTION WITH FUNDAMENTAL FREQUENCY =,F6.1,3H HZ / 1X, 11/07/75
     320F6.1 )                                                          09/08/75
      WRITE (NP,170) NMAX,(PSON(I),I=1,NMAX)                            09/08/75
  170 FORMAT (/ I4,30H PWL'S DUE TO NON-STEADY LOADS / 5(1X,20F6.1/))   09/08/75
C     FAN DIRECTIVITY FACTORS                                           09/08/75
  180 IF (DA(163) .LT. 0.) GO TO 200                                    09/08/75
      FCOR     = DA(160) / 3.                                           09/29/75
      DO 190 IA=1,15                                                    09/08/75
      DO 190 IF=1,30                                                    09/08/75
      CALL BIQUAD (DIRIN,1,PSI(IA),BCFR(IF)*FCOR,FDIRI(IA,IF),K)        02/10/76
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      CALL BIQUAD (DIREX,1,PSI(IA),BCFR(IF)*FCOR,FDIRE(IA,IF),K)       00002450   02/10/76
  150 CONTINUE                                                          00002460   09/08/75
      GO TO 220                                                         00002470   09/08/75
  200 DO 210 IA=1,15                                                    00002480   09/08/75
      CALL BIQUAD (RDIRIN,1,PSI(IA),0.,FDIRI(IA,1),K)                   00002490   09/08/75
      CALL BIQUAD (RDIREX,1,PSI(IA),0.,FDIRE(IA,1),K)                   00002500   09/08/75
      DO 210 IF=2,30                                                    00002510   09/08/75
      FDIRI(IA,IF) = FDIRI(IA,1)                                        00002520   09/08/75
  210 FDIRE(IA,IF) = FDIRE(IA,1)                                        00002530   09/08/75
C     TILT CORRECTION TO FUNDAMENTAL TONES                              00002540   09/08/75
  220 DDBT     = 0.                                                     00002550   09/08/75
      G1       = AMIN1(.2,VELFL*ABS(SIN(.0174532925*ALPHA)) / TS)       00002560   09/08/75
      IF (ALPHA.LT.90. .OR. ALPHA.GT.270.) DDBT = ((1133.89*G1-642.248)*00002570   09/08/75
     1G1+125.104)*G1                                                    00002580   09/08/75
      PSON(1) = PSON(1) + DDBT                                          00002590   09/08/75
      TPWL(1) = TPWL(1) + DDBT                                          00002600   09/08/75
C     BROADBAND NOISE , OPTION 3 IN AFAPL-TR-71-37                      00002610   09/08/75
      AB       = SIGR * (1.-DA(159)**2) * DA(160)**2 * .78539816        00002620   09/08/75
      H        = .13 * AB / (DA(160) * DA(161) * (1.-DA(159)))          00002630   09/08/75
      DBTX     = -75.791 + 57000.*THRUST/AB/TS**2 + 4.342945*ALOG(AB*TS**00002640   09/08/75
     16) + DBN                                                          00002650   09/08/75
      FREQM    = .06 * SQRT((.7*TS)**2+DA(4)**2) / H                    00002660   09/08/75
      DO 260 IA=1,15                                                    00002670   09/08/75
      C1       = DBTX - 8.68589*ALOG(ZO(IA)) - 3.3*SIN(.0174532925*(PSI(I00002680   09/08/75
     1A)+10.))**2                                                       00002690   09/08/75
      DO 260 IF=1,30                                                    00002700   09/08/75
      S        = ALOG10(BCFR(IF)/FREQM)                                 00002710   09/08/75
      IF (S .GT. -.1549) GO TO 230                                      00002720   09/08/75
      SPL(IA,IF) = C1 - 1.5 + 22.*S                                     00002730   09/08/75
      GO TO 255                                                         00002740   09/08/75
  230 IF (S .GT. .1461) GO TO 240                                       00002750   09/08/75
      SPL(IA,IF) = C1 - 3.4 + (2.23462-48.0894*S)*S                     00002760   09/08/75
      GO TO 255                                                         00002770   09/08/75
  240 IF (S .GT. .6021) GO TO 250                                       00002780   09/08/75
      SPL(IA,IF) = C1 - 2. - 15.*S                                      00002790   09/08/75
      GO TO 255                                                         00002800   09/08/75
  250 SPL(IA,IF) = C1 - 5.5 - 9.1*S                                     00002810   09/08/75
  255 IF (IA.EQ.8) BPWL(IF) = SPL(8,IF) + CSUM(8) + DPWSP(8) + 3.3*SIN( 00002820   09/08/75
     1.0174532925*(PSI(8)+10.))**2 -2.3                                 00002830   09/08/75
  260 SPL(IA,IF) = SPL(IA,IF) - ZO(IA)*ATTNT(IF)                        00002840   09/08/75
      IF (DA(6) .NE. 3.) GO TO 280                                      00002850   09/08/75
      WRITE (NP,270)                                                    00002860   09/08/75
  270 FORMAT (//22H ROTOR BROADBAND NOISE)                              00002870   11/26/75
      CALL PNLC(SPL)                                                    00002880   09/08/75
C     COMBINE TPWL,PSON,PWLB & BPWL                                     00002890   09/08/75
  280 VL       = BPF                                                    00002900   09/08/75
      I        = 1                                                      00002910   09/08/75
      DO 330 IF=1,30                                                    00002920   09/08/75
      CPWL(IF) = 10.**(PWLB(IF)/10.) + 10.**(BPWL(IF)/10.)              00002930   09/08/75
  300 IF (VL .GT. BLF(IF+1)) GO TO 310                                  00002940   09/08/75
      IF (I.LE.MMAX) CPWL(IF) = CPWL(IF) + 10.**(TPWL(I)/10.)           00002950   09/08/75
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      IF (I.LE.NMAX) CPWL(IF) = CPWL(IF) + 10.**(PSON(I)/10.)                       09/08/75
      VL       = VL + BPF                                                           09/08/75
      I        = I + 1                                                              09/08/75
      GO TO 300                                                                     09/08/75
  310 CPWL(IF) = 10.*ALOG10(CPWL(IF))                                               09/08/75
      DO 320 IA=1,15                                                                09/08/75
  320 SPL(IA,IF) = 10.*ALOG10(10.**((CPWL(IF)+FDIRI(IA,IF))/10.) + 10.**           09/08/75
     1((CPWL(IF)+FDIRE(IA,IF))/10.)) - DPWSP(IA) -ATTNT(IF)*ZO(IA)                  11/05/75
  330 CONTINUE                                                                      09/08/75
      IF (DA(6) .GT. 1.) WRITE (NP,440)                                             09/08/75
  440 FORMAT (//34H COMBINED TONE AND BROADBAND NOISE)                              11/26/75
      IF (DA(6) .GT. 1.) CALL PNIC(SPL)                                             11/26/75
      G1       = 0.                                                                 09/08/75
      G2       = 0.                                                                 09/08/75
      IF (DA(21).LE.0. .OR. DA(174).LT..4 .OR. DA(174).GT.1. .OR. DA(163            03/13/76
     1).LT.0.) GO TO 470                                                            11/05/75
      IF (DA(174) .GT. .95) GO TO 340                                               11/25/75
      G2       = ALOG10(1.-DA(174))                                                 09/08/75
      G1       = 37.*G2 + 8.                                                        09/08/75
      G2       = 30.*G2 + 9.                                                        09/08/75
      IF (DA(174) .LT. .5) G2 = 0.                                                  09/08/75
      GO TO 350                                                                     09/08/75
  340 G1       = - 40.                                                              09/08/75
      G2       = - 30.                                                              09/08/75
  350 WRITE (NP,360) DA(174)                                                        09/08/75
  360 FORMAT (33H1INLET WITH THROAT MACH NUMBER OF,F6.3,14H REDUCES NOIS            09/08/75
     1E)                                                                            09/08/75
      DO 370 IF=1,30                                                                09/08/75
      PWLB(IF) = PWLB(IF) + G2                                                      09/08/75
  370 BPWL(IF) = BPWL(IF) + G2                                                      09/08/75
      DO 380 IF=1,MMAX                                                              09/08/75
  380 TPWL(IF) = TPWL(IF) + G1                                                      09/08/75
      DO 390 IF=1,NMAX                                                              09/08/75
  390 PSON(IF) = PSON(IF) + G1                                                      09/08/75
      VL       = BPF                                                                09/08/75
      I        = 1                                                                  09/08/75
      DO 430 IF=1,30                                                                09/08/75
      CPWL(IF) = 10.**(PWLB(IF)/10.) + 10.**(BPWL(IF)/10.)                          09/08/75
  400 IF (VL .GT. BLF(IF+1)) GO TO 410                                              09/08/75
      IF (I.LE.MMAX) CPWL(IF) = CPWL(IF) + 10.**(TPWL(I)/10.)                       09/08/75
      IF (I.LE.NMAX) CPWL(IF) = CPWL(IF) + 10.**(PSON(I)/10.)                       09/08/75
      VL       = VL + BPF                                                           09/08/75
      I        = I + 1                                                              09/08/75
      GO TO 400                                                                     09/08/75
  410 CPWL(IF) = 10.*ALOG10(CPWL(IF))                                               09/08/75
      DO 420 IA=1,15                                                                09/08/75
  420 SPL(IA,IF) = 10.*ALOG10(10.**((CPWL(IF)+FDIRI(IA,IF))/10.) + 10.**           09/08/75
     1((CPWL(IF)+FDIRE(IA,IF))/10.)) - DPWSP(IA) -ATTNT(IF)*ZO(IA)                  09/08/75
  430 CONTINUE                                                                      09/08/75
      IF (DA(6).LT.2. .OR. DA(21).GT.0.) GO TO 470                                  09/08/75
      WRITE (NP,440)                                                                11/26/75
                                                                                    11/26/75
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      CALL PNLC (SPL)                                                 00003470     11/26/75
  470 IF (DA(21) .LE. 0.) GO TO 530                                   00003480     09/09/75
C     APPLY TREATMENT CORRECTION TO NOISE , GET ROTOR & STATOR PWLS   00003490     09/08/75
      VL       = BPF                                                  00003500     09/08/75
      I        = 1                                                    00003510     09/08/75
      DO 500 IF=1,30                                                  00003520     09/08/75
      RPWL(IF) = 10.**((BPWL(IF)-G2)/10.)                             00003530     03/18/76
      SPWL(IF) = 10.**((PWLB(IF)-G2)/10.)                             00003540     03/18/76
      C1       = 10.**(BPWL(IF)/10.) + 10.**(PWLB(IF)/10.)            00003550     03/18/76
      C2       = RPWL(IF) + SPWL(IF)                                  00003560     03/18/76
  480 IF (VL .GT. BLF(IF+1)) GO TO 490                                00003570     09/08/75
      IF (I .GT. MMAX) GO TO 483                                      00003580     03/18/76
      C3       = 10.**((TPWL(I)-G1)/10.)                              00003590     03/18/76
      RPWL(IF) = RPWL(IF) + C3                                        00003600     03/18/76
      C2       = C2 + C3                                              00003610     03/18/76
      C1       = C1 + 10.**(TPWL(I)/10.)                              00003620     03/18/76
  483 IF (I .GT. NMAX) GO TO 486                                      00003630     03/18/76
      C3       = 10.**((PSON(I)-G1)/10.)                              00003640     03/18/76
      SPWL(IF) = SPWL(IF) + C3                                        00003650     03/18/76
      C2        = C2 + C3                                             00003660     03/18/76
      C1       = C1 + 10.**(PSON(I)/10.)                              00003670     03/18/76
  486 VL       = VL + BPF                                             00003680     03/18/76
      I        = I + 1                                                00003690     09/08/75
      GO TO 480                                                       00003700     09/08/75
  490 RPWL(IF) = 10. * ALOG10(RPWL(IF))                               00003710     03/18/76
      SPWL(IF) = 10. * ALOG10(SPWL(IF))                               00003720     03/18/76
      C3       = 10. * ALOG10(C1/C2)                                  00003730     03/18/76
      DO 495 IA=1,15                                                  00003740     03/18/76
  495 FDIRI(IA,IF) = FDIRI(IA,IF) + C3                                00003750     03/18/76
  500 CONTINUE                                                        00003760     03/18/76
      CALL TREAT (RPWL,SPWL,CA(168)*.01*DA(160),CA(169)*.01*DA(160),DA(100003770     09/08/75
     170)*.01*DA(160),DA(160)*(1.-DA(159))/2.,QM,2,CA(171),SPL,FDIRI,FDI00003780     09/08/75
     2RE,CA(172),DA(173))                                             00003790     09/08/75
  530 DO 540 IF=1,30                                                  00003800     09/08/75
      DO 540 IA=1,15                                                  00003810     09/08/75
      C1       = 10.**(SPL(IA,IF)/10.)                                00003820     09/08/75
      PWLT(IA,IF) = PWLT(IA,IF) + C1                                  00003830     09/08/75
  540 SPLT(IA,IF) = SPLT(IA,IF) + C1                                  00003840     09/08/75
      IF (DA(19) .EQ. 0. .OR. DA(176).NE.0. .OR. DA(163).LT.0.)GO TO 54500003850     11/26/75
C     JET NOISE                                                       00003860     11/26/75
      WRITE (NP,460)                                                  00003870     11/26/75
  460 FORMAT (1H1, 9HJET NOISE)                                       00003880     11/26/75
      C1       = 0.                                                   00003890     11/26/75
      CALL JETN (W,DA(163),A2,C1,C1,C1,SPL,SPLD)                      00003900     02/12/76
      DO 450 IF=1,30                                                  00003910     11/26/75
      DO 450 IA=1,15                                                  00003920     11/26/75
      SPL(IA,IF) = SPL(IA,IF) + DBN                                   00003930     11/26/75
      SPLT(IA,IF)   = SPLT(IA,IF) + 10.**(SPL(IA,IF)/10.)             00003940     11/26/75
  450 PWLT(IA,IF)   = PWLT(IA,IF) + 10.**((SPLD(IA,IF)+DBN)/10.)      00003950     11/26/75
      IF (CA(6) .NE. 0.) CALL PNLC (SPL)                              00003960     11/26/75
  545 IF (CA(176) .EQ. 0.) GO TO 550                                  00003970     11/26/75
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C     HAVE INTEGRAL ENGINE                                                        09/08/75
      DA(184) = 0.                                                                09/08/75
      CALL COENG (0,CA(156),DA(164),CEN,IFIX(CA(178)),TS/DA(157),DENG,            09/08/75
     1DA(189),BENG,DA(19),DA(196),DA(157),W,CA(163)-THRUST,A2)                    09/26/75
  55C IF (CA(20) .EQ. 0.) RETURN                                                  09/08/75
      CALL GRBOXN (IFIX(DA(2C)),DA(154),19.098593*TS/DA(16C),DBN,DA(176)          09/25/75
     1)                                                                           09/25/75
      RETURN                                                                      09/08/75
C     REVERSE THRUST CASE                                                         09/08/75
 1000 IF (DA(177).LT..75 .OR. DA(177).GT.1.) GO TO 5                              09/08/75
      FIR     = (((1.74256E-7-3.42325E-10*VKTAS)*VKTAS-3.37591E-5)*VKTAS          09/08/75
     1+3.20144E-3)*VKTAS+1.                                                       09/08/75
      TS       = CA(157) * DA(177)                                                09/08/75
      TSTAT    = - DA(163) * .6 * FIR                                             09/08/75
      IF (DA(175) .NE. 0.) GC TC 103C                                             09/08/75
C     REVERSE THRCUGH FLAT PITCH                                                  09/08/75
      IF (SIGR .GT. 1.) GO TO 1010                                                09/08/75
      TSTAT    = 6.C447E-7*TSTAT*DA(157)**2 * SIGR**.83 / DA(158)                 09/03/75
      GO TO 1030                                                                  09/08/75
 1010 WRITE (NP,1020) SIGR                                                        09/08/75
 1020 FORMAT (78H CANNOT REVERSE VARIABLE-PITCH FAN THROUGH FLAT PITCH B          09/08/75
     1ECAUSE ROTOR SOLIDITY =,F4.1,34H , REVERSE THROUGH FEATHER INSTEAD          09/08/75
     2)                                                                           09/08/75
      DA(175) = 1.                                                                09/08/75
 1030 AR       = 1.                                                               09/08/75
      CALL GAAVPF (0.,DA(125),DA(126),DA(155),DA(156),DA(157),DA(158),            09/08/75
     1DA(159),DA(160),         DA(161),DA(162),A2,AR,TSAT,DA(164),TS,PR,          10/02/75
     2CM,CU,CUP,CON,SIGF,DCLDA,BE,RE,0,0.,W,2,ERRA,DA(165),THRUST,UM,CD,          09/08/75
     3SIGR)                                                                       09/08/75
      IA       = IFIX(DA(175))                                                    09/08/75
      VKTAS    = 0.                                                               09/08/75
      GC TO 25                                                                    09/08/75
      END
```

Subroutine VPLFAN

This subroutine supervises the calculation of noise and aerodynamic performance of a variable-pitch lift fan, including adjustments for duct acoustic treatment.

```
RUN NO. 5717     DATE  04/14/76     TIME  1653          LISTING OF MODULE H3940                                   PAGE   1

DESCRIPTION          VPLFAN - VAR.-PITCH LIFT FAN

MASTER FILE          LIBR.G04
ADDED TO MASTER      08/16/75
LAST DATE COPIED       NONE
LAST UPDATE          04/14/76  1653          *** TEMPORARY UPDATE ***

PASSWORD             SZCS
PROGRAMMER           F.W.BARRY
PROC PARAMETER       $NOJCL

      SUBROUTINE VPLFAN                                                 00000010
C     VARIABLE-PITCH LIFT FAN PERFORMANCE AND NOISE                     00000030
C     VPLFAN CALLS GAAVPF, RVINT, BESJH, PNLC, TREAT, JETN, BIQUAD,     00000040           10/01/75
C      CCENG, GRBOXN ; CALLED BY MAIN                                   00000050           10/01/75
      COMMON /DATA/ ANGLE(15),BCFR(30),NR,NP,C,FOL(20),DATE(2),TIME(2), 00000060
     1 ATTNT(30),SPLT(15,30),SPLTU(15,30),CBNU(7),XO(15),XC(15),ZO(15), 00000070
     2 PSI(15),CO(15),DDO(15),HPT,TR,VELFL,WM(15),PWLT(15,30),          00000080           10/01/75
     3 DIRIN(498),DIREX(498),BLF(31),DPWSP(15),RPMG,DHPT,RRPM,CSUM(15)  00000090           10/01/75
      COMMON /DATAI/CA(400)                                             00000100           10/01/75
      COMMON / JNX / CJ(450)                                            00000110           10/01/75
      DIMENSION TPWL(20),PWLB(30),SFL(15,30),PSQN(100),FDIRI(15,30),    00000120           10/01/75
     1FDIRE(15,30),BPWL(30),                                            00000130           10/01/75
     2CPWL(30),SPLD(15,30),RPWL(30),SPWL(30),DENG(10),BENG(6)           00000140           10/01/75
      EQUIVALENCE (CA(298),DENG(1)),(DA(310),BENG(1))                   00000150           10/01/75
C      277  = DESIGN (TAKEOFF) NET LIFT , LB , USED IF GT O.            00000160           10/01/75
C      278  = DESIGN (TAKEOFF) SHP , USED IF 277 LE O.                  00000170           10/01/75
C      279  = DESIGN (TAKEOFF) TIP SPEED (FPS) , USED IF GT MINIMUM     00000180           10/01/75
C      280  = DESIGN (TAKEOFF) PRESSURE RATIO , 1.0 TO 1.75, USED IF    00000190           10/01/75
C              282 = O.                                                 00000200           10/01/75
C      281  = HUB / TIP DIAMETER RATIO , USE IF GT MININUM              00000210           10/01/75
C      282  = TIP DIAMETER , FT , USED IF GT C.                         00000220           10/01/75
C      283  = NUMBER OF BLADES                                          00000230           10/01/75
C      284  = NUMBER OF OGVS                                            00000240           10/01/75
C      285  = NET LIFT , LB , USED IF NE O.                             00000250           10/01/75
C      286  = SHP , LSFD IF 285 = C.                                    00000260           10/01/75
C      287  = STACKING LINE DISTANCE , FT , IF GT O., -BVGAP IF LT O.,  00000270           10/01/75
C              IF = O. BVGAP = 2. USED                                  00000280           10/01/75
C      288  = STANDARD DEVIATION OF PAM , C. REPLACED BY 1.             00000290           10/01/75
C      289  = STANDARD DEVIATION OF PPM , O. REPLACED BY .02            00000300           10/01/75
C      290  = INLET TREATMENT LENGTH , PERCENT OF DIAMETER              00000310           10/01/75
C      291  = MID TREATMENT LENGTH , PERCENT OF DIAMETER                00000320           10/01/75
C      292  = EXHAUST TREATMENT LENGTH , PERCENT OF DIAMETER            00000330           10/01/75
C      293  = DUF , 1. OR 2.                                            00000340           10/01/75
C      294  = NUMBER OF INLET SPLITTERS                                 00000350           10/01/75
C      295  = NUMBER OF EXHAUST SPLITTERS                               00000360           10/01/75
C      296  = O. IF SHAFT DRIVE , = 1. IF INTEGRAL ENGINE               00000370           10/01/75
C      297  = O. IF USE TYPICAL TURBOSHAFT ENGINE , = 1. IF USE:        00000380           10/01/75
C      298  RPMC COMPRESSOR RPM                                         00000390           10/01/75
C      299  D     COMPRESSOR DIAMETER , FT                              00000400           10/01/75
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C      300  FPR   COMPRESSOR FIRST-STAGE PRESSURE RATIO                           10/01/75
C      301  RSS   COMPRESSOR FIRST-STAGE ROTOR-STATOR SPACING IN PERCENT          10/01/75
C      302  BC    COMPRESSOR FIRST-STAGE NUMBER OF BLADES                         10/01/75
C      303  CK    = 0. FOR TURBOSHAFT ENGINE                                      10/01/75
C      304  P3    COMBUSTOR INLET TOTAL PRESSURE , PSF                            10/01/75
C      305  T3    COMBUSTOR INLET TOTAL TEMPERATURE , DEG R                       10/01/75
C      306  T4    COMBUSTOR EXIT  TOTAL TEMPERATURE , DEG R                       10/01/75
C      307  QMA   COMBUSTOR MASS FLOW RATE , LB/SEC                               10/01/75
C      308  QMT   TURBINE MASS FLOW RATE , LB/SEC                                 10/01/75
C      309  VTR   RELATIVE TIP SPEED OF LAST TURBINE ROTOR , FPS                  10/01/75
C      310  CL    SPEED OF SOUND AT TURBINE EXIT , FPS                            10/01/75
C      311  SOC   LAST STAGE STATOR-ROTOR SPACING / STATOR CHORD                  10/01/75
C      312  VK    =0. FOR COPLANAR EXHAUSTS , -10. FOR RECESSED EXHAUST           10/01/75
C      313  BT    NUMBER OF BLADES IN LAST TURBINE ROTOR                          10/01/75
C      314  RPMT  TURBINE RPM                                                     10/01/75
C      315  THRT  JET THRUST , LB                                                 10/01/75
C      316  AREA  JET AREA , SQ FT                                                10/01/75
      IF ((DA(277).GT.0..OR.DA(278).GT.0.) .AND. DA(283).GT.1. .AND.             10/01/75
     1DA(284).GT.1. .AND. (DA(285).GT.0..OR.DA(286).GT.0.)) GO TO 20             10/01/75
    5 WRITE (NP,10)                                                               10/01/75
   10 FORMAT (76H1VARIABLE-PITCH LIFT FAN NOISE NOT CALCULATED BECAUSE            10/01/75
     1F ERROR IN INPUT DATA)                                                      10/01/75
      DA(26)  = 0.                                                                10/01/75
      RETURN                                                                      10/01/75
C     DEFAULT OPTIONS                                                             10/01/75
   20 IF (DA(281) .LT. .4) DA(281) = .4                                           10/01/75
      IF (DA(288) .LE. 0.) DA(288) = 1.                                           10/01/75
      IF (DA(289) .LE. 0.) DA(289) = .02                                          10/01/75
C     DBN     CORRECTION FOR NUMBER OF UNITS                                      10/01/75
      DBN      = 0.                                                               10/01/75
      IF (DA(26) .GT. 1.) DBN = DBNU(IFIX(DA(26)-.5))                             10/01/75
      VKTAS    = DA(5) / 1.6878                                                   02/11/76
      ALPHA    = 90.                                                              02/11/76
      IF (VELFL .GT. 0.) ALPHA = 90. - ATAN2(DA(5),DA(4))/.0174532925             02/11/76
      IF (ALPHA.GT.90. .AND. ALPHA.LT.270.) VKTAS = 0.                            10/01/75
      CALL GAAVPF (DA(124),DA(125),DA(126),DA(277),DA(278),DA(279),DA(280)        10/01/75
     10),DA(281),DA(282),DA(283),DA(284),A2,AR,DA(285),DA(286),TS,PR,CM,          10/01/75
     2CU,CUP,CDN,SIGF,DCLDA,BE,RE,0,VELFL/C,W,1,ERRA,DA(287),THRUST,QM,           10/01/75
     3CD,SIGR)                                                                    10/01/75
      IF (ERRA .NE. 0.) GO TO 5                                                   10/01/75
      IF (DA(296) .EQ. 0.) DHPT = DHPT + DA(26)*DA(278)                           10/01/75
      TS       = 0.                                                               10/01/75
      CALL GAAVPF (DA(124),DA(125),DA(126),DA(277),DA(278),DA(279),DA(280)        10/01/75
     10),DA(281),DA(282),DA(283),DA(284),A2,AR,DA(285),DA(286),TS,PR,CM,          10/01/75
     2CU,CUP,CDN,SIGF,DCLDA,BE,RE,0,VELFL/C,W,2,ERRA,DA(287),THRUST,QM,           10/01/75
     3CD,SIGR)                                                                    10/01/75
      IF (ERRA .NE. 0.) GO TO 5                                                   10/01/75
      IF (DA(296) .EQ. 0.) HPT = HPT + DA(26)*DA(286)                             10/01/75
      WRITE (NP,30) HCL,DATE,TIME, DA(282),DA(281),DA(284),DA(283),AR,DA          10/01/75
     1(287),DA(124),DA(125),DA(126),(DA(I),I=277,280),DA(285),DA(286),TS          10/01/75
     2,PR
```

```
   30 FORMAT (1H1,42X,29HVARIABLE-PITCH LIFT FAN NOISE // 1H ,20A4,2X,2A000C0920   10/01/75
     14,2X,2A4 // 14H CONFIGURATION /11H DIAMETER =,F6.2,30H FT , HUB/TI00000930   10/01/75
     2P DIAMETER RATIO =,F7.4,2H ,,F3.0, 7H OGVS ,,F3.0,22H BLADES , AREC0000940   10/01/75
     3A RATIO =,F5.2,27H , STACKING LINE DISTANCE =,F6.3 / 17H DESIGN C00000950   10/01/75
     4NDITION / F6.1,8H KNOTS ,F4.0,6H DEG F ,F7.3,20H PSIA , NET THRUSTC00000960   10/01/75
     5 =,F7.1,11H LBS , HP =,F7.1,14H , TIP SPEED =,F7.2,23H FPS , PRESS00000970   10/01/75
     6URE RATIO =,F5.2 / 20H OPERATING CONDITION / 13H NET THRUST =,F7.100000980   10/01/75
     7,11H LBS , HP =,F7.1,14H , TIP SPEED =,F7.2,23H FPS , PRESSURE RATC0000990   10/01/75
     8IO =,F5.2 )                                                        00001000   10/01/75
      IF (DA(6) .EQ. 3.) WRITE(NP,35) BE,CUP,CDN,SIGF,A2,W,CM,OM,CU,CD, 00001010   10/01/75
     1THRUST,DA(283),DA(289)                                             00001020   10/01/75
   35 FORMAT (/22H BLADE STAGGER ANGLE =,F4.0,20H DEG , BLADE CHORD =,F600001030   10/01/75
     1.3,14H , OGV CHORD =,F6.3,20H FT , OGV SOLIDITY =,F6.3,  7H , A2 =00001040   10/01/75
     2,F6.2,7H SQ.FT. /10H AIRFLOW =,F7.2,25H LB/SEC, AXIAL VELOCITY =,F00001050   10/01/75
     37.1,16H FPS , AXIAL M =,F6.3,19H , 1/2 SWIRL VEL. =,F7.1,16H FPS, 00001060   11/07/75
     4ROTOR CD =,F7.4/15H ROTOR THRUST =,F7.1,24H LE , STD. DEV. OF PAM 00001070   11/07/75
     5=,F5.2,21H , STD. DEV. OF PPM =,F6.3)                             00001080   10/01/75
      IF (DA(296) .EQ. 0.) FRPM = TS / DA(279)                          00001090   10/01/75
      MMAX    = 20                                                      00001100   10/01/75
C     TONE AND BROADBAND POWERS DUE TO ROTOR-OGV INTERACTION            00001110   11/07/75
      CALL RVINT (TPWL,PWLB,MMAX,1.9679E18*DA(282)**2*SQRT(TR),2,DA(283)00001120   10/01/75
     1,DA(284),RE,DA(281),DA(282),TS,TS*DA(283)/(3.1415927*DA(282)),TS/C00001130   10/01/75
     2,BE,CM,CU,CD,CUP,CDN,DA(287),SIGF,DCLDA,DA(288),DA(289))          00001140   10/01/75
C     NON-STEADY HARMONIC LOADING AS IN FAPROP                          00001150   10/01/75
C     VELOCITY CORRECTION                                               00001160   10/01/75
      IF (VKTAS .GT. 2.) GO TO 40                                       00001170   10/01/75
      DDBNSV  = -3.1 * VKTAS                                            00001180   10/01/75
      GO TO 50                                                          00001190   10/01/75
   40 DDBNSV = 10.*ALOG10((1.+SQRT(1.+375.99883*THRUST/(VKTAS*DA(282))**00001200   10/01/75
     12)) / (1.+SQRT(1.+267.8375*THRUST-DA(282)**2)) ) - 4.             00001210   10/01/75
   50 VMT     = TS / C                                                  00001220   10/01/75
      BPF     = TS * DA(283) * .31830988 / DA(282)                      00001230   10/01/75
      C1      = 9943.77 * (DA(283) / DA(282))**2                        00001240   10/01/75
      C2      = .03125 * (THRUST / DA(283))**2                          00001250   10/01/75
      C3      = .722 * DA(286)**2 / (DA(283)*VMT)**3                    00001260   10/01/75
      C4      = 44.7 - 10.*ALOG10(DA(3)/C) + DBN + DDBNSV               00001270   10/01/75
      C6      = 1.6 * DA(283) * VMT                                     00001280   10/01/75
      IB      = IFIX(DA(283))                                           00001290   10/01/75
      MAX     = 20/IB + 1                                               00001300   10/01/75
      VMAX    = FLOAT(MAX)                                              00001310   10/01/75
      NMAX    = MIN1(100.,22400./BPF)                                   00001320   10/01/75
      DO 60 IA=1,15                                                     00001330   10/01/75
      DO(IA)  = PSI(IA)                                                 00001340   10/01/75
   60 PSI(IA) = ARCOS(-DA(7) / ZO(IA)) / .017453295                     00001350   10/01/75
      DO 130 M=1,NMAX                                                   00001360   10/01/75
      VM      = FLOAT(M)                                                00001370   10/01/75
      IF (M .GT. MAX) GO TO 80                                          00001380   10/01/75
      SUM     = 0.                                                      00001390   10/01/75
      C5      = C3 / VM                                                 00001400   10/01/75
      PSCN(M) = 0.                                                      00001410   10/01/75
      MB      = M * IB                                                  00001420   10/01/75
```

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      NORD     = MINO(400,MB)                                             10/01/75
      CALL BESJH(VM*C6,NORD,QJ,RR,450,NP)                                 10/01/75
      IF (RR .NE. 0.) NORD = IFIX(RR)                                     10/01/75
      IF (NORD .GE. MB) GO TO 90                                          10/01/75
      IF (DA(6) .EQ. 3.) WRITE (NP,70) IA,M,NORD                          10/01/75
   70 FORMAT (/24H BESSEL FUNCTION FOR IA=,I3,3H M=,I3,20H LIMITED TO OR  10/01/75
     1DER OF,I4/)                                                         10/01/75
      GO TO 90                                                            10/01/75
   80 PSON(M) = 10. * ALOG10(PSONM / VM**1.219)                           11/26/75
      GO TO 130                                                           10/01/75
   90 VMB      = VM * DA(283)                                             10/01/75
      LMIN     = MAX1(1.,VMB*(1.-VMT))                                    10/01/75
      LMAX     = IFIX(VMB*(1.+VMT)) + 1                                   10/01/75
      DO 120 L=LMIN,LMAX                                                  10/01/75
      VL       = FLOAT(L)**3.22                                           10/01/75
      MBL      = MB - L                                                   10/01/75
      VN       = FLOAT(MBL)                                               10/01/75
      VNSQ     = VN**2                                                    10/01/75
      J        = MBL + MBL + 1                                            10/01/75
      C11      = VN + VN + 1.                                             10/01/75
      C12      = C11                                                      10/01/75
      C13      = VN + 1.                                                  10/01/75
      C14      = 1.                                                       10/01/75
      ETA      = 0.                                                       10/01/75
  100 DETA     = C2/C11*C12/(C11+2.)*C13*C14*QJ(J+2) + C5*VNSQ*QJ(J+1)    10/01/75
      ETA      = ETA + DETA                                               10/01/75
      IF (J+2 .GT. NORD) GO TO 110                                        10/01/75
      IF (C11.GT.VM*C6 .AND. ABS(DETA).LE..005*ABS(ETA)) GO TO 110        10/01/75
      J        = J + 2                                                    10/01/75
      C11      = C11 + 2.                                                 10/01/75
      C12      = C12 + 1.                                                 10/01/75
      C13      = C13 + 1.                                                 10/01/75
      C14      = C14 + 1.                                                 10/01/75
      GO TO 100                                                           10/01/75
C     COMPLETED SUM OVER K STARTING AT 0                                  10/01/75
  110 DSUM     = ETA / VL                                                 10/01/75
  120 SUM      = SUM + DSUM                                               10/01/75
      PSON(M) = 10. * ALOG10(C1*SUM) + C4                                 11/26/75
      IF (M .EQ. MAX) PSONM = 10.**(PSON(M)/10.) * VMAX**1.219            11/26/75
  130 CONTINUE                                                            11/26/75
      DO 140 I=1,30                                                       10/01/75
  140 PWLB(I) = 10.*ALOG10(PWLB(I)) + CBN                                 10/01/75
      DO 150 I=1,MMAX                                                     10/01/75
  150 TPWL(I) = 10.*ALOG10(TPWL(I)) + CBN                                 10/01/75
C     TILT CORRECTION TO FUNDAMENTAL TONES                                10/01/75
      DDBT     = 0.                                                       10/01/75
      G1       = AMIN1(.2,VELFL*ABS(SIN(.0174532925*ALPHA)) / TS)         10/01/75
      IF (ALPHA.LT.90. .OR. ALPHA.GT.270.) DDBT = (((1133.85*G1-642.248)* 10/01/75
     1G1+125.104)*G1                                                      10/01/75
      PSON(1) = PSON(1) + DDBT                                            10/01/75
      TPWL(1) = TPWL(1) + DDBT                                            10/01/75
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      IF (CA(6) .NE. 3.) GC TO 180                                      00001940   10/01/75
      WRITE (NP,160) PWLB,MMAX,BPF,(TPWL(I),I=1,MMAX)                   00001950   10/01/75
  16C FCRMAT (/57H 30 PWL'S OF BROADBAND NCISE DUE TO ROTOR-OGV INTERACT00001960   10/01/75
     1ICN/ 1X,20F6.1 / 1X,10F6.1 // I3,78H PWL'S CF TCNE NCISE DUE TO R00001970   10/01/75
     2TOR-OGV INTERACTION WITH FUNDAMENTAL FREQUENCY =,F6.1,3H HZ / 1X, 00001980   10/01/75
     320F6.1 )                                                          00001990   10/01/75
      WRITE (NP,170) NMAX,(PSCN(I),I=1,NMAX)                            00002000   10/01/75
  17C FCRMAT (/ 14,30H PWL'S DUE TC NCN-STEADY LOADS / 5(1X,20F6.1/))   00002010   10/01/75
C     FAN DIRECTIVITY FACTORS                                           00002020   10/01/75
  18C FCOR     = CA(282) / 3.                                           00002030   10/01/75
      DO 19C IA=1,15                                                    00002040   10/01/75
      DO 190 IF=1,3C                                                    00002050   10/01/75
      C1       = AMIN1(16C.,PSI(IA))                                    00002060   10/01/75
      CALL BIQUAD (CIRIN,1,C1,BCFR(IF)*FCCR,FDIRI(IA,IF),K)             00002070   02/10/76
      CALL BICUAD (CIREX,1,C1,BCFR(IF)*FCOR,FCIRE(IA,IF),K)             00002080   02/10/76
  190 CCNTINUE                                                          00002090   10/01/75
C     BRCADBAND NCISE , OPTICN 3 IN AFAPL-TR-T1-37                      00002100   10/01/75
      AB       = SIGR * (1.-DA(281)**2) * DA(282)**2 * .78539816        00002110   10/01/75
      H        = .13 * AB / (CA(282) * CA(283) * (1.-DA(281)))          00002120   10/01/75
      DBTX     = -75.751 + 57000.*THRUST/AB/TS**2 + 4.342945*ALOG(AB*TS**00002130   10/01/75
     16) + DBN                                                          00002140   10/01/75
      FREQM    = .06 * SCRT((.7*TS)**2+CA(4)**2) / H                    00002150   10/01/75
      DO 260 IA=1,15                                                    00002160   10/01/75
      C1       = DBTX - 8.68589*ALOG(ZO(IA)) - 3.3*SIN(.C174532925*(PSI(I00002170   10/01/75
     1A)+10.))**2                                                       00002180   10/01/75
      DO 260 IF=1,30                                                    00002190   10/01/75
      S        = ALCG10(BCFR(IF)/FREQM)                                 00002200   10/01/75
      IF (S .GT. -.1549) GC TO 230                                      00002210   10/01/75
      SPL(IA,IF) = C1 - 1.5 + 22.*S                                     00002220   10/01/75
      GO TO 255                                                         00002230   10/01/75
  230 IF (S .GT. .1461) GC TO 24C                                       00002240   10/01/75
      SPL(IA,IF) = C1 - 3.4 + (2.23462-48.C894*S)*S                     00002250   10/01/75
      GO TO 255                                                         00002260   10/01/75
  240 IF (S .GT. .6021) GO TC 25C                                       00002270   10/01/75
      SPL(IA,IF) = C1 - 2. - 15.*S                                      00002280   10/01/75
      GO TO 255                                                         00002290   10/01/75
  25C SPL(IA,IF) = C1 - 5.5 - 9.1*S                                     00002300   10/01/75
  255 IF (IA.EQ.8) BPWL(IF) = SPL(8,IF) + CSUM(8) + DPWSP(8) + 3.3*SIN( 00002310   10/01/75
     1.C174532925*(PSI(8)+10.))**2 -2.3                                 00002320   10/01/75
  260 SPL(IA,IF) = SPL(IA,IF) - ZO(IA)*ATTNT(IF)                        00002330   10/01/75
      IF (CA(6) .NE. 3.) GO TO 280                                      00002340   10/01/75
      WRITE (NP,270)                                                    00002350   10/01/75
  270 FORMAT (//22H RCTOR BRCADBAND NCISE)                              00002360   11/26/75
      CALL PNLC(SPL)                                                    00002370   10/01/75
C     CCMBINE TPWL,PSCN,PWLB & BPWL                                     00002380   10/01/75
  280 VL       = BPF                                                    00002390   10/01/75
      I        = 1                                                      00002400   10/01/75
      DC 330 IF=1,30                                                    00002410   10/01/75
      CPWL(IF) = 10.**(FWLB(IF)/10.) + 10.**(BPWL(IF)/10.)              00002420   10/01/75
  300 IF (VL .GT. BLF(IF+1)) GO TO 310                                  00002430   10/01/75
      IF (I.LE.MMAX) CPWL(IF) = CPWL(IF) + 1C.**(TPWL(I)/10.)           00002440   10/01/75
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      IF (I.LE.NMAX) CPWL(IF) = CPWL(IF) + 10.**(PSON(I)/10.)                10/01/75
      VL       = VL + BPF                                                    10/01/75
      I        = I + 1                                                       10/01/75
      GO TO 300                                                              10/01/75
  310 CPWL(IF) = 10.*ALOG10(CPWL(IF))                                        10/01/75
      DO 320 IA=1,15                                                         10/01/75
  320 SPL(IA,IF) = 10.*ALOG10(10.**((CPWL(IF)+FDIRI(IA,IF))/10.) + 10.**     11/26/75
     1((CPWL(IF)+FDIRE(IA,IF))/10.)) - DPWSP(IA) -ATTNT(IF)*ZO(IA)            10/01/75
  330 CONTINUE                                                               10/01/75
      IF (CA(6).LT.2. .OR. DA(29).GT.0.) GO TO 470                           11/26/75
      WRITE (NP,440)                                                         11/26/75
  440 FORMAT (//34H COMBINED TONE AND BROADBAND NOISE)                       11/26/75
      CALL PNLC (SPL)                                                        11/26/75
  470 IF (DA(29) .LE. 0.) GO TO 530                                          11/26/75
C     APPLY TREATMENT CORRECTION TO NOISE , GET ROTOR & STATOR PWLS          10/01/75
      VL       = BPF                                                         10/01/75
      I        = 1                                                           10/01/75
      DO 500 IF=1,30                                                         10/01/75
      RPWL(IF) = 10.**(BPWL(IF)/10.)                                         10/01/75
      SPWL(IF) = 10.**(FWLB(IF)/10.)                                         10/01/75
  480 IF (VL .GT. BLF(IF+1)) GO TO 490                                       10/01/75
      IF (I.LE.NMAX) RPWL(IF) = RPWL(IF) + 10.**(TPWL(I)/10.)                10/01/75
      IF (I.LE.NMAX) SPWL(IF) = SPWL(IF) + 10.**(PSON(I)/10.)                10/01/75
      VL       = VL + BPF                                                    10/01/75
      I        = I + 1                                                       10/01/75
      GO TO 480                                                              10/01/75
  490 RPWL(IF) = 10. * ALOG10(RPWL(IF))                                      03/19/76
  500 SPWL(IF) = 10. * ALOG10(SPWL(IF))                                      03/19/76
      CALL TREAT (RPWL,SPWL,DA(290)*.C1*CA(282),CA(291)*.01*DA(282),DA(2     10/01/75
     192)*.01*DA(282),DA(282)*(1.-DA(281))/2.,QM,2,DA(293),SPL,FDIRI,FDI     10/01/75
     2RE,DA(294),DA(295))                                                    10/01/75
  530 DO 540 IF=1,30                                                         10/01/75
      DO 540 IA=1,15                                                         10/01/75
      C1       = 10.**(SPL(IA,IF)/10.)                                       10/01/75
      PWLT(IA,IF) = PWLT(IA,IF) + C1                                         10/01/75
  540 SPLT(IA,IF) = SPLT(IA,IF) + C1                                         10/01/75
      IF (DA(27).EQ.0. .OR. DA(296).NE.0.) GO TO 545                         11/26/75
C     JET NOISE                                                              11/26/75
      WRITE (NP,460)                                                         11/26/75
  460 FORMAT (1H1, 9HJET NOISE)                                              11/26/75
      C1       = 0.                                                          11/26/75
      CALL JETN (W,CA(285),A2,C1,C1,C1,SFL,SPLC)                             03/19/76
      DO 450 IF=1,30                                                         11/26/75
      DO 450 IA=1,15                                                         11/26/75
      SFL(IA,IF) = SPL(IA,IF) + DBN                                          11/26/75
      SPLT(IA,IF)  = SPLT(IA,IF) + 10.**(SPL(IA,IF)/10.)                     11/26/75
  450 PWLT(IA,IF)  = PWLT(IA,IF) + 10.**((SPLC(IA,IF)+DBN)/10.)              11/26/75
      IF (CA(6) .NE. 0.) CALL PNLC (SPL)                                     11/26/75
  545 IF (DA(296) .EQ. 0.) GO TO 550                                         11/26/75
C     HAVE INTEGRAL ENGINE                                                   10/01/75
      DA(303) = 0.                                                           10/01/75
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      CALL CCENG (0,CA(278),CA(286),CBN,IFIX(DA(297)),TS/DA(279),DENG,    C0002960    10/01/75
     1DA(308),BENG,DA(27),CA(315),DA(316),W,DA(285)-THRUST-A2)           00002970    10/01/75
  550 IF (DA(28) .LE. 0.) GC TO 560                                       00002980    10/01/75
      CALL GRBJXN (IFIX(CA(28)),DA(286),19.098593*TS/DA(282),DBN,DA(256)  C0002990    10/01/75
     1)                                                                   00003000    10/01/75
  56C DC 570 IA=1,15                                                      00003010    10/01/75
  570 PSI(IA) = DO (IA)                                                   00003020    10/01/75
      RETURN                                                              00003030
      END                                                                 C0003040
```

Subroutine FPLFAN

This subroutine calculates the noise and performance of fixed-pitch lift fans including adjustments for duct acoustic treatment.

```
DESCRIPTICN          FPLFAN - FIXED-PITCH LIFT FAN

MASTER FILE          LIBR.G04
ACDED TC MASTER      08/16/75
LAST CATE COPIED       NCNE
LAST LPCATE          04/14/76  1653            *** TEMPORARY UPCATE ***

PASSWCRD             KPMB
PFCGRAMMER           F.W.BARRY
PRCC FARAMETER       $NOJCL

      SUBROUTINE FPLFAN                                                 00000010
C     FIXED-PITCH LIFT FAN PERFORMANCE ANC NOISE                        C0000030
C     FPLFAN CALLS GAAFPF, TREAT, PNLC, COENG, JETN ; CALLED BY MAIN    00000040     10/01/75
      CCMMCN /CATA/ ANGLE(15),BCFR(30),NR,NP,C,HOL(20),CATE(2),TIME(2), 00000050
     1 ATTNT(30),SPLT(15,30),SPLTU(15,30),CBNU(7),XC(15),XC(15),ZO(15), C0000060
     2 PSI(15),CO(15),DCO(15),HPT,TR,VELFL,VM(15),PWLT(15,30),          00000070
     3 DIRIN(498),DIREX(498),  F(31),DFWSF(15),RPMG,CHPT,RRPM,CSUM(15)  C0000080     10/01/75
      CCMMON /DATAI/ CA(400)                                            C0000090     10/01/75
      DIMENSION       DLF(4),YES(2),ATN15C(30),SPL(15,30),CDB(15)       00000100     10/01/75
     1 ,C1(15),Q2(15),FHOL(15,4),SPL34(15,3C),SFL36(15,30),             C0000110     10/01/75
     2 SPL39(15,30),SPL40(15,30),PWLI(30),PWLE(30),SFL34D(15,30),       C0000120     10/01/75
     3 SFL36D(15,30),               SFL39D(15,30),SPL40D(15,30),CI(15,30)00000130    10/01/75
     4,CE(15,30),DENG(10),PRSTDS(3),BENG(6),TRSS(3),TB(3),PRSTOP(3)     C0000140     10/01/75
      EQUIVALENCE (TSDS,DA(317)),(D,CA(318)),(VC,DA(319)),(PCTTH,DA(320)00000150     10/01/75
     1),(PRSTDS(1),CA(322)),(TRSS(1),RSS,DA(323)),(B,TB(1),DA(324)),(QIGCC000160     10/01/75
     2V,CA(325)),(DENG(1),CA(333)),(BENG(1),DA(344)),(FPR,PRSTOP(1))    CC000170     10/01/75
      CATA CLF / 0.,.16666666,.33333333,1./                             00000180     10/01/75
      DATA YES / 4H  NO,4HWITH/                                         CC000190     10/01/75
C     ATMOSPHERIC ATTENUATICN FOR 59F, 70PCT REL.HUM. AND 150 FT        00000200     10/01/75
      CATA ATN150 / .00537,.00677,.CC860,.01075,.C1355,.C1721,.02153,.02C0000210     10/01/75
     1692,.03449,.C4316,.054C2,.0681E,.C8679,.10877,.13751,.17545,.22051000C0220     10/01/75
     2,.27753,.35867,.45683,.60332,.81539,1.14517,1.36155,1.90627,2.782200000230     10/01/75
     35,4.11427,5.84058,8.59953,12.46500 /                              C0000240     10/01/75
      CATA FHOL /4HSHOR,4HT FA,4HN DU,4HCTS ,4H    ,4H    ,4H    ,4H    CC0C0250     10/01/75
     1,   4H    ,4H    ,4H    ,4H    ,4H    ,4H    ,4H    ,4H3/4-,4HLENG00000260     10/01/75
     2,   4HTH F,4HAN D,4HUCTS,4H    ,4H    ,4H    ,4H    ,4H    ,4H    CC000270     10/01/75
     3,   4H    ,4H    ,4H    ,4H    ,4HLCNG,4H FAN,4H DUC,4HTS W,4HITH CC000280     10/01/75
     4,   4HCOPL,4HANAR,4H PRI,4HMARY,4H/SEC,4HONCA,4HRY N,4HOZZL,4HE EX00000290     10/01/75
     5,   4HITS ,4HLCNG,4H FAN,4H DUC,4HTS W,4HITH ,4HA RE,4HTRAC,4HTED 00000300     10/01/75
     6,   4HPRIM,4HARY ,4HNCZZ,4HLE (,4HJT8D,4H)   ,4H    /             C0000310     10/01/75
C     317 TSDS    DESIGN TIP SPEED , FPS                                00000320     10/01/75
C     318 D       FAN DIAMETER , FT                                     C000033C     10/01/75
C     319 VC      = 1. FCR SHCRT FAN CLCT                               00000340     10/01/75
C                 = 2. FOR 3/4-LENGTH DUCT                              CC000350     10/01/75
C                 = 3. FCR LCNG FAN DUCTS WITH CCPLANAR PRIMARY /       00000360     10/01/75
C                          SECONDARY NOZZLE EXITS                       00000370     10/01/75
C                 = 4. FCR LCNG FAN DUCTS WITH RETRACTED PRIMARY NOZZLE C000038C     10/01/75
C                          (JT8D)                                       C0000390     10/01/75
C     320 PCTTH  OPERATING THRUST / DESIGN THRUST                       CC000400     10/01/75
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C       321 HOT     HUB / TIP DIAMETER RATIO , DEFAULT = .4                     10/01/75
C       322 FPR     DESIGN PRESSURE RATIO , 1.1 TO 1.75                         10/01/75
C       323 TRSS    ROTOR-STATOR SPACING IN PERCENT                             10/01/75
C       324 TB      NUMBER OF BLADES                                            10/01/75
C       325 QIGV    = 0. IF NO IGV , = 1. IF IGV                                10/01/75
C       326         INLET TREATMENT LENGTH , PERCENT OF DIAMETER                10/01/75
C       327         EXHAUST TREATMENT LENGTH , PERCENT OF DIAMETER              10/01/75
C       328         DOF , 1. OR 2.                                              10/01/75
C       329         NUMBER OF INLET SPLITTERS                                   10/01/75
C       330         NUMBER OF EXHAUST SPLITTERS                                 10/01/75
C       331         =0. IF SHAFT DRIVE, =1. IF INTEGRAL ENGINE, 32=-1. IF       10/01/75
C                   TIP TURBINE (MUST INPUT 342-348,350&351)                    10/01/75
C       332         =0. IF USE TYPICAL TURBOSHAFT ENGINE , =1. IF USE:          10/01/75
C       333 RPMC    COMPRESSOR RPM                                              10/01/75
C       334 D       COMPRESSOR DIAMETER , FT                                    10/01/75
C       335 FPR     COMPRESSOR FIRST-STAGE PRESSURE RATIO                       10/01/75
C       336 RSS     COMPRESSOR FIRST-STAGE ROTOR-STATOR SPACING IN PERCENT      10/01/75
C       337 BC      COMPRESSOR FIRST-STAGE NUMBER OF BLADES                     10/01/75
C       339 P3      COMBUSTOR INLET TOTAL PRESSURE , PSF                        10/01/75
C       340 T3      COMBUSTOR INLET TOTAL TEMPERATURE , DEG R                   10/01/75
C       341 T4      COMBUSTOR EXIT  TOTAL TEMPERATURE , DEG R                   10/01/75
C       342 CMA     COMBUSTOR MASS FLOW RATE , LB/SEC                           10/01/75
C       343 QMT     TURBINE MASS FLOW RATE , LB/SEC                             10/01/75
C       344 BTR     RELATIVE TIP SPEED OF LAST TURBINE ROTOR , FPS              10/01/75
C       345 CL      SPEED OF SOUND AT TURBINE EXIT , FPS                        10/01/75
C       346 SOC     LAST STAGE STATOR-ROTOR SPACING / STATOR CHORD              10/01/75
C       347 VL      =0. FOR COPLANAR EXHAUSTS , -10. FOR RECESSED EXHAUST       10/01/75
C       348 BT      NUMBER OF BLADES IN LAST TURBINE ROTOR                      10/01/75
C       349 RPMT    TURBINE RPM                                                 10/01/75
C       350 THRT    JET THRUST , LB                                             10/01/75
C       351 AREA    JET AREA , SQ FT                                            10/01/75
      DO 1 IA=1,15                                                              10/01/75
      CO(IA)  = PSI(IA)                                                         10/01/75
    1 PSI(IA) = ARCOS(-CA(7) / ZO(IA)) / .017453295                             10/01/75
      IF (TSDS.LE.0. .OR. D.LE.0. .OR. VC.LT.1. .OR. VC.GT.4. .OR. PCTTH        10/01/75
     1.LE.0. .OR. PRSTDS(1).LT.1.1 .OR. PRSTDS(1).GT.1.75 .OR. B.LT.2.)         10/01/75
     2GO TO 1000                                                                10/01/75
C     DEFAULT OPTION                                                            10/01/75
      DA(321) = AMAX1(.4,DA(321))                                               10/01/75
      CALL GAAFPF (TSDS,D,1.,PRSTDS,DA(321),DA(125),DA(126),DA(124),E,E,        10/09/75
     1I,1,ERRA,SHPDS,TNETDS,ZM2,A,PCTTH,VELFL/1.6878,CA(1),DA(3),PRSTOP,        10/09/75
     2WFAN,VTOP,ZMZOP,ZMSTE,SHP,TNETOP,FPRO,PRCP)                               10/01/75
      IF (ERRA .NE. 0.) GO TO 1000                                              10/01/75
      CALL GAAFPF (TSDS,D,1.,PRSTDS,DA(321),DA(125),DA(126),DA(124),E,E,        10/09/75
     1I,2,ERRA,SHPDS,TNETDS,ZM2,A,PCTTH,VELFL/1.6878,DA(1),DA(3),PRSTOP,        10/09/75
     2WFAN,VTOP,ZMZCP,ZMSTE,SHP,TNETCP,FPRC,PROP)                               10/01/75
      IF (ERRA .NE. 0.) GO TO 1000                                              10/01/75
      IF (A.LE.0. .OR. WFAN.LE.0. .OR. SHP.LE.0. .OR. SHPDS.LE.0.) GO TO        10/01/75
     11000                                                                      10/01/75
      IF (DA(32) .LT. 0.) GO TO 2                                               10/01/75
      IF (DA(331) .NE. 0.) GO TO 3                                              10/01/75
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C     SHAFT CRIVE                                                  10/01/75
      BPR      = 11.                                               10/01/75
      DHPT     = DHPT + SHPDS*DA(30)                               10/01/75
      HPT      = HPT + SHP*DA(30)                                  10/01/75
      RPEM     = VTOP / TSDS                                       10/01/75
      GO TO 6                                                      10/01/75
C     TIP TURBINE CRIVE IF CA(32) LT O.                            10/01/75
    2 BPR      = 11.                                               10/01/75
      GO TO 5                                                      10/01/75
C     INTEGRAL CRIVE                                               10/01/75
    3 IF (CA(332) .NE. 0.) WENG = CA(342) * 1.175                  10/01/75
      C2       = AMAX1(SHP/SHPDS,.28)                              10/01/75
      IF (CA(332) .EC. 0.) WENG = 50.3 * (SHPDS/9070.) * ((.8052-.18339*  10/01/75
     2C2)*C2 + .382163)                                            10/01/75
      IF (WENG .LE. 0.) GO TC 1000                                 10/01/75
      BPR      = AMAX1(0.,(WFAN-WENG) / WENG)                      10/01/75
    6 RPM      = 19.098593 * VTOP / D                              10/01/75
      DRPM     = 19.098593 * TSDS / D                              10/01/75
      QMTR     = SCRT ((VTOP/C)**2 + ZMZOP**2)                     10/01/75
C     VMTR =0. IF FIRST STACE IGV, CTHERWISE FIRST STAGE RELATIVE TIP  10/01/75
C     MACH NUMBER, IF GT 1. COMBINATICN TCNE NOISE TC BE INCLUDEC  10/01/75
      VMTR     = QMTR                                              10/01/75
      IF (QIGV .EQ. 1.) VMTR = 0.                                  10/01/75
      DC 10 IA=1,15                                                10/01/75
      DCB(IA)  = 20.*ALOG10(150./ZO(IA))                           10/01/75
      Q1(IA)   = 2C. * ALOG10(D/VM(IA)**2)                         10/01/75
   10 Q2(IA)   = 1C. * ALCG10(A/VM(IA)**4)                         10/01/75
C     CORRECT FOR NUMBER OF FANS                                   10/01/75
      CBN      = 0.                                                10/01/75
      IF (CA(30) .GT. 1.) CBN = DBNU(IFIX(CA(30)-.9))              10/01/75
      IC       = IFIX(VC)                                          10/01/75
C     BYPASS RATIO ANC CUCT LENGTH CCRRECTICN                      10/01/75
      DL       = 0.                                                10/01/75
      IF (BPR.GE.10. .OR. VC.EQ.1.) GO TO 30                       10/01/75
      IF (BPR .GT. .5) GC TO 20                                    10/01/75
      DL       = -7.8 * CLF(IC)                                    10/01/75
      GC TO 30                                                     10/01/75
   20 DL       = 6. * DLF(IC) * ALOG10(BPR/10.)                    10/01/75
C     IGV = 1 IF NO IGVS , = 2 IF IGVS                             10/01/75
   3C IGV      = IFIX (QIGV+1.1)                                   10/01/75
      KSTG     = 1                                                 10/01/75
      DO 40 IF=1,30                                                10/01/75
      DO 40 IA=1,15                                                10/01/75
      SPL(IA,IF) = 0.                                              10/01/75
      SPL34D(IA,IF) = 1.E-6                                        10/04/75
      SPL36D(IA,IF) = 1.E-6                                        10/04/75
      SPL39D(IA,IF) = 1.E-6                                        10/04/75
      SPL40C(IA,IF) = 1.E-6                                        10/04/75
      SPL34(IA,IF) = 1.E-6                                         10/04/75
      SPL36(IA,IF) = 1.E-6                                         10/04/75
      SPL39(IA,IF) = 1.E-6                                         10/04/75
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   40 SPL40(IA,IF) = 1.E-6                                                 00001430     10/04/75
      WRITE (NP,50) HCL,CATE,TIME,D,CA(321),A,NSTG, (FHOL(J,IC),J=1,15),00001440     10/01/75
     1 SHPDS,TNETDS,TSDS,DRPM,ZM2, SHP,TNETOP,VTCP,RPM,ZMZOP, PCTTH,PROP00001450     10/01/75
     2,WFAN,BPR                                                            00001460     10/01/75
   50 FORMAT (1H1,42X,26HFIXED-PITCH LIFT FAN NOISE//1H ,20A4,2X,2A4,2X,00001470     10/01/75
     12A4//11H DIAMETER =,F6.2,30H FT , HUB/TIP DIAMETER RATIO =,F6.3,2300001480     10/01/75
     2H , FAN DISCHARGE AREA =,F7.2,8H SQ FT ,,I2,7H STAGES / 1X,15A4// 00001490     10/01/75
     318H DESIGN CONDITIONS / 6H SHP =,F7.0,11H , THRUST =,F7.0,17H LB ,00001500     10/01/75
     4 TIP SPEED =,F6.0,12H FPS , RPM =,F7.0,32H FIRST STAGE INLET MACH 00001510     10/01/75
     5NUMBER =,F6.3 /21H OPERATING CONDITIONS / 6H SHP =,F7.0,11H , THRU00001520     10/01/75
     6ST =,F7.0,17H LB , TIP SPEED =,F6.0,12H FPS , RPM =,F7.0,32H FIRST00001530     10/01/75
     7 STAGE INLET MACH NUMBER =,F6.3 / 35H OPERATING THRUST / DESIGN TH00001540     10/01/75
     8RUST =,F5.2,27H , OVERALL PRESSURE RATIO =,F6.2,13H , FAN FLOW =,F00001550     10/01/75
     96.1,24H LB/SEC , BYPASS RATIO =,F6.2)                                00001560     10/01/75
      IF (TNETDS.LE.0. .OR. TNETCP.LE.0. .OR. FPRO.LE.1.) GO TO 1000      00001570     10/01/75
C     CROSS-FLOW CORRECTION TO FUNDAMENTAL TONES                           00001580     11/05/75
      DDBT    = 0.                                                         00001590     11/05/75
      IF (VELFL .EQ. 0.) GO TO 52                                          00001600     02/11/76
      VL34    = 1.5708 - ATAN2(CA(5),DA(4))                                00001610     02/11/76
      VKTAS   = DA(5) / 1.6E78                                             00001620     11/05/75
      IF (VL34.GT.1.5708 .AND. VL34.LT.4.7129) VKTAS = 0.                  00001630     11/05/75
      VL39    = AMIN1(.2,VELFL*ABS(SIN(VL34))/VTCP)                        00001640     11/05/75
      IF (VL39.GT..001 .AND. (VL34.LT.1.5708.OR.VL34.GT.4.7129)) DDBT =  00001650     11/05/75
     110.**((((1133.89*VL39-642.248)*VL39+125.104)*VL39)/10.)              00001660     11/05/75
C     FORWARD FLIGHT EFFECT ON DISCRETE TONE NOISE (ECNS. 36640)           00001670     10/01/75
   52 FDB     = 0.                                                         00001680     02/11/76
      IF (VMTR.LE.0. .OR. VMTR.GT.1. .OR. CA(5).LT.16.878) GO TO 55        00001690     10/01/75
      FDB     = .81                                                        00001700     10/01/75
      IF (CA(5) .LT. 135.) FDB = .9*ALOG10(DA(5)/16.878)                   00001710     10/01/75
      IF (VMTR .GT. .7) FDB = 3.33*FDB*(1.-VMTR)                           00001720     10/01/75
   55 J       =1                                                           00001730     10/01/75
      BPF     = RPM * B / 60.                                              00001740     10/01/75
C     PRINT STAGE DATA                                                     00001750     10/01/75
      WRITE (NP,60) J,B,RSS,PRSTDS(J),FPR,BPF                              00001760     10/01/75
   60 FORMAT (/ 6H STAGE,I2,2H ,,F4.0,32H BLADES , ROTOR/STATOR SPACING 00001770     10/01/75
     1=,F6.1,32H%, DESIGN STAGE PRESSURE RATIO =,F4.1,35H , OPERATING ST00001780     10/01/75
     2AGE PRESSURE RATIO =,F6.3 / 26H BLADE PASSING FREQUENCY =,F6.0,3H 00001790     10/01/75
     3HZ)                                                                  00001800     10/01/75
      IF (J .EQ. 1) WRITE (NP,70) VMTR,FPRC,YES(IGV)                       00001810     10/01/75
   70 FORMAT (27H RELATIVE TIP MACH NUMBER =,F6.3,13X,31HCRITICAL STAGE 00001820     10/01/75
     1PRESSURE RATIO =,F7.4 / 1H ,A4,18H INLET GUIDE VANES )               00001830     10/01/75
C        F1 (FIG.57) TERM -  BROADBAND INLET AND DISCHARGE NOISE IN        00001840     10/01/75
C      EQUATIONS 34 AND 39                                                 00001850     10/01/75
      VL39    = ALOG10(FPR-1.)                                             00001860     10/01/75
      VL34    = 83. + 17.*VL39                                             00001870     10/01/75
      VL39    = 93. + 20.*VL39                                             00001880     10/01/75
C     ADD F2 (FIG.61) TERM TO EQUATIONS 34 AND 39                          00001890     10/01/75
      IF (RSS .GT. 25.) GO TO 90                                           00001900     10/01/75
      VL34    = VL34 + 5.396                                               00001910     10/01/75
      VL39    = VL39 + 5.396                                               00001920     10/01/75
      GO TO 110                                                            00001930     10/01/75
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   90 IF (RSS .GT. 400.) GO TO 100                                    10/01/75
      C1       = 5. * ALOG10(300./RSS)                                10/01/75
      VL34     = VL34 + C1                                            10/01/75
      VL39     = VL39 + C1                                            10/01/75
      GO TO 110                                                       10/01/75
  100 VL34     = VL34 - .6247                                         10/01/75
      VL39     = VL39 - .6247                                         10/01/75
C     F1 (FIG.58) TERM FOR DISCRETE TONE INLET AND DISCHARGE NOISE IN 10/01/75
C      EQUATIONS 36 AND 40                                            10/01/75
  110 VL40     = 96.+ 20.*ALOG10(FPR-1.)                              10/01/75
      IF (J.EQ.1 .AND. VMTR.GT.1.) GO TO 130                          10/01/75
      IF (FPR .GE. 1.4) GO TO 120                                     10/01/75
      VL36     = 88. + 15.*ALOG10(FPR-1.)                             10/01/75
      GO TO 150                                                       10/01/75
  120 VL36     = 82.                                                  10/01/75
      GO TO 150                                                       10/01/75
  130 IF (FPRO .GT. 1.4) GO TO 140                                    10/01/75
      VL36     = 88. + 15.*ALOG10(FPRO-1.) - 30.4*ALOG10((FPR-1.)/(FPRO-  10/01/75
     1 1.))                                                           10/01/75
      GO TO 150                                                       10/01/75
  140 VL36     = 82. - 30.4*ALOG10((FPR-1.)/(FPRO-1.))                10/01/75
C     ADD F2 (FIG.61) TERM TO EQUATIONS 36 AND 40                     10/01/75
  150 IF (RSS .GT. 25.) GO TO 160                                     10/01/75
      VL36     = VL36 + 10.792                                        10/01/75
      VL40     = VL40 + 10.792                                        10/01/75
      GO TO 180                                                       10/01/75
  160 IF (RSS .GT. 400.) GO TO 170                                    10/01/75
      C1       = C1*2.                                                10/01/75
      VL36     = VL36 + C1                                            10/01/75
      VL40     = VL40 + C1                                            10/01/75
      GO TO 180                                                       10/01/75
  170 VL36     = VL36 - 1.249                                         10/01/75
      VL40     = VL40 - 1.249                                         10/01/75
C     ADD IGV AND BYPASS-RATIO AND DUCT LENGTH CORRECTIONS TO DISCHARGE  10/01/75
C      NOISE                                                          10/01/75
  180 VL39     = VL39 + DL/2.                                         10/01/75
      VL40     = VL40 + DL                                            10/01/75
      IF (J.EQ.1 .AND. IGV.EQ.1) GO TO 190                            10/01/75
      VL39     = VL39 + 3.                                            10/01/75
      VL40     = VL40 + 6.                                            10/01/75
C     START LOOP FOR 15 AZIMUTH ANGLES                                10/01/75
  190 DO 740 IA=1,15                                                  10/01/75
C     ADD DIRECTIVITY CORRECTIONS IN FIGS. 63&64 TO EQNS. 34,36,39 & 40  10/01/75
C     ALSO ADD SIZE-DOPPLER CORRECTION                                10/01/75
C     INLET BROADBAND NOISE                                           10/01/75
      VL34A    = VL34 + Q1(IA)                                        10/01/75
      IF (PSI(IA) .LE. 60.) GO TO 240                                 10/01/75
      IF (PSI(IA) .GT. 70.) GO TO 200                                 10/01/75
      VL34A    = VL34A + 12. - .2*PSI(IA)                             10/01/75
      GO TO 240                                                       10/01/75
  200 IF (PSI(IA) .GT. 80.) GO TO 210                                 10/01/75
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      VL34A   = VL34A + 19. - .3*PSI(IA)                    10/01/75
      GO TO 240                                             10/01/75
  210 IF (PSI(IA) .GT. 90.) GO TO 220                       10/01/75
      VL34A   = VL34A + 35. - .5*PSI(IA)                    10/01/75
      GO TO 240                                             10/01/75
  220 IF (PSI(IA) .GT. 120.) GO TO 230                      10/01/75
      VL34A   = VL34A + 44. - .6*PSI(IA)                    10/01/75
      GO TO 240                                             10/01/75
  230 VL34A   = VL34A - 28.                                 10/01/75
C     INLET DISCRETE TONE NOISE                             10/01/75
  240 VL36A   = VL36 + C1(IA) + 2.                          10/01/75
      IF (PSI(IA) .LE. 20.) GO TO 330                       10/01/75
      IF (PSI(IA) .GT. 30.) GO TO 250                       10/01/75
      VL36A   = VL36A + .4 - .02*PSI(IA)                    10/01/75
      GO TO 330                                             10/01/75
  250 IF (PSI(IA) .GT. 40.) GO TO 260                       10/01/75
      VL36A   = VL36A + .7 - .03*PSI(IA)                    10/01/75
      GO TO 330                                             10/01/75
  260 IF (PSI(IA) .GT. 50.) GO TO 270                       10/01/75
      VL36A   = VL36A + 1.5 - .05*PSI(IA)                   10/01/75
      GO TO 330                                             10/01/75
  270 IF (PSI(IA) .GT. 60.) GO TO 280                       10/01/75
      VL36A   = VL36A + 4.  - .1*PSI(IA)                    10/01/75
      GO TO 330                                             10/01/75
  280 IF (PSI(IA) .GT. 70.) GO TO 290                       10/01/75
      VL36A   = VL36A + 10. - .2*PSI(IA)                    10/01/75
      GO TO 330                                             10/01/75
  290 IF (PSI(IA) .GT. 80.) GO TO 300                       10/01/75
      VL36A   = VL36A + 17. - .3*PSI(IA)                    10/01/75
      GO TO 330                                             10/01/75
  300 IF (PSI(IA) .GT. 90.) GO TO 310                       10/01/75
      VL36A   = VL36A + 33. - .5*PSI(IA)                    10/01/75
      GO TO 330                                             10/01/75
  310 IF (PSI(IA) .GT. 120.) GO TO 320                      10/01/75
      VL36A   = VL36A + 42. - .6*PSI(IA)                    10/01/75
      GO TO 330                                             10/01/75
  320 VL36A   = VL36A - 26.                                 10/01/75
C     DISCHARGE BROADBAND NOISE                             10/01/75
  330 VL39A   = VL39 + Q2(IA) - 22.                         10/01/75
      IF (PSI(IA) .LE. 40.) GO TO 410                       10/01/75
      IF (PSI(IA) .GT. 60.) GO TO 340                       10/01/75
      VL39A   = VL39A - 24. + .6*PSI(IA)                    10/01/75
      GO TO 410                                             10/01/75
  340 IF (PSI(IA) .GT. 70.) GO TO 350                       10/01/75
      VL39A   = VL39A - 12. + .4*PSI(IA)                    10/01/75
      GO TO 410                                             10/01/75
  350 IF (PSI(IA) .GT. 90.) GO TO 360                       10/01/75
      VL39A   = VL39A + 2.  + .2*PSI(IA)                    10/01/75
      GO TO 410                                             10/01/75
  360 IF (PSI(IA) .GT. 110.) GO TO 370                      10/01/75
      VL39A   = VL39A + 11. + .1*PSI(IA)                    10/01/75
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      GO TO 410                                                 10/01/75
  370 IF (PSI(IA) .GT. 120.) GO TO 380                          10/01/75
      VL39A    = VL39A + 22.                                    10/01/75
      GO TO 410                                                 10/01/75
  380 IF (PSI(IA) .GT. 140.) GO TO 390                          10/01/75
      GO TO 410                                                 10/01/75
  390 IF (PSI(IA) .GT. 150.) GO TO 400                          10/01/75
      VL39A    = VL39A + 60. - .3*PSI(IA)                       10/01/75
      GO TO 410                                                 10/01/75
  400 VL39A    = VL39A + 90. - .5*PSI(IA)                       10/01/75
C     DISCHARGE DISCRETE TONE NOISE                             10/01/75
  410 VL40A    = VL40 + C2(IA) - 21.                            10/01/75
      IF (PSI(IA) .LE. 40.) GO TO 480                           10/01/75
      IF (PSI(IA) .GT. 60.) GO TO 420                           10/01/75
      VL40A    = VL40A - 24. + .6*PSI(IA)                       10/01/75
      GO TO 480                                                 10/01/75
  420 IF (PSI(IA) .GT. 100.) GO TO 430                          10/01/75
      VL40A    = VL40A + .2*PSI(IA)                             10/01/75
      GO TO 480                                                 10/01/75
  430 IF (PSI(IA) .GT. 110.) GO TO 440                          10/01/75
      VL40A    = VL40A + 10. + .1*PSI(IA)                       10/01/75
      GO TO 480                                                 10/01/75
  440 IF (PSI(IA) .GT. 120.) GO TO 450                          10/01/75
      VL40A    = VL40A + 21.                                    10/01/75
      GO TO 480                                                 10/01/75
  450 IF (PSI(IA) .GT. 130.) GO TO 460                          10/01/75
      VL40A    = VL40A + 33. - .1*PSI(IA)                       10/01/75
      GO TO 480                                                 10/01/75
  460 IF (PSI(IA) .GT. 150.) GO TO 470                          10/01/75
      VL40A    = VL40A + 59. - .3*PSI(IA)                       10/01/75
      GO TO 480                                                 10/01/75
  470 VL40A    = VL40A + 74. - .4*PSI(IA)                       10/01/75
  480 CONTINUE                                                  10/01/75
C     FUNDAMENTAL BLADE PASSAGE FREQUENCY IN HZ                 10/01/75
  610 FO       = B * RPM / (60. * VM(IA))                       10/01/75
      IPWL     = 0                                              10/01/75
      AOI      = (VL36A-3.) / 10. + .6                          10/01/75
      AOD      = (VL40A-3.) / 10. + .6                          10/01/75
      IF (J.EQ.1 .AND. IGV.EQ.1) GO TO 620                      10/01/75
      AOI      = AOI - .6                                       10/01/75
      AOD      = AOD - .6                                       10/01/75
  620 NII      = IFIX(1. + F(1)/FO)                             10/01/75
C     START 1/3-OCTAVE BAND FREQUENCY LOOP                      10/01/75
      DO 730 IF=1,30                                            10/01/75
C     ADD BROADBAND FREQUENCY CORRECTION , EQUATION 35 , FIGURE 56A   10/01/75
      C1       = BCFR(IF) / FC                                  10/01/75
      C2       = ALOG10(C1)                                     10/01/75
      IF (C1 .GT. 2.) GO TO 630                                 10/01/75
      FF       =  10.*C2 - 3.                                   10/01/75
      GO TO 640                                                 10/01/75
  630 FF       = -20.*C2 + 6.                                   10/01/75
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  640 VL34AF    = VL34A + FF                                         10/01/75
      VL39AF    = VL39A + FF                                         10/01/75
C     SUM INLET AND DISCHARGE BROADBAND AND DISCRETE TONE NOISE ON AN 10/01/75
C      ENERGY BASIS                                                  10/01/75
      N2I       = IFIX(F(IF+1) / FO)                                 10/01/75
      PI        = 0.                                                 10/01/75
      IF (F(IF).LT.FO .AND. F(IF+1).GE.FO) PI = DDBT                 11/05/75
      PE        = PI                                                 11/05/75
      IF (N1I .GT. N2I) GO TO 670                                    10/01/75
      DO 660 K=N1I,N2I                                               10/01/75
      IF (K .EQ. 1) GO TO 650                                        10/01/75
      C3        = .3 * FLOAT(K) + FCB/3.                             10/01/75
      PI        = PI + 10.**(A0I-C3)                                 10/01/75
      PE        = PE + 10.**(A0D-C3)                                 10/01/75
      GO TO 660                                                      10/01/75
  650 PI        = PI + 10.**(VL36A/10.-FCB)                          10/01/75
      PE        = PE + 10.**(VL40A/10.-FCB)                          10/01/75
  660 CONTINUE                                                       10/01/75
  670 IF (IPWL .EQ. 0) GO TO 690                                     10/01/75
      SPL34(IA,IF) = 10.**(VL34AF/10.) + SPL34(IA,IF)                10/01/75
      SPL36(IA,IF) = SPL36(IA,IF) + PI                               10/01/75
      SPL39(IA,IF) = 10.**(VL39AF/10.) + SPL39(IA,IF)                10/01/75
      SPL40(IA,IF) = SPL40(IA,IF) + PE                               10/01/75
      GO TO 700                                                      10/01/75
  690 SPL34D(IA,IF) = 10.**(VL34AF/10.) + SPL34D(IA,IF)              10/01/75
      SPL36D(IA,IF) = SPL36D(IA,IF) + PI                             10/01/75
      SPL39D(IA,IF) = 10.**(VL39AF/10.) + SPL39D(IA,IF)              10/01/75
      SPL40D(IA,IF) = SPL40D(IA,IF) + PE                             10/01/75
  700 N1I       = N2I + 1                                            10/01/75
  730 CONTINUE                                                       10/01/75
      IF (IPWL .EQ. 1) GO TO 740                                     10/01/75
      IPWL      = 1                                                  10/01/75
      FO        = FO * VM(IA)                                        10/01/75
      GO TO 620                                                      10/01/75
C     END OF FREQUENCY LOOP                                          10/01/75
  740 CONTINUE                                                       10/01/75
C     END OF AZIMUTH ANGLE LOOP                                      10/01/75
C     HAVE NOISE AT 150-FT RADIUS FOR STANDARD DAY , NOW CONVERT TO SPL, 10/01/75
C      ADD DBN TO ALLOW FOR NUMBER OF FANS, ADD ATN150(IF) TO REMOVE  10/01/75
C      STANDARD DAY ATMOSPHERIC ATTENUATION TO 150FT , SUBTRACT ACTUAL 10/01/75
C      ATTENUATION TO SIDELINE ATTNT(IF)*ZO(IA) , AND ADD DDB(IA) TO 10/01/75
C      ACCOUNT FOR SPHERICAL SPREADING FROM 150FT TO SIDELINE        10/01/75
      DO 760 IF=1,30                                                 10/01/75
      DO 760 IA=1,15                                                 10/01/75
      C1        = DBN + ATN150(IF) - ATTNT(IF)*ZO(IA) + DDB(IA)      10/01/75
      SPL34(IA,IF) = 10.*ALOG10(SPL34(IA,IF)) + C1                   10/01/75
      SPL36(IA,IF) = 10.*ALOG10(SPL36(IA,IF)) + C1                   10/01/75
      SPL39(IA,IF) = 10.*ALOG10(SPL39(IA,IF)) + C1                   10/01/75
      SPL40(IA,IF) = 10.*ALOG10(SPL40(IA,IF)) + C1                   10/01/75
      SPL34D(IA,IF) = 10.*ALOG10(SPL34D(IA,IF)) + C1                 10/01/75
      SPL36D(IA,IF) = 10.*ALOG10(SPL36D(IA,IF)) + C1                 10/01/75
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      SPL39D(IA,IF) = 10.*ALCG10(SPL39C(IA,IF)) + C1                    00003980    10/01/75
      SPL40D(IA,IF) = 1C.*ALOG10(SPL4CC(IA,IF)) + C1                    00003990    10/01/75
  760 SPL(IA,IF) = 10.*ALOGIC(10.**(SPL34D(IA,IF)/1C.) + 1C.**(SPL36C(IA00004000    11/05/75
     1,IF)/10.) + 10.**(SPL39C(IA,IF)/10.) + 10.**(SPL40C(IA,IF)/10.) ) CC004010    10/01/75
      IF (CA(6) .GT. 2.) CALL PNLC(SPL)                                 C0004020    10/01/75
      IF (CA(33) .EQ. 0.) GO TO 840                                     00004030    10/01/75
      DC 83C IF=1,30                                                    00004040    10/01/75
      PWLI(IF) = 0.                                                     00004050    10/01/75
      PWLE(IF) = 0.                                                     00004060    10/01/75
      DC 810 IA=1,15                                                    00004070    10/01/75
      PWLI(IF) = PWLI(IF) + CSUM(IA)*(10.**(SPL34D(IA,IF)/10.) )        00004080    10/01/75
      PWLI(IF) = PWLI(IF) + CSUM(IF)*10.**(SPL36D(IA,IF)/10.)           00004090    10/01/75
  810 PWLE(IF) = PWLE(IF) + CSUM(IA)*(10.**(SPL39C(IA,IF)/10.) + 10.**( 00004100    1C/01/75
     1SPL40D(IA,IF)/10.) )                                              00004110    10/01/75
      PWLI(IF) = 10.*ALOG10(PWLI(IF))                                   00004120    10/01/75
      PWLE(IF) = 10.*ALCG10(PWLE(IF))                                   C0004130    10/01/75
      C1       = PWLI(IF) - 3.0103                                      00004140    10/01/75
      C2       = PWLE(IF) - 3.0103                                      00004150    10/01/75
      DO 820 IA=1,15                                                    00004160    10/01/75
      DI(IA,IF) = SPL(IA,IF) - C1                                       00004170    10/01/75
  820 DE(IA,IF) = SPL(IA,IF) - C2                                       00004180    10/01/75
  830 CONTINUE                                                          00004190    10/01/75
      CALL TREAT (PWLI,PWLE,.01*D*CA(326),C.,.C1*C*CA(327),D*(1.-DA(321)00004200    10/01/75
     1)/2.,(ZMZOP+ZMSTE)/2.,4,DA(328),SPL,DI,DE,CA(329),DA(330))        00004210    10/01/75
      IF (DA(6) .NE. 0.) CALL PNLC (SPL)                                00004220    10/01/75
  840 DO 85C IF=1,30                                                    00004230    10/01/75
      DO 850 IA=1,15                                                    00004240    10/01/75
      C1       = 10.**(SPL(IA,IF)/10.)                                  00004250    10/01/75
      PWLT(IA,IF) = PWLT(IA,IF) + C1                                    00004260    10/01/75
  85C SPLT(IA,IF) = SPLT(IA,IF) + C1                                    00004270    10/01/75
C     DRIVE SELECTICN                                                   00004280    10/01/75
      IF (CA(32) .GE. 0.) GO TO 900                                     00004290    10/01/75
C     TIP TURBINE DRIVE                                                 00004300    10/01/75
      CA(349) = RPM                                                     00004310    10/01/75
      CALL COENG (1,SHPDS,SHP,DBN,IFIX(DA(331)),VTOP/TSDS,DENG,DA(343), 00004320    10/01/75
     1BENG,0.,A,A,A,A,A)                                                00004330    10/01/75
      IF (DA(31) .LE. 0.) GO TO 880                                     00004340    10/01/75
      G1       = TNETGP*(DA(343)-WFAN)/CA(343)                          00004350    10/01/75
      CALL JETN (WFAN,G1,A,DA(343),DA(350),DA(351),SPL34,SPL39)         00004360    10/01/75
      DC 860 IF=1,30                                                    00004370    10/01/75
      DO 860 IA=1,15                                                    00004380    10/01/75
      SPL34(IA,IF) = SPL34(IA,IF) + DBN                                 00004390    10/01/75
      SPL39(IA,IF) = SPL39(IA,IF) + DBN                                 00004400    10/01/75
      F2       = 10.**(SPL39(IA,IF)/10.)                                00004410    10/01/75
      PWLT(IA,IF)  = PWLT(IA,IF)  + 10.**(SPL39(IA,IF)/ 10.)            00004420    10/01/75
  86C SPLT(IA,IF)  = SPLT(IA,IF)  + F2                                  00004430    11/05/75
      IF (DA(6) .LT. 3.) GO TO 880                                      00004440    10/01/75
      WRITE (NP,870) HCL,DATE,TIME, WFAN,G1,A, CA(343),DA(350),DA(351)  00004450    10/01/75
  870 FORMAT (1H1,30X,50HJET NOISE OF FIXED-PITCH LIFT FAN WITH TIP-TURB00004460    10/01/75
     1INE // 1H ,20A4,2X,2A4,2X,2A4 / 16H FAN FLOW RATE =,F5.1,18H LB/SE00004470    10/01/75
     2C , THRUST =,F7.0,12H LB , AREA =,F5.1,6H SQ.FT / 20H TURBINE FLOW00004480    10/01/75
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    3 RATE =,F5.1,18H LB/SEC , THRUST =,F7.0,12H LB , AREA =,F5.1,6H SQ       10/01/75
    4.FT)                                                                     10/01/75
      CALL PNLC (SPL34)                                                       10/01/75
  880 DO 890 IA=1,15                                                          10/01/75
  890 PSI(IA) = DO(IA)                                                        10/01/75
      RETURN                                                                  10/01/75
  900 IF (DA(331) .EQ. 0.) GO TO 920                                          10/01/75
C     HAVE INTEGRAL ENGINE                                                    10/01/75
      DA(338) = 0.                                                            10/01/75
      CALL CDENG (0,SHPDS,SHP,CBN,IFIX(CA(331)),VTOP/TSCS,DENG,DA(343),       10/01/75
     1BENG,CA(31),CA(350),DA(351),WFAN,TNETOP*BPR/(1.+BPR),A)                 10/01/75
  910 IF (CA(32) .GT. 0.) CALL GRBOXN(IFIX(DA(32)),SHP,RPM,DBN,DA(331))       10/01/75
      GO TO 880                                                               10/01/75
  920 IF (DA(31) .LE. 0.) GO TO 910                                           10/01/75
      CALL JETN (WFAN,.92*TNETOP,A,0.,0.,0.,SPL34,SPL39)                      10/01/75
      DO 930 IF=1,30                                                          10/01/75
      DO 930 IA=1,15                                                          10/01/75
      SPL34(IA,IF) = SPL34(IA,IF) + DBN                                       10/01/75
      SPL39(IA,IF) = SPL39(IA,IF) + DBN                                       10/01/75
      G1       = 10.**(SPL34(IA,IF)/10.)                                      10/01/75
      PWLT(IA,IF) = PWLT(IA,IF) + 10.**(SPL39(IA,IF)/10.)                     10/01/75
  930 SPLT(IA,IF) = SPLT(IA,IF) + G1                                          10/01/75
      IF (CA(6) .LT. 3.) GO TO 910                                            10/01/75
      G1       = .92 * TNETOP                                                 10/01/75
      WRITE (NP,940) HOL,DATE,TIME, WFAN,G1,A                                 10/01/75
  940 FORMAT (1H1,40X,30HFIXED-PITCH LIFT FAN JET NOISE // 1H ,20A4,2X,2      10/01/75
     1A4,2X,2A4 / 16H JET FLOW RATE =,F5.1,18H LB/SEC , THRUST =,F7.0,12      10/01/75
     2H LB , AREA =,F5.1,6H SQ.FT)                                            10/01/75
      GO TO 910                                                               10/01/75
 1000 WRITE (NP,1010)                                                         10/01/75
 1010 FORMAT (/73H FIXED-PITCH LIFT FAN NOISE NOT CALCULATED BECAUSE OF       10/01/75
     1ERROR IN INPUT DATA)                                                    10/01/75
      DA(30)  = 0.                                                            10/01/75
      GO TO 880
      END
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Subroutine SHTR

This subroutine predicts the noise and aerodynamic performance of shrouded helicopter tail rotors and includes adjustments for duct acoustic treatment and cross-flow effects.

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DESCRIPTION          SHTR - SHROUDED TAIL ROTOR

MASTER FILE          LIBR.G04
ADDED TO MASTER      08/16/75
LAST DATE COPIED       NONE
LAST UPDATE          04/14/76  1653          *** TEMPORARY UPDATE ***

PASS*CRC             LKMF
PROGRAMMER           F.W.BARRY
PROC PARAMETER       SNOJCL

      SUBROUTINE SHTR
C     SHROUDED TAIL ROTOR PERFORMANCE AND NOISE
C     SHTR CALLS GAAVPF, RVINT, BESJH, BICUAC, PNLC, GRBOXN : CALLED BY    10/02/75
C      ROTOR                                                               10/02/75
      COMMON /DATA/ ANGLE(15),BCFR(30),NR,NP,C,HOL(20),DATE(2),TIME(2),
     1 ATTNT(30),SPLT(15,30),SPLTU(15,30),DBNU(7),XC(15),XD(15),ZC(15),
     2 PSI(15),DD(15),DDD(15),HPT,TR,VELFL,WM(15),PWLT(15,30),             09/25/75
     3 DIRIN(498),DIREX(498),BLF(31),DP,SP(15),RPMG,DHPT,RRPM,CSUM(15)     09/25/75
      COMMON / DATAI/CA(300)                                               09/25/75
      COMMON / INX / JJ(450)                                               09/25/75
      DIMENSION TPWL(20),PWLB(30),SPL(15,30),PSUN(100),FDIRI(15,30),       09/25/75
     1FDIRE(15,30)                                                         09/25/75
C     200   = DESIGN & OPERATING NET THRUST , LB , USED IF GT 0.           09/25/75
C     201   = DESIGN & OPERATING SHP , USED IF 200 LE 0.                   09/25/75
C     202   = DESIGN & OPERATING TIP SPEED (FPS), USED IF GT MINIMUM       09/25/75
C     203   = DESIGN & OPERATING PRESSURE RATIO, 1.0 TO 1.75, USED IF      09/25/75
C                205 = 0.                                                  09/25/75
C     204   = HUB / TIP DIAMETER RATIO, USE IF GT MINIMUM                  09/25/75
C     205   = TIP DIAMETER , FT , USED IF GT 0.                            09/25/75
C     206   = NUMBER OF BLADES                                             09/25/75
C     207   = NUMBER OF IGVS                                               09/25/75
C     208   STACKING LINE DISTANCE ,FT, IF GT 0., -BVGAP IF LT 0., IF =    09/25/75
C           0. BVGAP = 2. USED                                             09/25/75
C     209   STANDARD DEVIATION OF PAM , 0. REPLACED BY .5                  09/25/75
C     210   STANDARD DEVIATION OF PPM , 0. REPLACED BY .01                 09/25/75
      IF ((CA(200).GT.0..OR.DA(201).GT.0.) .AND. CA(206).GT.1. .AND.       09/25/75
     1DA(207).GT.1) GO TO 20                                               09/25/75
    5 WRITE (NP,10)                                                        09/25/75
   10 FORMAT (72H1SHROUDED TAIL ROTOR NOISE NOT CALCULATED BECAUSE OF ER   09/25/75
     1ROR IN INPUT DATA)                                                   09/25/75
      CA(42)   = 0.                                                        09/25/75
      RETURN                                                               09/25/75
C     DEFAULT OPTIONS                                                      09/25/75
   20 DA(204) = AMAX1(.4,DA(204))                                          09/25/75
      IF (CA(209) .LE. 0.) DA(209) = .5                                    09/25/75
      IF (CA(210) .LE. 0.) DA(210) = .01                                   09/25/75
C     DBN    CORRECTION FOR NUMBER OF UNITS                                09/25/75
      DBN      = 0.                                                        09/25/75
      IF (CA(42) .GT. 1.) DBN = DBNU(IFIX(DA(42)-.9))                      09/25/75
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      TS      = 0.                                                         09/25/75
      CALL GAAVPF (0.     ,DA(125),DA(126),DA(200),DA(201),DA(202),DA(20    09/25/75
     13),DA(204),DA(205),DA(206),DA(207),A2,AR,DA(200),CA(201),TS,PR,CM,    09/25/75
     2CU,CUP,CDN,SIGF,DCLDA,BE,RE,1,0.      ,W,1,ERRA,DA(208),THRUST,QM,    09/25/75
     3CD,SIGR)                                                              09/25/75
      IF (ERRA .NE. 0.) GO TO 5                                             09/25/75
      DHPT    = DHPT + CA(42)*DA(200)                                       09/25/75
      CALL GAAVPF (0.     ,CA(125),CA(126),CA(200),CA(201),DA(202),DA(20    09/25/75
     13),DA(204),DA(205),CA(206),DA(207),A2,AR,DA(200),DA(201),TS,PR,CM,    09/25/75
     2CU,CUP,CDN,SIGF,DCLDA,BE,RE,1,0.      ,W,2,ERRA,DA(208),THRUST,QM,    09/25/75
     3CD,SIGR)                                                              09/25/75
      IF (ERRA .NE. 0.) GO TO 5                                             09/25/75
      HPT     = HPT + DA(42)*DA(200)                                        09/25/75
      WRITE (NP,30) HOL,DATE,TIME, CA(205),DA(204),CA(207),DA(206),AR,DA    09/25/75
     1(208),(DA(I),I=124,126),(DA(I),I=200,203),DA(2CC),DA(201),TS,PR       09/25/75
   30 FORMAT (1H1,45X,25HSHROUDED TAIL ROTOR NOISE//1H ,20A4,2X,2A4,2X,2    09/25/75
     1A4// 14H CONFIGURATION /11H DIAMETER =,F6.2,3CH FT , HUB/TIP DIAME    09/25/75
     2TER RATIO =,F7.4,2H ,,F3.0, 7H OGVS ,,F3.C,22H BLADES , AREA RATIO    09/25/75
     3 =,F5.2,27H , STACKING LINE DISTANCE =,F6.3 /18H TAKEOFF CONDITIONO   09/25/75
     4 / F6.1,8H KNOTS ,F4.0,8H DEG F ,F7.3,2CH PSIA , NET THRUST =,F7.1    09/25/75
     5,11H LBS , HP =,F7.1,14H , TIP SPEED =,F7.2,23H FPS , PRESSURE RAT    09/25/75
     6IO =,F5.2 / 20H OPERATING CONDITION / 13H NET THRUST =,F7.1,11H LB    09/25/75
     7S , HP =,F7.1,14H , TIP SPEED =,F7.2,23H FPS , PRESSURE RATIO =,F5    09/25/75
     8.2 )                                                                  09/25/75
      IF (CA(6) .EQ. 3.) WRITE(NP,35) BE,CUP,CDN,SIGF,A2,W,CM,QM,CU,CD,     09/25/75
     1THRUST,DA(209),DA(21C)                                                09/25/75
   35 FORMAT (/22H BLADE STAGGER ANGLE =,F4.C,18H DEG , IGV CHORD =,F6.3    09/25/75
     1,16H , ROTOR CHORD =,F6.3,22H FT , ROTOR SOLIDITY =,F6.3,7H , A2 =    09/25/75
     2,F6.2,7H SQ.FT. /10H AIRFLOW =,F7.2,25H LB/SEC, AXIAL VELOCITY =,F    09/25/75
     37.1,16H FPS , AXIAL M =,F6.3,15H , 1/2 SWIRL VEL. =,F7.1,15H FPS ,    09/25/75
     4 IGV CD =,F7.4 /15H ROTOR THRUST =,F7.1,24H LB , STD. DEV. OF PAM     09/25/75
     5=,F5.2,21H , STD. DEV. OF PPM =,F6.3)                                 09/25/75
      RRPM    = TS / DA(202)                                                09/25/75
      MMAX    = 20                                                          09/25/75
C     TONE AND BROADBAND POWERS DUE TO IGV-ROTOR INTERACTION                09/25/75
      CALL RVINT (TPWL,PWLB,MMAX,1.9679E18*CA(205)**2*SQRT(TR),1,DA(206)    09/25/75
     1,CA(207),RE,DA(204),CA(205),TS,TS*DA(206)/(3.1415927*DA(205)),TS/C    09/25/75
     2,BE,CM,CU,CD,CUP,CDN,DA(208),SIGF,DCLDA,DA(209),DA(210))              09/25/75
      VMT     = TS / C                                                      09/25/75
      BPF     = TS * CA(206) * .31830988 / CA(206)                          09/25/75
      C1      = 9943.77 * (DA(206)/DA(205))**2                              09/25/75
      C2      = .03125 * (THRUST/DA(206))**2                                09/25/75
      C3      = .722 * DA(201)**2 / (CA(206)*VMT)**3                        09/25/75
      C4      = 44.7 - 10.*ALOG10(DA(3)/C) + DBA                            09/25/75
      C6      = 1.6 * CA(206) * VMT                                         09/25/75
      IB      = IFIX(CA(206))                                               09/25/75
      MAX     = 2C/IB + 1                                                   09/25/75
      VMAX    = FLOAT(MAX)                                                  09/25/75
      NMAX    = MIN1(10C.,22400./BPF)                                       09/25/75
      DO 130 M=1,NMAX                                                       09/25/75
      VM      = FLOAT(M)                                                    09/25/75
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      IF (M .GT. MAX) GO TO 80                                    09/25/75
      SUM      = 0.                                               09/25/75
      C5       = C3 / VM                                          09/25/75
      PSON(M) = 0.                                                09/25/75
      MB       = M * IB                                           09/25/75
      NORD     = MINO(400,MB)                                     09/25/75
      CALL BESJH(VM*C5,NORD,QJ,RR,450,NP)                         09/25/75
      IF (RR .NE. 0.) NORD = IFIX(RR)                             09/25/75
      IF (NORD .GE. MB) GO TO 90                                  09/25/75
      IF (DA(6) .EQ. 3.) WRITE (NP,70) IA,M,NORD                  09/25/75
   70 FORMAT (/24H BESSEL FUNCTION FOR IA=,I3,3H M=,I3,20H LIMITED TO OR09/25/75
     1DER OF,I4/)                                                 09/25/75
      GO TO 90                                                    09/25/75
   80 PSON(M) = PSON(MAX) * (VMAX/VM)**1.219                      09/25/75
      GO TO 130                                                   09/25/75
   90 VMB      = VM * DA(206)                                     09/25/75
      LMIN     = MAX1(1.,VMB*(1.-VMT))                            09/25/75
      LMAX     = IFIX(VMB*(1.+VMT)) + 1                           09/25/75
      DO 120 L=LMIN,LMAX                                          09/25/75
      VL       = FLOAT(L)**3.22                                   09/25/75
      MBL      = MB - L                                           09/25/75
      VN       = FLOAT(MBL)                                       09/25/75
      VNSQ     = VN**2                                            09/25/75
      J        = MBL + MBL + 1                                    09/25/75
      C11      = VN + VN + 1.                                     09/25/75
      C12      = C11                                              09/25/75
      C13      = VN + 1.                                          09/25/75
      C14      = 1.                                               09/25/75
      ETA      = 0.                                               09/25/75
  100 DETA     = C2/C11*C12/(C11+2.)*C13*C14*QJ(J+2) + C5*VNSQ*QJ(J+1)09/25/75
      ETA      = ETA + DETA                                       09/25/75
      IF (J+2 .GT. NORD) GO TO 110                                09/25/75
      IF (C11.GT.VM*C6 .AND. ABS(DETA).LE..005*ABS(ETA)) GO TO 110  09/25/75
      J        = J + 2                                            09/25/75
      C11      = C11 + 2.                                         09/25/75
      C12      = C12 + 1.                                         09/25/75
      C13      = C13 + 1.                                         09/25/75
      C14      = C14 + 1.                                         09/25/75
      GO TO 100                                                   09/25/75
C     COMPLETED SUM OVER K STARTING AT 0                          09/25/75
  110 DSUM     = ETA / VL                                         09/25/75
  120 SUM      = SUM + DSUM                                       09/25/75
  130 PSON(M) = 10. * ALOG10(C1*SUM) + C4                         09/25/75
      DO 140 I=1,30                                               09/25/75
  140 PWLB(I) = 10.*ALOG10(PWLB(I)) + CBN                         09/25/75
      DO 150 I=1,MMAX                                             09/25/75
  150 TPWL(I) = 10.*ALOG10(TPWL(I)) + DBN                         09/25/75
C     TILT CORRECTION TO FUNDAMENTAL TONES                        09/25/75
      C1       = AMIN1(.2,VELFL/TS)                               09/25/75
      DDBT     = 10.**((((1133.89*C1-642.248)*C1+125.104)*C1)/10.) 09/25/75
      PSON(1) = PSON(1) + DDBT
```

```
      TPWL(1) = TPWL(1) + CCBT                                               09/25/75
      IF (DA(6) .NE. 3.) GO TO 180                                           09/25/75
      WRITE (NP,160) PWLB,MMAX,BPF,(TPWL(I),I=1,MMAX)                        09/25/75
  160 FORMAT (/57H 30 PWL'S CF BROADBAND NCISE CUE TO IGV-ROTOR INTERACT     09/25/75
     1ICN/ 1X,20F6.1 / 1X,10F6.1 // I3,73H PWL'S CF TCNE NCISE DUE TO IG     09/25/75
     2V-RCTCR INTERACTION WITH FUNCAMENTAL FREQUENCY =,F6.1,3H HZ / 1X,      09/25/75
     320F6.1 )                                                               09/25/75
      WRITE (NP,170) NMAX,(PSON(I),I=1,NMAX)                                 09/25/75
  170 FORMAT (/ I4,30H PWL'S DUE TO NCN-STEADY LCADS / 5(1X,20F6.1/))        09/25/75
C     FAN DIRECTIVITY FACTCRS                                                09/25/75
  18C FCCR     = DA(205) / 3.                                                09/25/75
      DC 190 IA=1,15                                                         09/25/75
      DC 190 IF=1,30                                                         09/25/75
      CALL BIQUAD (DIRIN,1,AMAX1(20.,ABS(PSI(IA)-90.)),BCFR(IF)*FCOR,        02/10/76
     1FDIRI(IA,IF),K)                                                        09/25/75
      CALL BIQUAD (CIREX,1,AMAX1(20.,ABS(PSI(IA)-90.)),BCFR(IF)*FCOR,        02/10/76
     1FCIRE(IA,IF),K)                                                        09/25/75
  190 CCNTINUE                                                               09/25/75
C     COMBINE TPWL, PSCN & PWLB INTO PWLB AND GET SPL                        09/25/75
      VL       = BPF                                                         09/25/75
      I        = 1                                                           09/25/75
      DC 230 IF=1,30                                                         09/25/75
      PWLB(IF) = 10.**(PWLB(IF)/10.)                                         09/25/75
  2CC IF (VL .GT. BLF(IF+1)) GO TO 21C                                       09/25/75
      IF (I.LE.MMAX) PWLB(IF) = PWLB(IF) + 10.**(TPWL(I)/1C.)                09/25/75
      IF (I.LE.NMAX) PWLB(IF) = PWLB(IF) + 10.**(PSON(I)/10.)                09/25/75
      VL       = VL + BPF                                                    09/25/75
      I        = I + 1                                                       09/25/75
      GO TO 200                                                              09/25/75
  210 PWLB(IF) = 10.*ALCG10(PWLB(IF))                                        09/25/75
      DO 22C IA=1,15                                                         09/25/75
      SPL(IA,IF) = 10.*ALOG10(10.**((PWLB(IF)+FDIRI(IA,IF))/10.) + 10.**     09/25/75
     1((PWLB(IF)+FDIRE(IA,IF))/1C.)) - CPWSP(IA) - ATTNT(IF)*ZO(IA)          09/25/75
      C1       = 1C.**(SPL(IA,IF)/10.)                                       09/25/75
      PWLT(IA,IF) = PWLT(IA,IF) + C1                                         09/25/75
  220 SPLT(IA,IF) = SPLT(IA,IF) + C1                                         09/25/75
  230 CCNTINUE                                                               09/25/75
      IF (DA(6) .GE. 2.) CALL PNLC(SPL)                                      09/25/75
      IF (DA(44) .GT. 0.) CALL CRBOXN (IFIX(CA(44)),DA(201),19.098593*TS     09/25/75
     1/CA(205),DBN,0.)                                                       09/25/75
      RETURN
      END
```

Subroutines GAAVPF, GAADES, GAAPFM, GAASEC, GAASIA, GAASIB, GAASIC, GAASID, GAACLK, GAAFM, GAA123, GAAINL, and GAAEXL

These subroutines are interrelated and are used to calculate the generalized design and aerodynamic performance of variable-pitch fans. The calculations include design and off-design conditions and performance losses due to partly sonic inlets and acoustic treatment in inlet and exhaust ducts.

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DESCRIPTION         GEN. AERO.ANAL. V.P.FANS

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      SUBROUTINE GAAVPF
     1 (TCVKTS,TSODF,PSOIA,TNET,SHP,TS,PR,HOT,DIAM,B,V,A2,AR,
     2  INETA,SHPA,TSA,PRA,CM,CU,CUP,CDN,SIGF,DCLDA,BE,RE,IGVA,
     3  VMC,W,IOPTA ,ERRA, STLD, THRUST, ZMCS, CCUS,SIGR)
C     GENERALIZED AERODYNAMIC ANALYSIS OF VARIABLE-PITCH FANS
C     GAAVPF CALLS GAADES, GAAPFM ; CALLED BY SHRP, VPFAN, VPLFAN, SHTR
C  I  TCVKTS  DESIGN (TAKEOFF) SPEED , KNOTS
C  I  TSODF   DESIGN (TAKEOFF) AMBIENT TEMPERATURE , DEG F
C  I  PSOIA   DESIGN (TAKEOFF) AMBIENT PRESSURE , PSIA
C  IO TNET    DESIGN (TAKEOFF) NET THRUST , LB
C  IO SHP     DESIGN (TAKEOFF) SHP
C  IO TS      DESIGN (TAKEOFF) TIP SPEED , FPS
C  IO PR      DESIGN (TAKEOFF) PRESSURE RATIO
C  IO HOT     HUB / TIP DIAMETER RATIO
C  IO DIAM    TIP DIAMETER , FT
C  I  B       NUMBER OF BLADES
C  I  V       NUMBER OF VANES
C   O A2      FAN ANNULAR AREA , SQ FT
C   O AR      AREA RATIO
C  IO TNETA   OPERATING NET THRUST , LB
C  IO SHPA    OPERATING SHP
C  IO TSA     OPERATING TIP SPEED , FPS , IF GT MINIMUM
C   O PRA     OPERATING PRESSURE RATIO
C   O CM      OPERATING AXIAL VELOCITY , FPS
C   O CU      OPERATING HALF SWIRL VELOCITY BETWEEN ROWS , FPS
C   O CUP     UPSTREAM CHORD , FT
C   O CDN     DOWNSTREAM CHORD , FT
C   O SIGF    DOWNSTREAM SOLIDITY
C   O DCLDA   DOWNSTREAM LIFT CURVE SLOPE , /RADIAN
C   O BE      DOWNSTREAM STAGGER ANGLE , DEG
C   O RE      EFFECTIVE RADIUS RATIO
C  I  IGVA    =1 IF IGV-ROTOR , =0 IF ROTOR-OGV
C  I  VMC     OPERATING FLIGHT MACH NUMBER
C   O W       OPERATING AIRFLOW , LB/SEC
C  I  IOPTA   =1 FOR DESIGN CASE , =2 FOR OPERATING CASE
C   O ERRA    =0. IF NO ERROR
C  IO STLD    STACKING LINE DISTANCE IF GT 0., FT, -BVGAP IF LT 0., IF
C             =0. ON INPUT USE BVGAP=2.
C   O THRUST  OPERATING ROTOR THRUST , LB
```

```
                                                                      00000400
C     C ZMDS     OPERATING MEAN DUCT MACH NUMBER                      00000410
C     O CDUS     OPERATING UPSTREAM DRAG COEFFIECINT                  00000420
C     C SIGR     ROTOR SCLIDITY                                       00000430
        CCMMCN /TRANFR/RRL(50),INTG(2)                                00000440
C                                                                     00000450
        CCMMCN /DATA/ ANGLE(15),BCFR(30),NR,NP,C,HOL(20),DATE(2),TIME(2),  00000460
       1 ATTNT(30),SPLT(15,30),SPLTU(15,30),DBNU(7),XO(15),XC(15),ZO(15),  00000470
       2 PSI(15),CO(15),DDC(15),HPT,TR,VELFL,VM(15),PWLT(15,30),     00000480
       3 DIRIN(498),DIREX(498),BLF(31),CPWSF(15),RPMG,CHPT           00000490
        CCMMCN /DATAI/DATAIN(3)                                       00000500
C                                                                     00000510
        ERRA = 0.                                                     00000520
        VELA = VELFL                                                  00000530
        PSAIA= DATAIN(3)                                              00000540
        TSAIA= DATAIN(1)                                              00000550
        IF (IOPTA .EQ. 1) CALL GAADES                                 00000560
       1 (TOVKTS,TSODF,PSOIA,TNET,SHP,TS,PR,HOT,DIAM,B,V,A2,AR,       00000570
       2  TNETA,SHPA,TSA,PRA,CM,CU,CUP,CDN,SIGF,DCLDA,BE,RE,IGVA,     00000580
       3  VMC,W,IOPTA ,VELA,PSAIA,TSAIA,ERRA,STLD,THRUST,ZMDS,CDUS,SIGR)  00000590
C                                                                     00000600
        IF (IOPTA .NE. 1) CALL GAAPFM                                 00000610
       1 (TOVKTS,TSODF,PSOIA,TNET,SHP,TS,PR,HOT,DIAM,B,V,A2,AR,       00000620
       2  TNETA,SHPA,TSA,PRA,CM,CU,CUP,CDN,SIGF,DCLDA,BE,RE,IGVA ,    00000630
       3  VMO,W,IOPTA ,VELA,PSAIA,TSAIA,ERRA,STLD,THRUST,ZMDS,CDUS,SIGR)  00000640
C                                                                     00000650
        RETURN                                                        00000660
C                                                                     00000670
        END                                                           00000680
        SUBROUTINE GAADES                                             00000690
       1 (TOVKTS,TSODF,PSOIA,TNET,SHP,TS,PR,HOT,DIAM,B,V,A2,AR,       00000700
       2  TNETA,SHPA,TSA,PRA,CM,CU,CUP,CDN,SIGF,DCLDA,BE,RE,IGVA,     00000710
       3  VMO,W,IOPTA ,VELA,PSAIA,TSAIA,ERRA,STLD,THRUST,ZMDS,CDUS,SIGR)  00000720
C       GAADES CALLS GAASEC; CALLED BY GAAVPF                         00000730    04/13/76
C                                                                     00000740    04/13/76
C GAACCM                                                              00000750    04/13/76
        CCMMCN /TRANFR/RRL(50),INTG(2)                                00000760    04/13/76
        EQUIVALENCE                                                   00000770    04/13/76
       1(RRL(01),TNET1 ),(RRL(02),SHP1  ),(RRL(03),PR1  ),(RRL(04),HOT1 ),00000780    04/13/76
       2(RRL(05),VKTAS1),(RRL(06),TS1   ),(RRL(07),PSO1 ),(RRL(08),TSO1 ),00000790    04/13/76
       3(RRL(09),DIAM1 ),(RRL(10),PRDUM ),(RRL(11),A21  ),(RRL(12),AR1  ),00000800    04/13/76
       4(RRL(13),CX3   ),(RRL(14),DCU   ),(RRL(15),BMR  ),(RRL(16),BMS  ),00000810    04/13/76
       5(RRL(17),TAUBS ),(RRL(18),TAUBR ),(RRL(19),BETAS),(RRL(20),BETAR),00000820    04/13/76
       6(RRL(21),DCLDAS),(RRL(22),DCLDAR),(RRL(23),WFAN1),(RRL(24),SHPCR),00000830    04/13/76
       7(RRL(25),TNETCR),(RRL(26),WCOR  ),(RRL(27),ZM1  ),(RRL(28),ERR  ),00000840    04/13/76
       8(RRL(29),DELTAS),(RRL(30),DELTAT),(RRL(31),B1   ),(RRL(32),V1   ),00000850    04/13/76
       9(RRL(33),THETAS),(RRL(34),THETAT),(INTG(1),IOPT ),(INTG(2),IGV  ),00000860    04/13/76
       A(RRL(35),CDR   ),(RRL(36),CDS   ),(RRL(37),ZM3  ),(RRL(38),STLD1),00000870    04/13/76
       B(RRL(39),TROTOR),(RRL(40),SHPDS ),(RRL(41),TGRCS),(RRL(42),PCT  ),00000880    04/13/76
       C(RRL(43),WFDS  ),(RRL(44),CDRDS ),(RRL(45),CDSDS),(RRL(46),TOR  ) 00000890    04/13/76
       D(RRL(47),TSDS  )                                              00000900    04/13/76
C
```

```
 C
       CCMMCN /PTREAT/NOWALI,DWODI(2),ZLWDI(2),NORINI,DRCCI(5),ZLRDDI(5),
      1              NOWALE,CWDDE(2),ZLWDE(2),NCRINE,DRCDE(5),ZLRDDE(5),
      2              ZTREAT,ZMTHR
 C
       ERR = ERRA
       PCT = 1.000
       TNET1 = TNET
       SHP1  = SHP
       PR1   = PR
       VKTAS1= TOVKTS
       HOT1  = HOT
       IF (HOT1 .LE. 1.) HOT1 = .400
       TS1   = TS
       PSC1  = PSOIA
       TSO1  = TSODF
       DIAM1 = CIAM
       IOPT  = IOPTA
       IGV   = IGVA
       B1    = B
       V1    = V
       STLD1 = STLD
 C
       DWCCI(1) = HOT1
       DWDDE(1) = HOT1/.8
       IF (NORINI .LE. 0) GO TO 10
       DXX  = (1.-HOT1)/(NCRINI + 1)
       DO 9 I=1,NCRINI
       DRCCI(I) = DXX + HOT1                                           11/10/75
 9     DXX = DXX + DXX
 C
 10    IF (NCRINE .LE. 0) GC TO 2C
       DXX = (1.-HOT1/.8) / (NORINE + 1)
       DC 19 I=1,NORINE
       DRCDE(I) = DXX + HOT1/.8                                        11/10/75
 19    DXX = DXX + DXX
 C
 20    CONTINUE
       CALL CAASEC
       ERRA = ERR
       IF (ERR .GT. .001) RETURN
 C
       TNET  = TNET1
       SHP   = SHP1
       TS    = TS1
       PR    = PR1
       HOT   = HOT1
       SHPDS = SHP1
       TGRDS = TNET1 + WFAN1/32.2*(1.688*VKTAS1)
       WFDS  = WFAN1
       TSDS  = TS1
```

```
      DIAM   = DIAM1
      A2     = A21
      AR     = AR1
      STLD   = STLD1
      CM     = CX3
      CU     = DCU/2.
      CUP    = BMR
      IF (IGV .EQ. 1) CUP = BMS
      CDN    = BMS
      IF (IGV .EQ. 1) CDN = BMR
      SIGF   = 1./TAUBS
      IF (IGV .EQ. 1) SIGF = 1./TAUBR
      SIGR = 1./TAUBR
      DCLDA  = DCLDAS
      IF (IGV .EQ. 1) DCLDA= DCLDAR
      BE     = 90. - BETAS
      RE     = SQRT (.5*(1. + HOT1**2))
      W      = WFAN1
C
C
      RETURN
      END
      SUBROUTINE GAAPEM
     1 (TCVKTS,TSDCF,PSDIA,TNET,SHP,TS,PR,PCT,DIAM,B,V,A2,AR,
     2  TNETA,SHPA,TSA,PRA,CM,CU,CUP,CDN,SIGF,DCLDA,BE,RE,IGVA,
     3  VMO,W,IOPTA ,VELA,PSAIA,TSAIA,ERRA,STLD,THRUST,ZMDS,CDUS)
C     GAAPEM CALLS GAASEC: CALLED BY GAAVPF
C
C GAACCM
      COMMON /TRANFR/RRL(50),INTG(2)
      EQUIVALENCE
     1(RRL(01),TNET1 ),(RRL(02),SHP1  ),(RRL(03),PR1   ),(RRL(04),HOT1 ),
     2(RRL(05),VKTAS1),(RRL(06),TS1   ),(RRL(07),PSC1  ),(RRL(08),TSD1 ),
     3(RRL(09),DIAM1 ),(RRL(10),PRDUM ),(RRL(11),A21   ),(RRL(12),AR1  ),
     4(RRL(13),CX3   ),(RRL(14),DCU   ),(RRL(15),BMR   ),(RRL(16),BMS  ),
     5(RRL(17),TAUBS ),(RRL(18),TAUBR ),(RRL(19),BETAS ),(RRL(20),BETAR),
     6(RRL(21),DCLDAS),(RRL(22),DCLDAR),(RRL(23),WFAN1 ),(RRL(24),SHPCR),
     7(RRL(25),TNETCR),(RRL(26),WCOR  ),(RRL(27),ZM1   ),(RRL(28),ERR  ),
     8(RRL(29),DELTAS),(RRL(30),DELTAT),(RRL(31),B1    ),(RRL(32),V1   ),
     9(RRL(33),THETAS),(RRL(34),THETAT),(INTG(1),IOPT  ),(INTG(2),IGV  ),
     A(RRL(35),CDR   ),(RRL(36),CDS   ),(RRL(37),ZM3   ),(RRL(38),STLD1),
     B(RRL(39),TROTOR),(RRL(40),SHPDS ),(RRL(41),TCRDS ),(RRL(42),PCT  ),
     C(RRL(43),WFDS  ),(RRL(44),CDRDS ),(RRL(45),CDSDS ),(RRL(46),T2R  ),
     D(RRL(47),TSDS  )
C
C  CALC. FAN PERFORMANCE
       DIMENSION TORTS(6),TSTOR(6)
       DIMENSION TCRPCT(5),PCTTOR(5)
       DATA TORTS/.50,.60,.70,.80,.90,1.0/
       DATA TSTOR/.85,.81,.82,.88,.93,1.0/
       DATA TCRPCT/.500,.600,.700,.800,.900/
```

```
      DATA PCTTOR/.900,.975,.950,.975,1.CC/
      ITER = 0
      ERR = ERRA
      PR1    = PRA
      TNET1  = TNETA
      SHP1   = SHPA
      VKTAS1 = VELA/1.688
      TS01   = TSAIA
      PSC1   = PSAIA
      TOR = SHP1/SHPCS
      IF (SHP1 .LE. 0.) TOR = (TNET1 + WFCS/32.2*(1.688*VKTAS1)) / TGRDS
    3 CALL UNINT(5,TORPCT,PCTTCR,TCR,PCT,LIM)
      CALL UNINT(6,TORTS ,TSTCR ,TCR,TSF,LIM)
      TS1    = TS * TSF
      IF (TSA .GT. .001) TS1 = TSA
      AR1    = AR
      HOT1   = HOT
      DIAM1  = DIAM
      IOPT   = IOPTA
      IGV    = IGVA
      STLD1  = STLD
C
      CALL GAASEC
      ERRA = ERR
      IF (ERR .GT. .001) RETURN
C
      ITER = ITER + 1
      IF (ITER .GE. 2  ) GO TO 5
      TCR    = SHP1/SHPDS
      GC TO 3
    5 CCNTINUE
C
C
      TNETA   = TNET1
      SHPA    = SHP1
      TSA     = TS1
      PRA     = PR1
      CM      = CX3
      CU      = DCU/2.
      W       = WFAN1
      BETDN = BETAS
      BETUP = BETAR
      IF (IGV .EQ. 1) BETCN = BETAR
      IF (IGV .EQ. 1) BETUP = BETAS
      IF (IGV .EQ. 1) BE = 9C. - BETON                                   11/14/75
      IF (STLD1.GT. .001) GO TO 10
      IF (STLD1.EQ. 0.  )
     A STLD1 = 2.*CDN + CUP/2.*COS(.C1745*(90.-BETUP)) +                 11/14/75
     B         .517*CDN*SIN(.01745*(BETDN))
      IF (STLD1.LT. .C01)
     A STLD1 = -STLD1*CDN + CUP/2.*CCS(.C1745*(90.-BETUP)) +             11/14/75
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```
      8         .517*CDN*SIN(.01745*(BETCN))
C
 10   CONTINUE
      THRUST = TROTCR
      STLD   = STLD1
      CDUS   = CDR
      IF (IGV . EQ. 1) CDUS = CDS
      ZMDS   = ZM3
      RETURN
      END
      SUBROUTINE GAASEC
C     GAASEC CALLS GAAFM, GAASIA, GAASIB, GAASIC, GAASIC, UNINT, VMACH,
C     &GAACLK; CALLED BY GAACES & GAAPFM                                      04/13/76
C                                                                             04/13/76
C GAACCM                                                                      04/13/76
      COMMON /TRANFR/RRL(50),INTG(2)                                          04/13/76
      EQUIVALENCE                                                             04/13/76
     1(RRL(01),TNET1 ),(RRL(02),SHP1  ),(RRL(03),PR1   ),(RRL(04),HOT1 ),     04/13/76
     2(RRL(05),VKTAS1),(RRL(06),TS1   ),(RRL(07),PSO1  ),(RRL(08),TSO1 ),     04/13/76
     3(RRL(09),CIAM1 ),(RRL(10),PRDUM ),(RRL(11),A21   ),(RRL(12),AR1  ),     04/13/76
     4(RRL(13),CX3   ),(RRL(14),CCU   ),(RRL(15),BMR   ),(RRL(16),BMS  ),     04/13/76
     5(RRL(17),TAUBS ),(RRL(18),TAUBR ),(RRL(19),BETAS ),(RRL(20),BETAR),     04/13/76
     6(RRL(21),CCLDAS),(RRL(22),CCLDAR),(RRL(23),WFAN1 ),(RRL(24),SHPCR),     04/13/76
     7(RRL(25),TNETCR),(RRL(26),WCCR  ),(RRL(27),ZM1   ),(RRL(28),ERR  ),     04/13/76
     8(RRL(29),DELTAS),(RRL(30),DELTAT),(RRL(31),B1    ),(RRL(32),V1   ),     04/13/76
     9(RRL(33),THETAS),(RRL(34),THETAT),(INTG(1),ICPT  ),(INTG(2),IGV  ),     04/13/76
     A(RRL(35),CCR   ),(RRL(36),CDS   ),(RRL(37),ZM3   ),(RRL(38),STLD1),     04/13/76
     E(RRL(39),TROTOR),(RRL(40),SHPDS ),(RRL(41),TGRDS ),(RRL(42),PCT  ),     04/13/76
     C(RRL(43),WFDS  ),(RRL(44),CDRDS ),(RRL(45),CCSDS ),(RRL(46),TOR  ),     04/13/76
     D(RRL(47),TSCS  )                                                        04/13/76
C
       DIMENSION PRHOT(6),HOTPR(6)                                            11/14/75
       DIMENSION PRTS(6),TSPR(6)                                              11/14/75
       DIMENSION ZMECV(9),CVZME(9)                                            11/14/75
       DIMENSION PRETA(6),ETAPR(6)                                            11/14/75
       DIMENSION PRA2A3(6),A2A3PR(6)                                          11/14/75
       DIMENSION PRCD(6),CDPR(6)
       DATA PRHOT/1.0,1.1,1.2,1.3,1.4,1.5/
       DATA HOTPR/.385,.418,.451,.487,.527,.577/
       DATA PRTS/1.0,1.1,1.2,1.3,1.4,1.5/
       DATA TSPR/488.,620.,753.,883.,1016.,1148./
       DATA ZMECV/0.,.2,.4,.6,.8,.9,1.0,1.05,1.10/
       DATA CVZME/1.,.9957,.9920,.9895,.9905,.9918,.9937,.9954,.9948/
       DATA PRETA/1.0,1.1,1.2,1.3,1.4,1.5/
       DATA ETAPR/.873,.880,.885,.890,.884,.850/
       DATA  PRA2A3/1.0,1.1,1.2,1.3,1.4,1.5/
       DATA  A2A3PR/1.0,1.0,1.02,1.07,1.14,1.227/
       DATA  PRCD  /1.0,1.1,1.2,1.3,1.4,1.5/
       DATA  CDPR  /.008,.013,.023,.037,.054,.072/
C      SECTION I AND II
       ZM1    = VKTAS1/(29.04*SQRT(459.69+TSO1))
```

```
      THETAS = (TSC1 + 459.69)/518.6
      DELTAS = (PS01/14.696)
      THETAT = THETAS * GAAFM(ZM1,1.0)
      DELTAT = DELTAS * GAAFM(ZM1,3.5)
C
      ICCUNT = C
C
C  SIA IF PR GIVEN FOR DESIGN CASE
C  SIB IF FAN DIAM.IS GIVEN FOR DESIGN CASE
C  SIC IF PR GIVEN FOR PERF CASE
C  SID IF TNET CR SHP GIVEN FOR PERF CASE
C
      IF (ICPT .EG. 1 .ANC. PR1 .GT. 1.CCC) ICALL = 1
      IF (IOPT .EQ. 1 .AND. DIAM1.GT.0.0  ) ICALL = 2
      IF (IOPT .NE. 1 .AND. PR1 .GT. 1.CCC) ICALL = 3
      IF (IOPT .NE. 1 .AND.(TNET1.GT.0. .CR. SHP1.GT.0.)) ICALL = 4
 1    IF (ICALL .EQ. 1) CALL GAASIA
      IF (ICALL .EQ. 2) CALL GAASIB
      IF (ICALL .EQ. 3) CALL GAASIC
      IF (ICALL .EQ. 4) CALL GAASID
      IF (ERR .GT. .001) RETURN
C
C     AR1,PR1,TNETCR,SHPCR,A21 HAVE BEEN DEFINED FCR ALL CASES
C     WCOR
C
C
      CALL UNINT (6,PRHCT,HCTPR,PR1,HOTMIN,LIM)
C
C
      CALL UNINT (6,PRTS,TSPR,PR1,TSMIN,LIM )
C
      IF (IOPT .NE. 1) GO TO 30
C
      IF (HOT1 .GT. HCTMIN) GO TO 30
      ICCUNT = ICOUNT + 1
      IF (ICOUNT .GT. 5 ) GC TO 30
      HCT1 = HOTMIN
      GO TC 1
 30   IF (TS1  .GT. TSMIN ) GC TC 40
      TS1  = TSMIN
 40   CCNTINUE
C
      IF (ICPT .NE. 1) GO TO 10
      CALL UNINT (6,PRCD,CDPR,PR1,CDFF,LIM)
      CCRDS = CDFF * (TS1/TSMIN) ** 2
      CDSDS = CDFF
      COR   = CORDS
      CDS   = CDSDS
      GC TO 20
 10   TSOFFD = TSDS * TOR **.333333
      CALL UNINT (6,PRCD,CDPR,PR1,CCFF,LIM)
```

```
      FFF  =  (TS1/TSOFFC) **10
      CDR  =  COFF * FFF
      CDS  =  COFF
   20 CONTINUE
C
C     SECTION III
C
      WFAN1   = WCOR*DELTAT*A21/SQRT(THETAT)
      TNET1   = TNETCR*DELTAS*A21
      SHP1    = SHPCR*DELTAS*SQRT(THETAS)*A21
      DIAM1   = SQRT(4./3.14159*A21/(1.-HCT1**2))
C
C
      PSOPTE = 1./(PR1*GAAFM(ZM1,3.5))
      ZME    = SQRT((PSOPTE**(-.286)-1)*5)
C
C
      CALL UNINT (9,ZMECV,CVZME,ZME,CV,LIM)
C
      VE      = (TNET1*32.2/WFAN1 + VKTAS1*1.688)/CV
C
      ZM2     = VMACH(1.025*WCOR)
      TS2TTO = GAAFM(ZM2,-1.C)
      CX2     = SQRT  (518.6*THETAT*TS2TTO)*ZM2*49.02
C
C
      CALL UNINT (6,PRETA,ETAPR,PR1,ETA,LIM)
      ETA = ETA * PCT                                                                11/14/75
      DTR = (PR1**.286-1.)/ETA
      TS3 = (TS2TTO+DTR) * .98*518.6*THETAT                                           11/14/75
      TT3 = (1.+DTR)*518.6*THETAT
C
C
      CALL UNINT (6,PRA2A3,A2A3PR,PR1,A2A3,LIM)
      A31 = A21/A2A3
C   SECTION IV  - CGV FANS
C
      IF (IGV .NE. 0) GO TO 50
C
      ZM3 = SQRT (5*(TT3/TS3-1))*(A21+A31)/(2*A31)
      C3  = 49.02 * ZM3 * SQRT (TS3)
      DCU = 550*SHP1*32.2/(WFAN1*TS1*.7)
      CX3 = SQRT (C3**2 - DCU**2)
      PT3 = PR1 * DELTAT * 2116. * .598
      PS3 = PT3 * GAAFM(ZM3,-3.5)                                                     11/14/75
      PS2 = GAAFM(ZM2,-3.5) * 2116. * DELTAT
C
      TRCTOR = WFAN1/32.2*(CX3-CX2) + (PS3*A31-PS2*A21) +
     1          (PS3+PS2)/2.*(A21-A31)
       BETA1  = ATAN (CX3/DCU)* 57.295                                                11/14/75
      THETAS = 95.-BETA1
```

```
      BETAS  = (90.+BETA1)/2. + 5. + .226*THETAS                        11/14/75
      BETAR  = ATAN (CX2/(.8*TS1 + DCU/2.)) * 57.295                    11/14/75
C
C  SECTION  V  DESIGN CASE - OGV'S
      IF  (ICPT .NE. 1) GO TO 50
      W3 = SQRT(CX3**2 + (.8*TS1-DCU)**2)
      W2 = SQRT(CX2**2 + (.8*TS1)**2)
C
      TAUBR = (W3/W2 -.57) * 2.*W2/DCU                                  02/10/76
      BMR    = 3.14159*.8*DIAM1/(B1*TAUBR)
      TAUBS = (CX3/C3-.57) * 2.*C3/DCU                                  02/10/76
      BMS    = 3.14159*.6*DIAM1/(V1*TAUBS)
C
C
      CALL GAACLK (BETAS,TAUBS,CLK)
C
      DCLCAS = 6.28318 * CLK
C
      GO TO 60
C
C  SECTION VI  IGV'S ONLY
C
 50   IF (IGV .NE. 1) GO TO 60
C
      CX3 = CX2/2. * (A21/A31 + 1.)                                     11/14/75
      DCU = 550. * SHP1 *32.2/(WFAN1 * .7 * TS1)                        11/14/75
      C3  = SQRT (CX3**2 + DCU**2)
      ZM3 = C3/(49.02*SQRT(TS2TTC*THETAT*518.6)) * .98
       PS3 = 2116. * DELTAT * GAAFM(ZM3,-3.5)                           02/16/76
      TS4 = TS3
       ZM4=SQRT(5.*((THETAT+CTR*THETAT)*518.6/TS4-1.))*(A21+A31)/(2*A21)  02/16/76
      CX4 = 49.02*SQRT(TS4)*ZM4
       PS4 = GAAFM(ZM4,-3.5) * .95 * DELTAT * PR1 * 2116.               02/16/76
C
      TROTOR = WFAN1/32.2*(CX4-CX3)+(PS4+PS3)/2.*(A21-A31) +
     1         (PS4*A31 - PS3*A21)
       BETA2  = ATAN (CX2/DCU) * 57.295
      THETAS = 95.-BETA2                                                11/14/75
      BETAS  = (90.+BETA2)/2. + 5. + .226*THETAS                        11/14/75
      BETAR  = ATAN (CX3/(.8*TS1 + DCU/2.)) * 57.295                    11/14/75
C
C  SECTION VII  DESIGN - IGV'S
C
      IF (ICPT .NE. 1) GO TO 60
C
      W4  = SQRT(CX4**2 + (.8*TS1)**2)
      W3  = SQRT(CX3**2 + (.8*TS1 + DCU)**2)
C
      TAUBR = (W4/W3 -.57) * 2.*W3/DCU                                  02/10/76
      BMR    = 3.14159*DIAM1*.8/(B1*TAUBR)
      TAUBS = (C3/CX2-.57) * 2.*CX2/DCU                                 02/10/76
```

```
      BMS     = 3.14159*CIAM1*.8/(V1*TAUBS)
C
C
      CALL GAACLK (BETAR,TAUBR,CLK)
C
      DCLDAR = 6.28318*CLK
C
 60   RETURN
C
      END
      SUBROUTINE GAASIA
C     GAASIA CALLS GAAFN3; CALLEC BY GAASEC
      CCMMCN /DATA/ A(45),NR,NP
C                                                                    04/13/76
C GAACCM                                                             04/13/76
      COMMON /TRANFR/FRL(50),INTG(2)                                 04/13/76
      EQUIVALENCE                                                    04/13/76
     1(RRL(01),TNET1 ),(RRL(02),SHP1  ),(RRL(C3),FR1  ),(RRL(04),HOT1 ), 04/13/76
     2(RRL(05),VXTAS1),(RRL(06),TS1   ),(RRL(07),PSC1 ),(RRL(08),TS01 ), 04/13/76
     3(RRL(09),DIAM1 ),(RRL(10),PRDUP ),(RRL(11),A21  ),(RRL(12),AR1  ), 04/13/76
     4(RRL(13),CX3   ),(RRL(14),CCU   ),(RRL(15),BMR  ),(RRL(16),BMS  ), 04/13/76
     5(FRL(17),TAUBS ),(RRL(18),TAUBR ),(RRL(19),BETAS),(RRL(20),BETAR), 04/13/76
     6(RRL(21),CCLCAS),(RRL(22),CCLDAR),(RRL(23),WFAN1),(RRL(24),SHPCR), 04/13/76
     7(RRL(25),TNETCR),(RRL(26),WCOR  ),(RRL(27),ZM1  ),(RRL(28),ERR  ), 04/13/76
     8(RRL(29),DELTAS),(RRL(30),DELTAT),(RPL(31),B1   ),(RRL(32),V1   ), 04/13/76
     9(RRL(33),THETAS),(FRL(34),THETAT),(INTG(1),ICPT ),(INTG(2),IGV  ), 04/13/76
     A(RRL(35),CCR   ),(RRL(36),CDS   ),(FRL(37),ZM3  ),(RRL(38),STLD1), 04/13/76
     E(RRL(39),TRCTOR),(RRL(40),SHPDS ),(RRL(41),TGRDS),(RRL(42),PCT  ), 04/13/76
     C(RRL(43),WFDS  ),(RPL(44),CORDS ),(RRL(45),CCSDS),(RRL(46),TOR  ), 04/13/76
     C(FRL(47),TSCS  )                                               04/13/76
C                                                                    04/13/76
C
C     DETERMINE   - AR,DIAM,TNETCR/SHPCR, ANC A2 -  DESIGN CASE A
C     FRCM          PR, MC, WCOR = 40, ANC SHP/TNET
C
      IF (PR1 .GE. 1.00 .OR. PR1 .LE. 1.75 )  GC TO 10
C
      WRITE (NP,1) PR1
    1 FORMAT (27H PR1 CUTSIDE PRCGRAM RANCE   , E12.4)
C
      ERR = 6.0
      GO TO 20
C
 10   WCOR = 40.
      CALL GAA123 (ZM1,AA,WCOR,AB,TNETCR,SHPCR,3,I,PR1,AC,AR1)
C
C IF AR .GT. 1. LIMIT AR TC 1.0 AND FIND WCOR WHICH IS REQUIRED
C
      IF (AR1 .LE. 1.0 ) GO TO 15
C
      AR1 = 1.0
```

```
      CALL GAA123 (ZM1,AR1,AA,AB,TNETCR,SHPCR,1,I,PR1,WCCR,AC)
C
 15   CONTINUE
C
      A21 =  TNET1/TNETCR / DELTAS
      IF  ( SHP1 .GT. C.)
     2A21 =  SHP1 /SHPCR   /(DELTAS*SQRT(THETAS))
C
 20   RETURN
      END
      SUBROUTINE GAASIB
C     GAASIB CALLS GAAFN3, UNINT; CALLED BY GAASEC
      COMMON /DATA/ A(45),NR,NP
C
C GAACCM
      COMMON /TRANFR/RRL(5C),INTG(2)
      EQUIVALENCE
     1(RRL(01),TNET1 ),(RRL(02),SHP1  ),(RRL(03),PR1   ),(RRL(04),HOT1 ),
     2(RRL(05),VKTAS1),(RRL(06),TS1   ),(RRL(07),PS01  ),(RRL(08),TS01 ),
     3(RRL(09),DIAM1 ),(RRL(10),PRDUM ),(RRL(11),A21   ),(RRL(12),AR1  ),
     4(RRL(13),CX3   ),(RRL(14),DCU   ),(RRL(15),BMP   ),(RRL(16),BMS  ),
     5(RRL(17),TAUBS ),(RRL(18),TAUBF ),(RRL(19),BETAS ),(RRL(20),BETAR),
     6(RRL(21),CCLDAS),(RRL(22),UCLDAR),(RRL(23),WFAN1 ),(RRL(24),SHPCR),
     7(RRL(25),TNETCR),(RRL(26),WCOR  ),(RRL(27),ZM1   ),(RRL(28),ERR  ),
     8(RRL(29),DELTAS),(RRL(30),CELTAT),(RRL(31),B1    ),(RRL(32),V1   ),
     9(RRL(33),THETAS),(RRL(34),THETAT),(INTG(1),IOPT  ),(INTG(2),IGV  ),
     A(RRL(35),CDR   ),(RRL(36),CDS   ),(RRL(37),ZM3   ),(RRL(38),STLD1),
     B(RRL(39),TROTOR),(RRL(40),SHPDS ),(RRL(41),TGRDS ),(RRL(42),PCT  ),
     C(RRL(43),WFDS  ),(RRL(44),CDRDS ),(RRL(45),CDSDS ),(RRL(46),TOR  ),
     D(RRL(47),TSDS)
C
C
C     DETERMINE   PR,TNETCR/SHPCR, AND AR   -   DESIGN CASE B
C     FROM        DIAM, MU, WCOR=40, AND SHP/TNET
C
      DIMENSION  PRS(19),ARS(19),TNETS(19),SHPS(19)
      DATA PRS/1.020,1.075,1.10,1.125,1.150,1.175,1.200,1.225,1.250,
     1        1.275,1.300,1.325,1.350,1.375,1.400,1.425,1.450,1.475,1.5/
C
      WCOR = 40.
      DO 1 I = 1,19
    1 CALL GAA123 (ZM1,AA,WCCR,AB,TNETS(I),SHPS(I),3,J,PRS(I),AC,ARS(I))
C
      A21 = 3.14159/4. * DIAM1* CIAM1*(1-HCT1**2)
      IDC = 1
      IF (TNET1 .GT. C. ) IDC = 2
      IF (SHP1  .GT. 0. ) IDO = 3
      GC TO (10,20,3C),IDO
C
 10   WRITE (NP,11) DIAM1
 11   FORMAT (52H A THRUST OR SHP MUST BE SPECIFIED IF DIAM .GT. C.,
```

```
     1 ,        18H FOR A DESIGN CASE   , E12.4)
      ERR = 5.0
      GO TO 50
C
 20   TNETC =  TNET1/A21/DELTAS
      CALL UNINT (19,TNETS,PRS,TNETC,PR1,LIM)
      CALL GAA123 (ZM1,AA,WCOR,AB,TNETCR,SHPCR,3,J,PP1,AC,AR1)
      GO TO 40
 30   SHPC  =  SHP1 /A21/DELTAS/SQRT(THETAS)
      CALL UNINT (19,SHPS ,PRS,SHPC ,PR1,LIM)
      CALL GAA123 (ZM1,AA,WCOR,AB,TNETCR,SHPCR,3,J,PP1,AC,AR1)
C
 40   IF (PR1 .GE. 1.00 .AND. PR1 .LE. 1.75) GO TO 50
C
      WRITE (NP,41) PR1,DIAM1
 41   FORMAT (49H PRESSURE RATIO CALC. FOR THIS CASE OUT OF RANGE
     1 , 2E12.4 )
C
      ERR = 4.0
 50   IF (AR1 .LE. 1.) GO TO 60
C
C IF AR1 .GT. 1. SET AR1 = 1.0 AND FIND WCOR WHICH IS REQUIRED
C
      AR1 = 1.0
      CALL GAASIC
C
 60   RETURN
      END
      SUBROUTINE GAASIC
C     GAASIC CALLS GAAFN1: CALLED BY GAASEC
      COMMON /DATA/ A(45),NR,NP
C
C GAACOM
      COMMON /TRANFF/RRL(50),INTG(2)
      EQUIVALENCE
     1(RRL(01),TNET1 ),(RRL(02),SHP1  ),(RRL(03),PR1   ),(RRL(04),HOT1 ),
     2(RRL(05),VKTAS1),(RRL(06),TS1   ),(RRL(07),PSO1  ),(RRL(08),TSO1 ),
     3(RRL(09),DIAM1 ),(RRL(10),PRDUM ),(RRL(11),A21   ),(RRL(12),AR1  ),
     4(RRL(13),CX3   ),(RRL(14),CCU   ),(RRL(15),BMR   ),(RRL(16),BMS  ),
     5(RRL(17),TAUBS ),(RRL(18),TAUBR ),(RRL(19),BETAS ),(RRL(20),BETAR),
     6(RRL(21),DCLDAS),(RRL(22),DCLDAR),(RRL(23),WFAN1 ),(RRL(24),SHPCR),
     7(RRL(25),TNETCR),(RRL(26),WCOR  ),(RRL(27),ZM1   ),(RRL(28),ERR  ),
     8(RRL(29),DELTAS),(RRL(30),DELTAT),(RRL(31),B1    ),(RRL(32),V1   ),
     9(RRL(33),THETAS),(RRL(34),THETAT),(INTG(1),IOPT  ),(INTG(2),IGV  ),
     A(RRL(35),CDR   ),(RRL(36),CDS   ),(RRL(37),ZM3   ),(RRL(38),STLD1),
     B(RRL(39),TROTOR),(RRL(40),SHPDS ),(RRL(41),TGRDS ),(RRL(42),PCT  ),
     C(RRL(43),WFDS  ),(RRL(44),CORDS ),(RRL(45),CDSDS ),(RRL(46),TOR  ),
     D(RRL(47),TSDS  )
C
C
C     DETERMINE  TNETCR,SHPCR,PR, AND WCOR   - OFF DESIGN A
```

```
C      FRCM        DIAP,AR, AND PR AT MC
C
       CALL GAA123 (ZM1,AR1,AA,AB,TNETCR,SHPCR,1,I,PR1,WCOR,AC)
       IF (PR1 .GE. 1.00 .AND. PR1 .LE. 1.75) RETURN
C
       WRITE (NP,10) PR1
 10    FORMAT(38H PR1 OUT-OF RANGE FOR OFF-DESIGN CASE   ,E12.4)
C
       ERR = 3.0
C
       RETURN
       END
       SUBROUTINE GAASID
C      GAASIC CALLS GAAFN2, UNINT; CALLEC BY GAASEC
       CCMMCN /CATA/ A(45),NR,NP
C                                                                       04/13/76
C GAACUM                                                                04/13/76
       CCMMCN /TRANFR/RRL(50),INTG(2)                                   04/13/76
       EQUIVALENCE                                                      04/13/76
      1(RRL(01),TNET1 ),(RRL(02),SHP1  ),(RRL(03),PR1  ),(RRL(04),HOT1 ),    04/13/76
      2(RRL(05),VKTAS1),(RRL(06),TS1   ),(RRL(07),PSO1 ),(RRL(08),TSO1 ),    04/13/76
      3(RRL(09),DIAM1 ),(RRL(10),PRDUM ),(RRL(11),A21  ),(RRL(12),AR1  ),    04/13/76
      4(RRL(13),CX3   ),(RRL(14),CCU   ),(RRL(15),BMR  ),(RRL(16),BMS  ),    04/13/76
      5(RRL(17),TAUBS ),(RRL(18),TAUBR ),(RRL(19),BETAS),(RRL(20),BETAR),    04/13/76
      6(RRL(21),CCLDAS),(RRL(22),DCLDAR),(RRL(23),WFAN1),(RRL(24),SHPCR),    04/13/76
      7(RRL(25),TNETCR),(RRL(26),WCOR  ),(RRL(27),ZM1  ),(RRL(28),ERR  ),    04/13/76
      8(RRL(29),CELTAS),(RRL(30),DELTAT),(RRL(31),B1   ),(RRL(32),V1   ),    04/13/76
      S(RRL(33),THETAS),(RRL(34),THETAT),(INTG(1),IOPT ),(INTG(2),IGV  ),    04/13/76
      A(RRL(35),CDR   ),(RRL(36),CDS   ),(RRL(37),ZM3  ),(RRL(38),STLD1),    04/13/76
      B(RRL(39),TROTOR),(RRL(40),SHPDS ),(RRL(41),TGRDS),(RRL(42),PCT  ),    04/13/76
      C(RRL(43),WFDS  ),(RRL(44),CDRDS ),(RRL(45),CDSDS),(RRL(46),TOR  ),    04/13/76
      C(RRL(47),TSDS  )                                                 04/13/76
C                                                                       04/13/76
C
C      DETERMINE  PR,WCCR, TNETCR/SHPCR   -OFF DESIGN B
C      FRCM       DIAM,AR, SHP/TNET  AT MC
C
       DIMENSION  TNETS(25),SHPS(25),WCORS(25)
       DATA WCORS/15.,17.,20.,23.,24.,25.,26.,27.,28.,29.,30.,31.,32.,
      1           33.,34.,35.,36.,37.,38.,39.,40.,41.,42.,43.,44./
C
       A21 =  3.14159/4.*DIAM1*DIAM1*(1.-HOT1**2)
C
       DO 1 I=1,25
 1     CALL GAA123 (ZM1,AR1,WCORS(I),PRS,TNETS(I),SHPS(I),2,J,B,C,D)
C
       IDO = 1
       IF (TNET1 .GT. 0.) IDC = 2
       IF (SHP1  .GT. 0.) IDO = 3
C
       GO TO (10,20,30), IDO
```

```
C
 10   WRITE (NP,11) DIAM1
 11   FORMAT (53H A THRUST OR SHP MUST BE SPECIFIED IF DIAM .GT. 0.0,
     1 ,        24H FOR AN OFF-DESIGN CASE   , E12.4)
C
      ERR = 2.0
      GO TO 50
C
 20   TNETC = TNET1/A21/DELTAS
      CALL UNINT (25,TNETS,WCORS,TNETC,WCOR,LIM)
      CALL GAA123 (ZM1,AR1,WCOR,PR1,TNETCR,SHPCR,2,J,B,C,D)
      GO TO 40
 30   SHPC  = SHP1/A21/DELTAS/SQRT(THETAS)
      CALL UNINT (25,SHPS ,WCORS,SHPC ,WCOR,LIM)
      CALL GAA123 (ZM1,AR1,WCOR,PR1,TNETCR,SHPCR,2,J,B,C,D)
C
 40   IF (PR1 .GE. 1.00 .AND. PR1 .LE. 1.75) RETURN
C
      WRITE (NP,41) PR1,DIAM1
 41   FORMAT(50H PRESSURE RATIO CALC. FOR THIS CASE OUT OF RANGE
     1 , 2E12.4,14H OFF - DESIGN  )
C
      ERR = 1.0
 50   RETURN
      END
      FUNCTION GAAFM (ZM,ZP)
      GAAFM = (1. + ZM*ZM/5.) ** ZP
      RETURN
      END
       SUBROUTINE GAACLK(THETA,TAUB,CLKFAC)
C
C     GAACLK CALLS UNBAR; CALLED BY GAASEC
C     CALCULATE WEINIG  LIFT CURVE SLOPE FACTOR  REF AR1401 FIG.1
C
      DIMENSION WEINIG(240)
      DATA WEINIG/1.,16.,13.,
     10.,.1,.2,.3,.4,.5,.6,.7,.8,.9,1.,1.4,2.,3.,4.,5.,
     215.0,20.0,25.0,30.0,35.0,40.0,45.0,50.0,55.0,60.0,70.0,80.0,90.0,
     30.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,
     4.250,.190,.150,.130,.110,.100,.090,.090,.080,.080,.070,.070,.070,
     5.490,.370,.300,.250,.220,.200,.180,.170,.160,.150,.140,.130,.130,
     6.740,.560,.450,.380,.330,.290,.270,.250,.230,.220,.210,.200,.190,
     7.990,.750,.610,.510,.450,.400,.360,.330,.310,.290,.270,.260,.250,
     81.23,.940,.760,.630,.560,.500,.450,.420,.390,.370,.340,.330,.320,
     91.49,1.12,.910,.760,.670,.590,.540,.500,.460,.440,.410,.390,.380,
     A1.71,1.30,1.05,.890,.780,.680,.630,.570,.530,.510,.470,.450,.440,
     B1.90,1.46,1.18,.990,.860,.760,.700,.640,.600,.570,.530,.500,.490,
     C2.00,1.58,1.28,1.03,.940,.830,.760,.700,.650,.620,.570,.550,.540,
     D2.00,1.64,1.35,1.14,.990,.890,.810,.750,.710,.670,.620,.600,.580,
     E1.45,1.40,1.27,1.16,1.07,1.00,.930,.880,.840,.800,.760,.730,.720,
     F1.22,1.18,1.14,1.10,1.06,1.02,.990,.950,.920,.890,.860,.840,.830,
```

```
      G1.C9,1.07,1.05,1.03,1.C2,1.0C,1.01,.990,.970,.960,.940,.930,.920, 00007030
      H1.04,1.03,1.02,1.02,1.01,1.CC,.SSC,.S90,.980,.980,.970,.970,.96C, 00007040
      J1.00,1.00,1.00,1.0C,1.00,1.00,1.00,1.00,1.00,1.00,1.0C,1.C0,1.00,1.00 /00007050
C                                                                        00007060
       CALL UNBAR(WEINIG,1,TAUR,THETA,CLKFAC,LIMIT)                      00007070
C                                                                        00007080
       RETURN                                                            00007090
       END                                                               00007100
       SUBROUTINE GAA123 (ZMC,PAR,XWCCR,PR,TNETC,SHPCOR,IOPT1,NSTG,XPR,  00007110
      1WCRF,AR)                                                          00007120
C      GAA123 CALLS UNINT & UNBAR; GAAFN1 CALLED BY GAASIC, GAAFN2 CALLED00007130
C      BY GAASID, GAAFN3 CALLED BY GAASIB, GAAFN4 CALLED BY GAAFDS,      00007140
C      GAAFN5 CALLED BY GAAFPM                                           00007150
C                                                                        00007160
C                                                                        00007170     04/13/76
C GAACOM                                                                 00007180     04/13/76
       COMMON /TRANFR/RRL(50),INTG(2)                                    00007190     04/13/76
       EQUIVALENCE                                                       00007200     04/13/76
      1(RRL(01),TNET1 ),(RRL(02),SHP1  ),(RRL(03),PR1   ),(RRL(04),HOT1 ),00007210     04/13/76
      2(RRL(05),VKTAS1),(RRL(06),TS1   ),(RRL(C7),PS01  ),(RRL(08),TS01 ),0000C7220     04/13/76
      3(RRL(09),CIAM1 ),(RRL(1C),FROUM ),(RRL(11),A21   ),(RRL(12),AR1  ),00007230     04/13/76
      4(RRL(13),CX3   ),(RRL(14),DCU   ),(RRL(15),RMP   ),(RRL(16),RMS  ),000C7240     04/13/76
      5(RRL(17),TAUBS ),(RRL(18),TAUBR ),(RRL(19),BETAS),(PRL(20),BETAR),00007250     04/13/76
      6(RRL(21),DCLDAS),(RRL(22),DCLDAR),(RRL(23),WFAN1),(RRL(24),SHPCR),00007260     04/13/76
      7(RRL(25),TNETCR),(RRL(26),WCCR  ),(RRL(27),ZM1   ),(RRL(28),ERR  ),000C7270     04/13/76
      8(RRL(29),DELTAS),(RRL(30),DELTAT),(RRL(31),P1    ),(RRL(32),V1   ),00007280     04/13/76
      9(RRL(33),THETAS),(RRL(34),THETAT),(INTG(1),ICPT ),(INTG(2),IGV  ),00007290     04/13/76
      A(RRL(35),CCR   ),(RRL(36),CDS   ),(RRL(37),ZM3  ),(RRL(38),STLD1),00007300     04/13/76
      B(RRL(39),TROTOR),(RRL(40),SHPDS ),(RRL(41),TGFCS),(RRL(42),PCT  ),00007310     04/13/76
      C(RRL(43),WFDS  ),(RRL(44),CLRDS ),(RRL(45),CDSLS),(RRL(46),TOR  ),0000C7320     04/13/76
      L(RRL(47),TSDS  )                                                  00007330     04/13/76
C                                                                        00007340     04/13/76
C                                                                        00007350
       DIMENSION XETA(15),XPRS(15)                                       00007360
       DIMENSICN ZMTABL(13),CVTABL(13)                                   00007370
       DIMENSION FLD(2C)                                                 00007380
       DIMENSICN WACC(C5),ZMC(50),WAC(5C)                                00007390
       DIMENSICN ZLOD(13),ZKD(13)                                        00007400
       INTEGER OPT                                                       00007410
       DATA XPRS/1.0,1.05,1.1,1.15,1.2,1.25,1.3,1.35,1.4,1.45,1.5,1.55   00007420
      1,1.6,1.65,1.7/                                                    00007430
       CATA XETA/.872,.876,.880,.883,.886,.888,.890,.889,.884,.867,.851  00007440
      1,.839,.830,.82C,.816/                                             00007450
       CATA ZMTABL/0.,.1,.2,.3,.4,.5,.6,.7,.8,.9,1.,1.1,1.2/             00007460
       CATA CVTABL/1.,.984,.9815,.982C,.9830,.9845,.9863,.9883,.9902,    00007470
      1          .9924,.9944,.9957,.9950/                                00007480
       DATA ZLOD /.5,.55,.6C,.65,.7C,.75,.8C,.85,.90,.95,1.C,1.05,1.1C/  00007490
       CATA ZKD  /2.64,2.27,1.98,1.75,1.57,1.43,1.31,1.22,1.14,1.08,1.04500007500
      1,1.02,1.0 /                                                       00007510
       DATA WACC/1.,8.,6.,0.,10.,20.,25.,30.,35.,4C.,45.,                00007520
      10.,.025,.05,.1,.15,.20,                                           00007530
```

```
 21.,1.,1.,1.,1.,1.,
 3.99950,.99975,.99975,.99980,.99985,.99990,
 4.99830,.99850,.99910,.9994C,.99950,.99960,
 5.99735,.99820,.99865,.9991C,.99920,.99930,
 6.99605,.99720,.99795,.99870,.9988C,.99900,
 7.99425,.99600,.99710,.9982C,.99840,.99860,
 8.99200,.99440,.99600,.99750,.9978C,.99810,
 9.98980,.99260,.99460,.99670,.99700,.99740    /
      DATA ICT/0/
      DATA FLOND,FMAX,XO/1.24,1.18,.46C/
      AR = PAR
      PR=XPR
      WCRF = XWCCR
      KNT=2
      OPT = IOPT1
      KNT=1
      DEF = 0.
      IF (IOPT1 .EQ. 4) DEF = (NSTG-1)/100.
      IF (IOPT1 .EQ. 4) OPT = 3
      IF (IOPT1 .EQ. 5) DEF = (NSTG-1)/10C.
      IF (IOPT1 .EQ. 5) OPT = 2
      IF (IOPT1 .EQ. 4) PCT = 1.C00
      QK1=0.
      ETAX = 0.0
      QCV=0.
       CK2 = 0.0
      ZK1=1.0
      ZK2=1.0
      ZKP=1.0
      CVS=1.0
      DXTCOR = 0.
    8 CCNTINUE
      ZMM=1.+ZMO**2/5.
      PSOPTO= ZMM**(-3.5)
      BPR = 9999.
      GC TO (300,400,450), CFT
  300  CCNTINUE
      PSEPTE= PSOPTC*ZKP/(ZK1*ZK2*PR)
      ZME = 5./(PSEPTE)**.286 -5.
      IF (ZME.LE.0.) GO TO 11
      ZME=SQRT(ZME)
      CALL UNINT (13,ZMTABL,CVTABL,ZME,CVS,LIMIT)
      IF(QCV.NE.0.)CVS=QCV
      IF (KNT.EQ.1) CVS=1.0
      WCRF =(BPR+1.)/BPR*AR*85.4*ZK2*ZME/(ZMM**3*(ZK1*ZK2/ZKP)**.858)
      IF (ZME.GE.1.0) WCRF=49.421*ZK2*PR**(6./7.)*(BPR+1.)/BPR*AR
      GC TO 500
  400 CCNTINUE
      ZME = WCRF *(ZMM**3)*(ZK1*ZK2/ZKP)**.858*BPR/((1.+BPR)*AR*85.4
     1 *ZK2)
      IF ( ZME. LE. 0. ) GC TO 11
```

```
      PSEPTE = (1.+ZME**2/5.)** (-3.5)                                   11/14/75
      PR = PSOPTO*ZKP/(ZK1*ZK2*PSEPTE)
      IF ( ZME .GT. 1. ) PR = (WCRF*BPR/((1.+BPR)*AR*49.421*ZK2))**
     1 (7./6.)
      CALL UNINT (13,ZMTABL,CVTABL,ZME,CVS,LIMIT)
      IF (QCV.NE.0.) CVS = QCV
      IF (KNT .EQ.1 ) CVS = 1.
      GC TC 500
  450 CCNTINUE
      PSEPTE = PSOPTO * ZKP/(ZK1*ZK2*PR)
      ZME = 5./(PSEPTE)**.286-5.
      IF (ZME .LE. C.) GO TO 11
      ZME = SQRT(ZME)
      CALL UNINT(13,ZMTABL,CVTABL,ZME,CVS,LIMIT)
      IF (KNT.EQ.1)CVS=1.0
      AR = WCRF*(ZMM**3*(ZK1*ZK2/ZKP)**.858)*(BPR/(BPR+1.0))/
     2     (85.4*ZK2*ZME)
      IF (ZME .GE. 1.)
     2AR =WCRF*(BPR/(BPR+1.))/(49.421*ZK2*PR**(6./7.))
      GO TO 500
  5CC  CCNTINUE
      CALL UNINT (15,XPRS,XETA,PR,ETA,LIMIT)
      ETA = PCT * ETA
      ETA = ETA - DEF
      IF ( ETAX .GT. 0. ) ETA = ETAX
      SHPCOR=WCRF*.24*778./550.*(PR**.286-1.)/ETA*518.7
      TR=(PR**.286-1.)/ETA+1.
      TCOR=WCRF/32.2*49.02*SQRT(518.7)*(ZME*SQRT(TR/(1.+ZME**2/5.))*CVS
     1      -ZMO/SQRT(ZMM))
C CCRRECT TO STATIC AMBIENT CCNDITIONS
      SHPCOR=SHPCOR*ZK1*ZMM**4
      TCOR=TCOR*ZK1*ZMM**3.5*BPR/(BPR+1.)                                11/14/75
      TNETC = TCOR - CXTCOR
      IF (KNT.EQ.1) GO TO 600
  600 CONTINUE
      ETNET = 0.0
      IF (SHPCOR.LE.0.0 ) GO TO 9891
      ETNET = 2.03*TNETC*ZMC/SHPCOR
 9891 CCNTINUE
      IF (KNT.EQ.2) GO TO 7
C THIS SECTION CALC.'S THE INSTALLED EFFECTS
      CALL UNBAR (WACC,1,WCRF,ZMO,ZK1,LIMIT)
      IF (QK1 .NE. 0. ) ZK1 = QK1
      CSEPTE= .7*ZME**2*PSEPTE
      IF (ICT.NE.0) GO TO 5
      ICT=1
      ZM=0.
      DZM=.025
      DC 6 I=1,41
      WAC(I)=85.4*ZM/(1.+ZM**2/5.)**3
      ZMC(I)=ZM
```

```
    6 ZM=ZM+DZM
    5 CCNTINUE
      CALL UNINT(40,WAC,ZMC,WCRF,ZM2,LIM)
      PS2PT2= (1.+ ZM2**2/5.)**(-3.5)
      CALL GAAINL (ZK1,PS2PT2,ZM2)
      PS2PTE= PS2PT2/(ZK2*PR)
      QS2PTE= .7*ZM2**2*PS2PTE
      CALL UNINT (15,ZLOC,ZKC,FLCND,WKD,LIMIT)
      WKD = 1.0
      ZK2=1.-4.*WKD*(QS2PTE+QSEPTE)*FMAX**2*FLCNC*.002/(1.-XO**2)/(1.+AR
     1 )
      CALL GAAEXL (ZK2,QS2FTF,QSEPTE)
      IF (ZK2 .NE. 0. ) ZK2 = ZK2
      DXTCUR = 29.62*WKD*ZMC**2*FLCNC*FMAX**2/(1.-XC**2)
      KNT=KNT+1
      GO TO 8
    7 CCNTINUE
   11 RETURN
      END
      SUBROUTINE GAAINL(ZK1,PS2PT2,ZM2)
      DIMENSICN  ZKSCN(5),ZMSON(5)
      CATA  ZMSON/.5,.7,.8,.9,1.C/
      CATA  ZKSCN/1.00,.994,.992,.988,.982/
C     DP IS  DP/G
C     DWDDI(1) ANC DWDDE(1) MUST BE H/T
      CCMMCN /PTREAT/NCWALI,CWDCI(2),ZLWDI(2),NCRINI,DRDDI(5),ZLRDDI(5),
     1                NOWALE,CWDDE(2),ZLWDE(2),NCPINE,CRDCE(5),ZLRDDE(5),
     2                ZTREAT,ZMTHR
      DP = 0.
      DP1= 0
      ZKS= 1.
C
      IF (ZTREAT .LE. 0.) RETURN
C
      IF (ZMTHR .LT. .5) GO TO   8
C
      CALL UNINT(4,ZMSCN,ZKSCN,ZMTHR,ZKS  ,LIM)
    8 CCNTINUE
C
      IF (NCWALI.EG. 0) GO TO 2CC
      DC 10 I=1,NCWALI
   10 DF = DP + DWCCI(I)**2*ZLWDI(I)/(1.-DWCCI(1)**2)*.004                 11/14/75
C
      IF (NORINI.EQ.0 ) GO TO 200
C
      CO 110 I=1,NORINI
  11C DP1 = DP1 + DRDDI(I)**2 * ZLRDCI(I)/(1.-DWDDI(1)**2)*.036            11/14/75
C
  20C DPT = DP + CP1
      ZZ  = .7 * DPT * (PS2PT2) * ZM2 **2
      ZK1 = 1.-  ( ZZ + 1.-ZK1 + 1.-ZKS)                                    11/14/75
```

```
 1000 RETURN
      END
      SUBROUTINE GAAEXL (ZK2,QS2PTE,QSEPTE)
C
C     DP IS DP/Q
C     DWDDE(1) MUST BE H/T
C
      COMMON /PTREAT/NOWALI,DWDDI(2),ZLWDI(2),NORINI,DRDDI(5),ZLRDDI(5),
     1              NOWALE,DWDDE(2),ZLWDE(2),NORINE,DRDDE(5),ZLRDDE(5)
     1     ,ZTREAT,ZMTHR
C
      DP = 0.
      DP1= 0.
      IF (ZTREAT .EQ. 0.) RETURN
C
      IF (NOWALE .EQ. 0 ) RETURN
C
      DO 10 I=1,NOWALE
   10 DP = DP + DWDDE(I)**2 * ZLWDE(I)/(1.-DWDDE(1)**2)* .C04          11/14/75
C
      IF (NORINE .EQ. 0) GO TO 200
C
      DO 110 I=1,NORINE
  110 DP1 = DP1 + DRDDE(I)**2 * ZLRDDE(I)/(1.-DWDDE(1)**2)*.036        11/14/75
C
  200 DPT = DP + DP1
C
      ZZ  = DPT/2.*(QS2PTE + QSEPTE)
C                                                                      11/14/75
      ZK2 = 1.-  ( ZZ + 1.-ZK2)
      RETURN
      END
```

Function VMACH

This function calculates the Mach number corresponding to a given corrected airflow per unit area.

```
DESCRIPTION          VMACH - M FOR WC/A

MASTER FILE          LIBR.GC4
ADDED TC MASTER      08/14/75
LAST DATE COPIED       NONE
LAST UPDATE          04/14/76  1653          *** TEMPORARY UPDATE ***

PASSWORD             NRMT
PROGRAMMER           F.W.BARRY
PROC PARAMETER       $NOJCL

      FUNCTION VMACH(WC)
C     MACH NUMBER CORRESPONDING TO CORRECTED AIR FLOW / AREA
C     VMACH CALLS EXIT; CALLED BY GAAVPF.
      COMMON /DATA/ ANGLE(15),BCFR(30),AR,NP
      DIMENSION VM(11), WCT(11), WCD(10)
      DATA VM / 0.,.1,.2,.3,.4,.5,.6,.7,.8,.9,1./
      DATA WCT / 0.,8.48695,16.67259,24.2791,31.0725,36.8771,41.5836,45.
     11486,47.5901,48.9754,49.4095 /
      DATA WCD / 84.8695,81.8564,76.0650,67.9334,58.0463,47.0645,35.6519
     1,24.4143,13.8531,4.3406 /
C     CHECK WC LEGAL
      IF (WC.GE.0. .AND. WC.LE.WCT(11)) GO TO 20
      WRITE (NP,10) WC
   10 FORMAT (14H0ILLEGAL WC OF,E15.4)
      CALL EXIT
   20 N      = 10
   30 IF (WCT(N)-WC) 70,40,60
   40 VMACH  = VM(N)
   50 RETURN
   60 N      = N - 1
      GO TO 30
   70 VMACH  = VM(N) + (WC-WCT(N)) / WCD(N)                                  08/20/75
   80 X      = 1. + .2*VMACH**2
      DM     = (WC - 85.3797*VMACH/X**3) + VMACH*X/(WC*(1.-VMACH**2))
      VMACH  = VMACH + DM
      IF (ABS(DM) .LE. .01) GO TO 50
      GO TO 80
      END
```

COPY AVAILABLE TO DDC DOES NOT PERMIT FULLY LEGIBLE PRODUCTION

Subroutine TREAT

This subroutine accepts inputs of duct treatment lengths and flow splitter configurations and optimizes the tuning to minimize a fan sideline PNLT then calculates the treated fan noise levels.

```
RUN NC. 5717     DATE  04/14/76     TIME  1653          LISTING CF MODULE H334T                                   PAGE   1

DESCRIPTICN          TREAT - NOISE SUPPRESSICN

MASTER FILE          LIBR.G04
ADDED TO MASTER      C3/16/75
LAST CATE CCPIED       NONE
LAST UPCATE          04/14/76  1653          *** TEMPCRARY UPCATE ***

PASSWORD             JJGV
PRCGRAMMER           F.W.BARRY
PRCC PARAMETER       $NOJCL

      SUBRCUTINE TREAT (RPWL,SPWL,VLI,VLM,VLE,H,CM,IT,CCF,SPL,DI,DE,SI,                      09/09/75
     1SE)                                                                                    09/09/75
C     APPLIES NOISE SUPPRESSICN TREATMENT EFFECTS TO MINIMIZE PNLT
C     TREAT CALLS BIQUAC, NOYS, TCNE, FALC; CALLEC BY SHRP, VPFAN,
C     FPFAN, VPLFAN, FPLFAN                                                                  03/18/76
C     RPWL    ROTOR PWL , DB , OR FIXEC-PITCH FAN INLET PWL
C     SPWL    STATOR PWL , DB , CR FIXEC-PITCH FAN EXHAUST PWL
C     VLI     INLET TREATMENT LENGTH , FT
C     VLM     MIC TREATMENT LENGTH , FT , 0. FOR FIXEC-PITCH FANS
C     VLE     EXIT TREATMENT LENGTH , FT
C     H       DISTANCE BETWEEN TREATED SURFACES , FT
C     CM      MEAN DUCT MACH NUMBER                                                          08/20/75
C     IT      TREATMENT CONFIGURATION
C             = 2 FANS WITH OGV'S                                                            09/09/75
C             = 3 FANS WITH IGV'S , RCTCR CNLY                                               11/10/75
C             = 4 F-P FANS                                                                   09/09/75
C     DCF     DEGREES OF FREEDCM , =1. OR 2.
C     SPL     TREATED SPL , DB
C     DI      FAN INLET DIRECTIVITY INDEX
C     DE      FAN EXIT DIRECTIVITY INDEX
C     SI      NUMBER CF SPLITTERS IN FAN INLET                                               09/09/75
C     SE      NUMBER CF SPLITTERS IN FAN EXIT                                                09/09/75
      COMMON /DATA/ ANGLE(15),BCFR(30),NR,NP,C,HCL(20),DATE(2),TIME(2),
     1 ATTNT(30),SPLT(15,30),SPLTU(15,30),CENU(7),XC(15),XD(15),ZC(15),
     2 PSI(15),DO(15),DDO(15),HPT,TR,VELFL,VM(15),PWLT(15,30),
     3 CIRIN(498),DIREX(498),BLF(31),CPWSP(15)
      CCMMCN /DATAI/CA(2C0)
      CIMENSICN RPWL(30),SPWL(30),SPL(15,30),F31(29),F32(29),F4IT(33),
     1 F4ET(33),TE(15),TI(15),DI(15,30),DE(15,3C),ZNOY(24),CCFA(122)
     2 ,SPLZ(24),CCF1(125),CFII(5),CFIM(5),CFIE(5),CCFB(3)                                   10/23/75
      EQUIVALENCE ( CCF1(1),CCFA(1)),(CCF1(123),CCFB(1))                                     08/25/75
      DATA F31 / 1.,.9,.7,.52,.38,.28,.21,.16,.13,.11,.09,.07,.05,.03,.0
     11,14*0. /
      CATA F32 / 1.,.S,.7,.62,.67,.54,.42,.34,.28,.22,.17,.12,.07,.02,15
     100./                                                                                   08/20/75
      CATA F4IT / 1.,15.,0.,0.,10.,20.,30.,4C.,5C.,6C.,7C.,80.,90.,100.,C
     1110.,120.,130.,180.,.58,.67,.76,.85,.93,.99,.SS,.96,.89,.80,5*.68/
      DATA F4ET / 2.,15.,0.,0.,50.,6C.,7C.,8C.,9C.,1CC.,110.,120.,13C.,1
     140.,150.,160.,170.,180.,5*.7,.78,.89,.97,1.,.96,.86,.74,.56,.39,.2
```

```
      22 /
      DATA CCFA/1.15487,.00615676,-.00504648,.865953E-3,-.432048E-4,-.33000
     13536,-.0190651,.0164053,-.00280704,1.39983E-4, .116821,-.00636249,.000
     2-.010205,.00211038,-1.13803E-4, -.0215635,-.00126296,.00360271,-7.0
     34.48372E-4,3.16552E-5, .00152097,4.49819E-4,-4.29553E-4,8.91763E-5,-3
     45.1361E-6, 1.15688,-.0162049,.00836379,-.00132091,.639796E-4, -.20
     559409,.0292555,-.0153114,.00238743,-1.13367E-4, .0876125,-.0412761
     6,.0142795,-.0019613,6.77321E-5, -.0152659,.0104262,-.00376196,5.05
     71E-4,-2.20175E-5, 9.52573E-4,-7.55582E-4,2.83834E-4,-3.76823E-5,1.C
     861659E-6, 1.15873,.0311246,-.00826021,9.19582E-4,-3.65148E-5, -.193
     96642,-.0760477,.018487,-.00194653,7.4933E-5, .0432187,.0176535,-.00
     AC487051,4.77541E-4,-1.60978E-5, -.00494031,-.00175911,4.82045E-4,-CC
     84.27698E-5,1.14147E-6, 2.06031E-4,6.44768E-5,-1.71747E-5,1.34144E-[illegible]
     C6,-2.60051E-8, 1.31463,.00561494,.00208003,-3.96070E-4,1.43069E-5,
     D -.283553,-.0642441,.0283185,-.00675865,5.74818E-4, .0714101,-.001
     E52993,.00297462,-5.7756E-4,2.59547E-5, -.00841401,6.31066E-4,-4.[illegible]
     F465E-4,8.4695E-5,-4.4463E-6, 3.5465E-4,-1.32075E-5,2.05922E-5,-3.7[illegible]
     G4337E-6,1.99502E-7, 1.25055,.0225245,-.00495113,5.50547E-4,-2.2518[illegible]
     H7E-5, -.159543,-.0543211,.0112229,-.00116274,4.47483E-5, .0185622,.00[illegible]
     I.010741,-.00355647,4.10137E-4,-1.59481E-5, -6.9163E-4,-.00122745,5.[illegible]
     J.32762E-4,-6.44258E-5,2.55089E-6, -1.26269E-5,5.56556E-5 /
      DATA CCFB / -2.65541E-5,3.[illegible]-6,-1.34715E-7 /
      IF (VLI .LE. 0.) GO TO 90
      HI=H/(SI+1.)
      HCCI=HI/C
      IF (HI .GT. .833333) GO TO 10
      L=0
      A=2.-HI/.416667
      GO TO 40
   10 IF (HI .GT. 1.666667) GO TO 20
      L=1
      A=2.-HI/.833333
      GO TO 40
   20 IF (HI .GT. 2.5) GO TO 30
      L=2
      A=3.-HI/.833333
      GO TO 40
   30 L=3
      A=4.-HI/.833333
   40 B=1.-A
      ELOHI    = (.6*SI+.75) * VLI / H
      IF (ELOHI - 10.) 60,50,50
   50 PAI      = 20. + 1.25* ELOHI
      GO TO 70
   60 PAI      = (((.100452-.00337148*ELOHI)*ELOHI-1.23581)*ELOHI+8.91906
     1)*ELOHI+.110921
   70 L        = 25*L - 4
      DO 80 I=1,5
      J        = L + 5*I
   80 CFI1(I) = A*((((CCF1(J+4)*ELOHI+CCF1(J+3))*ELOHI+CCF1(J+2))*ELOHI+
     1CCF1(J+1))*ELOHI+CCF1(J)) + B*((((CCF1(J+29)*ELOHI+CCF1(J+28))*EL
```

```
      2HI+CCF1(J+27))*ELCHI+CCF1(J+26))*ELCHI+CCF1(J+25))                00000920
   90 IF (VLM .LE. 0.) GO TO 140                                          00000930
      HOCM=H/C                                                            00000940    03/15/76
      IF (H .GT. .833333) GO TO 92                                        00000950    03/15/76
      L=0                                                                 00000960    03/15/76
      A=2.-H/.416667                                                      00000970    03/15/76
      GO TO 98                                                            00000980    03/15/76
   92 IF (H .GT. 1.666667) GO TO 94                                       00000990    03/15/76
      L=1                                                                 00001000    03/15/76
      A=2.-H/.833333                                                      00001010    03/15/76
      GO TO 98                                                            00001020    03/15/76
   94 IF (H .GT. 2.5) GO TO 96                                            00001030    03/15/76
      L=2                                                                 00001040    03/15/76
      A=3.-H/.833333                                                      00001050    03/15/76
      GO TO 98                                                            00001060    03/15/76
   96 L=3                                                                 00001070    03/15/76
      A=4.-H/.833333                                                      00001080    03/15/76
   98 B=1.-A                                                              00001090    03/15/76
      ELOHM    = .75 * VLM / H                                            00001100
      IF (ELOHM - 10.) 110,100,100                                        00001110
  100 PAM      = 20. + 1.25* ELOHM                                        00001120
      GO TO 120                                                           00001130
  110 PAM      = (((.100452-.00337148*ELOHM)*ELOHM-1.23581)*ELOHM+8.9190600001140
     1)*ELOHM+.110921                                                     00001150
  120 L=25*L-4                                                            00001160    03/15/76
      DO 130 I=1,5                                                        00001170    03/15/76
      J        = L + 5*I                                                  00001180
  130 CFIM(I) = A*((((CCF1(J+4)*ELOHM+CCF1(J+3))*ELOHM+CCF1(J+2))*ELOHM+00001190
     1CCF1(J+1))*ELOHM+CCF1(J)) + B*((((CCF1(J+29)*ELOHM+CCF1(J+28))*EL000001200
     2HM+CCF1(J+27))*ELOHM+CCF1(J+26))*ELOHM+CCF1(J+25))                  00001210
C     CHANGE IN MID-TREATMENT TUNING FREQUENCY 1/3-O.B. NUMBER DUE TO VM00001220
      IFMDS=0                                                             00001230    03/15/76
      IF (QM .GT. .19) IFMDS=1                                            00001240    03/15/76
      IF (QM .GT. .51) IFMDS=2                                            00001250    03/15/76
      IF (QM .GT. .77) IFMDS=3                                            00001260    03/15/76
      IFMDR=0                                                             00001270    03/15/76
      IF (QM .GT. .21) IFMDR=1                                            00001280    03/15/76
      IF (QM .GT. .72) IFMDR=2                                            00001290    03/15/76
  140 IF (VLE .LE. 0.) GO TO 190                                          00001300
      HE=H/(SE+1.)                                                        00001310    03/15/76
      HOCE=HE/C                                                           00001320    03/15/76
      IF (HE .GT. .833333) GO TO 142                                      00001330    03/15/76
      L=0                                                                 00001340    03/15/76
      A=2.-HE/.416667                                                     00001350    03/15/76
      GO TO 148                                                           00001360    03/15/76
  142 IF (HE .GT. 1.666667) GO TO 144                                     00001370    03/15/76
      L=1                                                                 00001380    03/15/76
      A=2.-HE/.833333                                                     00001390    03/15/76
      GO TO 148                                                           00001400    03/15/76
  144 IF (HE .GT. 2.5) GO TO 146                                          00001410    03/15/76
      L=2                                                                 00001420    03/15/76
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      A=3.-HE/.833333                                                   03/15/76
      GC TO 148                                                         03/15/76
  146 L=3                                                               03/15/76
      A=4.-HE/.333333                                                   03/15/76
  148 B=1.-A                                                            03/15/76
      ELCHE    = (.6*SE+.75) * VLE / F                                  10/04/75
      IF (ELOHE - 10.) 160,150,15C
  150 PAE      = 20. + 1.25* ELOHE
      GC TO 170
  160 PAE      = (((.100452-.C0337148*ELOHE)*ELOHE-1.23581)*ELOHE+8.91906
     1)*ELOHE+.110921
  170 L=25*L-4                                                          03/15/76
      DC 190 I=1,5                                                      03/15/76
      J        = L + 5*I
  180 CFIE(I) = A*((((CCF1(J+4)*ELOHE+CCF1(J+3))*ELOHE+CCF1(J+2))*ELOHE+  08/22/75
     1CCF1(J+1))*ELOHE+CCF1(J)) + B*((((CCF1(J+29)*ELOHE+CCF1(J+28))*EL
     2HE+CCF1(J+27))*ELOHE+CCF1(J+26))*ELCHE+CCF1(J+25))
  190 CO 200 IA=1,15
      CALL BIQUAD (F4IT,1,PSI(IA),0.,TI(IA),I)
      CALL BIQUAD (F4ET,1,PSI(IA),0.,TE(IA),I)
  2C0 CCNTINUE
      F2A      = (((.12o123*QM-.E57657)*QM+.242874)*QM-.0348804)*QM+1.  08/20/75
      IAR      = 8                                                      03/18/76
      PNLTM    = -10C.                                                  03/18/76
      DG 240 IA=1,IAR
      PNL      = 0.
      ZNOYMX   = 0.
      DO 230 IF=1,24
      SPLZ(IF)= 10.**((RPWL(IF+3) + DE(IA,IF)) / 10.) + 10.**((RPWL(IF+3
     1) + PI(IA,IF)) / 10.)
      SPLZ(IF) = 10.*ALOGIC(SPLZ(IF))     -CPWSP(IA)-ATTAT(IF+3)*ZO(IA)
      CALL NOYS (SPLZ,IF,ZNCY)
      PAL      = PNL + ZNOY(IF)
      IF (ZNOY(IF) .LT. ZNCYPX) GO TC 230
      IFR      = IF
      ZNCYMX   = ZNOY(IF)
  230 CONTINUE
      PNLT     = 4G. + 33.3*ALOG10(.85*ZNOYMX+.15*PNL) + TONE(SPLZ)
      IF (PNLT .LT. PALTM) GO TO 240
      PNLTM    = PNLT
      IFRR     = IFR + 3
  240 CCNTINUE                                                          03/18/76
      PKLTM    = -100.
      DO 290 IA=8,15
      PAL      = 0.
      ZNOYMX   = 0.
      DC 280 IF=1,24
      IF (IT .EC. 3) GO TO 260
      SPLZ(IF) = 10.**((SPWL(IF+3)+DE(IA,IF))/10.)+ 10.**((SPWL(IF+3)+DI
     1(IA,IF))/10.)
      GO TO 270
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  26C SPLZ(IF) = 10.**((RPWL(IF+3)+DE(IA,IF))/1C.)+ 10.**((RPWL(IF+3)+DIC
     1(IA,IF))/10.)
  270 SPLZ(IF) = 10.*ALOG10(SPLZ(IF))     -DPWSP(IA)-ATTNT(IF+3)*ZO(IA)
      CALL NOYS (SPLZ,IF,ZNCY)
      PNL      = PNL + ZNCY(IF)
      IF (ZNOY(IF) .LT. ZNOYMX) GC TC 28C
      IFR      = IF
      ZNCYMX   = ZNOY(IF)
  28C CCNTINUE
      PNLT     = 40. + 33.3*ALOG10(.85*ZNOYMX+.15*PNL) + TCNE(SPLZ)
      IF (PNLT .LT. PNLTM) GC TC 290
      PNLTM    = PNLT
      IFSR     = IFR + 3
  29C CCNTINUE
      IF (IFRR .GT. IFSR) GO TO 320                                  10/28/75
      IF1      = MAXO(14,IFRR-2)
      IF2      = MINO(27,MAXO(IFSR,IFRR+2))
      IF3      = MAXO(14,MINO(IFRR,IFSR-2))
      IF4      = MINO(27,IFSR+2)
      IF5      = IF1
      IF6      = IF4
      GO TO 330
  320 IF1      = MAXO(14,MINO(IFSR,IFRR-2))
      IF2      = MINO(27,IFRR+2)
      IF3      = MAXO(14,IFSR-2)
      IF4      = MINO(27,MAXO(IFRR,IFSR+2))
      IF5      = IF3
      IF6      = IF2
C     TUNING FREQUENCIES OF INLET TREATMENT = BCFR(IF1) TO BCFR(IF2) HZ
C     TUNING FREQUENCIES OF MID TREATMENT = BCFR(IF5) TO BCFR(IF6) HZ
C     LESS IFMOS 1/3-OCTAVE BANDS FOR STATOR (OGV) NOISE AND PLUS IFMOR  03/15/76
C     1/3-OCTAVE BANDS FOR ROTOR NOISE
C     TUNING FREQUENCIES OF EXHAUST TREATMENT = BCFR(IF3) TO BCFR(IF4)
  330 PNLTMM   = 100C.
      IF (VLI .LE. 0.) IF1 = 1                                       10/28/75
      IF (VLI .LE. C.) IF2 = 1                                       10/28/75
      DO 570 IFI=IF1,IF2
      IF (VLI .LE. 0.) GO TO 350                                     10/28/75
      X1       =HOCI*BCFR(IFI)                                       03/15/76
      ATPI     = .97C470 + .29524/X1                                 11/13/75
      IF (OM .LT. .1)  ATPI = 1.+OM*(ATPI -1.)*10.                   08/25/75
      ATPI     = PAI * ATPI   * ((((CFII(5)*X1+CFII(4))*X1+CFII(3))*X1+CF
     1I(2))*X1+CFII(1))
  350 IF (VLM .LE. C.) IF5 = 1                                       10/28/75
      IF (VLM .LE. 0.) IF6 = 1                                       10/28/75
      DO 550 IFM=IF5,IF6
      IF (VLM .LE. 0.) GC TO 36C                                     10/28/75
      X1       =HCCM*BCFR(IFM)*(1.-.5695*OM)                         03/15/76
      ATPMI    = .57C476 + .29524/X1                                 11/13/75
      IF (OM .LT. .1) ATPMI = 1.+OM*(ATPMI-1.)*10.                   08/20/75
      ATPMI    = PAM * ATPMI  * ((((CF1M(5)*X1+CF1M(4))*X1+CF1M(3))*X1+CF1
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     1M(2))*X1+CF1M(1))
      X1        =HOCM*BCFR(IFM)*(1.+.5695*QM)                                03/15/76
      ATFME     = PAM * ((((CF1M(5)*X1+CF1M(4))*X1+CF1M(3))*X1+CF1M(2))*X1
     1+CF1M(1)) * (F2A +((((4.23741E-3-1.85459E-4*X1)*X1-.0336187)*X1+.1
     2167451*X1-.0959504)*QM)                                                08/20/75
  360 IF (VLE .LE. 0.) IF3 = 1                                               10/28/75
      IF (VLE .LE. 0.) IF4 = 1                                               10/28/75
      DO 530 IFE=IF3,IF4
      IF (VLE .LE. 0.) GO TO 370                                             10/28/75
      X1        =HOCE*BCFR(IFE)                                              03/15/76
      ATPE      = PAE * ((((CF1E(5)*X1+CF1E(4))*X1+CF1E(3))*X1+CF1E(2))*X1   08/25/75
     1+CF1E(1)) * (F2A +((((4.23741E-3-1.85459E-4*X1)*X1-.0336187)*X1+.10
     2167451*X1-.0599934)*QM)                                                08/25/75
C     START LOOP OVER 15 AZIMUTH ANGLES
  370 DO 510 IA=1,15
      PNLTM     = -100.
      FNL       = 0.
      ZNCYPX    = 0.
      DO 500 IF=1,24
      X2        = RPWL(IF+3) + DE(IA,IF+3)
      X4        = RPWL(IF+3) + DI(IA,IF+3)
      IF (IT .EQ. 3) GO TO 380                                               03/18/76
      X1        = SPWL(IF+3) + CE(IA,IF+3)
      X3        = SPWL(IF+3) + CI(IA,IF+3)
  380 IF (VLI .LE. 0.) GO TO 410
      IF (DOF.EQ.2. .AND. IF+3.GT.IFI) GO TO 390
      F3        = F31(IABS(IF+3-IFI)+1)
      GO TO 400
  390 F3        = F32(IF+4-IFI)
  400 F3        = F3 * ATPI * TI(IA)
      X4        = X4 - F3
      IF (IT .NE. 3) X3 = X3 - F3                                            03/18/76
  410 IF (VLE .LE. 0.) GO TO 440
      IF (DOF.EQ.2. .AND. IF+3.GT.IFE) GO TO 420
      F3        = F31(IABS(IF+3-IFE)+1)
      GO TO 430
  420 F3        = F32(IF+4-IFE)
  430 F3        = F3 * ATPE * TE(IA)
      X2        = X2 - F3
      IF (IT .NE. 3) X1 = X1 - F3                                            03/18/76
  440 IF (VLM .LE. 0.) GO TO 490
      IF (DOF.EQ.2. .AND. IF+3.GT.MINO(30,IFM+IFMDR)) GO TO 450              03/15/76
      F3        =F31(IABS(IF+3-MINO(30,IFM+IFMDR))+1)                        03/15/76
      GO TO 460
  450 F3        =F32(IF+4-MINO(30,IFM+IFMDR))                                03/15/76
  460 X2        = X2 - F3 * ATPME * TE(IA)
      IF (IT .EQ. 3) GO TO 490                                               03/18/76
      IF (DOF.EQ.2. .AND. IF+3.GT.IFM-IFMDS) GO TO 470                       03/15/76
      F3        =F31(IABS(IF+3-MAXO(1,IFM-IFMDS))+1)                         03/15/76
      GO TO 480
  470 F3        =F32(IF+4-MAXO(1,IFM-IFMDS))                                 03/15/76
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480 X3       = X3 - F3 * ATPMI * TI(IA)
490 X2       = 10.**(X2/10.) + 1C.**(X4/10.)
    IF (IT .NE. 3) X2 = X2 + 10.**(X1/10.) + 1C.**(X3/10.)              03/18/76
    SPLZ(IF) = 10.*ALOG10(X2) - DPWSP(IA) - ATTNT(IF+3)*ZO(IA)
    CALL NCYS (SPLZ,IF,ZNCY)
    PNL      = PNL + ZNCY(IF)
5CC ZNCYMX   = AMAX1(ZNOYMX,ZNOY(IF))                                      10/23/75
    PNLT     = 40. + 33.3*ALOG10(.85*ZNOYMX+.15*PNL) + TCNE(SPLZ)
510 PNLTM    =AMAX1(PNLTM,PNLT)                                            03/15/76
C   ENC OF AZIMUTH ANGLE LOOP
    IF (PNLTM .GE. PNLTMM) GO TC 530                                       10/23/75
    IFTI     = IFI
    IFTM     = IFM
    IFTE     = IFE
    PNLTMM   = PNLTM
    CTPI     = ATPI
    OTPE     = ATPE
    OTPMI    = ATPMI
    CTPME    = ATPME
530 CONTINUE
550 CCNTINUE
570 CCNTINUE
C   NOW HAVE OPTIMUM TUNING FREQUENCIES , IFTI,IFTM&IFTE
    DO 750 IF=1,30                                                         10/28/75
    IF (VLI .LE. 0.) GC TC 610
    IF (DCF.EC.2. ANC. IF.GT.IFTI) GO TO 59C
    F1       = F31(IABS(IF-IFTI)+1)
    GO TO 600
59C F1       = F32(IF+1-IFTI)
6CC F1       = F1 * OTPI
61C IF (VLE .LE. 0.) GC TC 640
    IF (COF.EQ.2. .ANC. IF.GT.IFTE) GO TO 620
    F2       = F31(IABS(IF-IFTE)+1)
    GO TO 630
62C F2       = F32(IF+1-IFTE)
630 F2       = F2 * OTPE
640 IF (VLM .LE. 0.) GO TO 690
    IF (DOF.EQ.2. .ANC. IF.GT.MINO(30,IFTM+IFMDR)) GO TO 650              03/15/76
    F3       =F31(IABS(IF-MINO(30,IFTM+IFMDR))+1)                          03/15/76
    GO TO 660
65C F3       =F32(IF+1-MINO(30,IFTM+IFMDR))                                03/15/76
66C F3       = F3 * OTPME
    IF (IT .EQ. 3) GC TC 690                                               03/13/76
    IF (DCF.EQ.2. .ANC. IF.GT.IFTM-IFMDS) GO TO 670                        03/15/76
    F4       =F31(IABS(IF-MAXO(1,IFTM-IFMDS))+1)                           03/15/76
    GC TO 690
67C F4       =F32(IF+1-MAXC(1,IFTM-IFMDS))                                 03/15/76
68C F4       = F4 * OTPMI
69C DO 740 IA=1,15
    X2       = RPWL(IF) + CE(IA,IF)
    X4       = RPWL(IF) + CI(IA,IF)
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      IF (IT .EQ. 3) GO TO 700                                          00003470        03/18/76
      X1       = SPWL(IF) + DE(IA,IF)                                   00003480
      X3       = SPWL(IF) + DI(IA,IF)                                   00003490
  700 IF (VLI .LE. 0.) GO TO 710                                        00003500
      X4       = X4 - F1*TI(IA)                                         00003510
      IF (IT .NE. 3) X3 = X3 - F1*TI(IA)                                00003520        03/18/76
  710 IF (VLM .LE. 0.) GO TO 720                                        00003530
      X2       = X2 - F3*TE(IA)                                         00003540
      IF (IT .NE. 3) X3 = X3 - F4*TI(IA)                                00003550        03/18/76
  720 IF (VLE .LE. 0.) GO TO 730                                        00003560
      X2       = X2 - F2*TE(IA)                                         00003570
      IF (IT .NE. 3) X1 = X1 - F2*TE(IA)                                00003580        03/18/76
  730 X2       = 10.**(X2/10.) + 10.**(X4/10.)                          00003590
      IF (IT .NE. 3) X2 = X2 + 10.**(X1/10.) + 10.**(X3/10.)            00003600        03/18/76
  740 SPL(IA,IF) = 10.*ALOG10(X2) - DP*SP(IA) -ATTAT(IF)*ZC(IA)         00003610        03/15/76
  750 CONTINUE                                                          00003620
      WRITE (NP,760) H,UM,DOF                                           00003630        11/14/75
  760 FORMAT (71HINOISE SUPPRESSION TREATMENT USED , DISTANCE BETWEEN TR00003640        11/14/75
     1EATED SURFACES =,F6.3,19H FT , MEAN DUCT M =,F5.2,2H ,,F3.0,19H DE00003650        11/14/75
     2GREES OF FREEDOM)                                                 00003660        11/14/75
      IF (DA(6) .EQ. 1.) RETURN                                         00003670
      IF (VLI .GT. 0.) WRITE (NP,770) VLI,BCFR(IFTI),SI,OTPI            00003680        03/15/76
  770 FORMAT (25H INLET TREATMENT LENGTH =,F6.2,27H FT WITH TUNING FREQU00003690
     1ENCY =,F7.0,5H HZ ,,F3.0,12H SPLITTERS ,,F4.1,20H DB PEAK ATTENUAT00003700        03/15/76
     2ION)                                                              00003710        03/15/76
      IF (VLM .GT. 0.) WRITE (NP,780) VLM,BCFR(IFTM),OTPMI,OTPME        00003720        03/15/76
  780 FORMAT (23H MID TREATMENT LENGTH =,F6.2,27H FT WITH TUNING FREQUEN00003730
     1CY =,F7.0,5H HZ ,,F4.1,25H DB PEAK ATT INLET MODE ,,F4.1,25H DB PE00003740        03/15/76
     2AK ATT EXHAUST MODE)                                              00003750        03/15/76
      IF (VLE .GT. 0.) WRITE (NP,790) VLE,BCFR(IFTE),SE,OTPE            00003760        03/15/76
  790 FORMAT (24H EXIT TREATMENT LENGTH =,F6.2, 27H FT WITH TUNING FREQU00003770
     1ENCY =,F7.0,5H HZ ,,F3.0,12H SPLITTERS ,,F4.1,20H DB PEAK ATTENUAT00003780        03/15/76
     2ION)                                                              00003790        03/15/76
      CALL PNLC(SPL)                                                    00003800
      RETURN                                                            00003810
      END                                                               00003820
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Subroutine GRBOXN

This subroutine calculates the noise of the propulsion system transmissions and includes procedures for estimating spur, bevel, planetary, and star configuration.

```
DESCRIPTION          GRBCXN - GEARBOX NOISE

MASTER FILE          LIBR.G04
ADDED TO MASTER      08/20/75
LAST DATE COPIED       NONE
LAST UPDATE          04/14/76  1653          *** TEMPORARY UPDATE ***

PASSWORD             BXLV
PROGRAMMER           F.W.BARRY
PROC PARAMETER       $NOJCL

      SUBROUTINE GRBCXN (NC,BHP,RPMO,CBN,B)                                09/25/75
C     CALCULATES PWL OF GEARBOXES IN POWER TRANSMISSION
C     GRBCXN CALLED BY MAIN, HELI, FAFFCP, SHRP, VPFAN, VPLFAN, SHTR       10/02/75
      COMMON /DATA/ ANGLE(15),BCFR(30),NR,NP,C,HOL(20),DATE(2),TIME(2),
     1 ATTNT(30),SPLT(15,30),SPLTU(15,30),CBNL(7),XO(15),XC(15),ZC(15),
     2 PSI(15),DC(15),DCO(15),HPT,TR,VELFL,VM(15),PWLT(15,30),
     3 CIRIN(498),DIREX(498),BLF(31),DPWSP(15),RPMG
      COMMON /DATAI/CA(400)                                                09/25/75
      DIMENSION DPWL(16),PWL(30),SPL(15,30)
      DATA DPWL / -30.,-28.,-26.,-25.,-18.,-5.,-10.,-17.,-5.,-15.,-13.5,
     1-12.,3*-25.,-30. /
C     ND    CA(ND) = NUMBER OF GEARBOXES IN SERIES
C     BHP          = SHP TRANSMITTED
C     RPMO         = RPM OF OUTPUT SHAFT
C     DBN          = DB CORRECTION FOR NUMBER OF UNITS IN PARALLEL
C       FOR GEARBOX I (I=1 TO DA(ND)) 3 DATA ITEMS:
C     DA(3I+ND-2)  = 1. FOR SPUR GEAR, = 2. FOR BEVEL GEAR, = 3. FOR
C                    PLANETARY (FIXED RING GEAR), = 4. FOR STAR (FIXED
C                    CAGE) GEARBOX CONFIGURATION
C     CA(3I+ND-1)  = NUMBER OF TEETH ON OUTPUT GEAR (RING IF PLANETARY)    10/31/75
C     DA(3I+ND)    = INPUT RPM / OUTPUT RPM
C     B            = 0 IF TO MAIN ENGINES , = 1 IF TO INTEGRAL ENGINE      09/25/75
      N        = IFIX(DA(ND))
      IF (N.GT.0 .AND. BHP.GT.0. .AND. RFMC.GT.C.) GO TO 30                09/11/75
   10 WRITE (NP,20)
   20 FORMAT (60H GEARBOX NOISE NOT CALCULATED BECAUSE OF ERROR IN INPUT
     1 DATA)
      RETURN
   30 A        = 10.**(CBN/10.)
      DO 40 I=1,30
   40 PWL(I)   = A
      WRITE (NP,45) HOL,DATE,TIME                                          08/27/75
   45 FORMAT (1H1,37X,13HGEARBOX NOISE //1H ,20A4,2X,2A4,2X,2A4)           08/27/75
      RPM      = RPMO
      DO 160 I=1,N
      IF (CA(3*I+ND-2).LE.0. .OR. DA(3*I+NC-2).GT.4. .OR. DA(3*I+ND-1).L
     1E.1. .OR. DA(3*I+ND).LE.0.) GO TO 10
      RPMI     = RPM * DA(3*I+ND)
      J        = IFIX(DA(3*I+ND-2))
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      GO TO (50,70,90,110), J
C     SPUR GEAR SET
   50 TPWL     = 18.*ALOG10(BHP) + 76.                                   08/26/75
      FTC      = RPM * DA(3*I+ND-1) / 60.
      WRITE (NP,60)  BHP,RPMI,RPM,DA(3*I+ND-1),FTC
   60 FORMAT (/26H SPUR-GEAR GEARBOX NOISE ,,F8.0,5H SHP,,F8.0,11H INPUT     08/28/75
     1 RPM,,F8.0,12H OUTPUT RPM,,F5.0,21H TEETH ON OUTPUT GEAR/26H TOOTH     08/28/75
     2 CONTACT FREQUENCY =,F7.0,3H HZ)
      GO TO 130
C     BEVEL GEAR SET
   70 TPWL     = 14.8*ALOG10(BHP) + 89.4                                 08/26/75
      FTC      = RPM * DA(3*I+ND-1) / 60.
      WRITE (NP,80)  BHP,RPMI,RPM,DA(3*I+ND-1),FTC
   80 FORMAT (/27H BEVEL-GEAR GEARBOX NOISE ,,F8.0,5H SHP,,F8.0,11H INPU     08/28/75
     1T RPM,,F8.0,12H OUTPUT RPM,,F5.0,21H TEETH ON OUTPUT GEAR/26H TOOT     08/28/75
     2H CONTACT FREQUENCY =,F7.0,3H HZ)
      GO TO 130
C     PLANETARY (FIXED RING GEAR) SET
   90 IF (DA(3*I+ND) .GT. 2.) GO TO 96                                   08/28/75
      WRITE (NP,93) DA(3*I+ND)                                           08/28/75
   93 FORMAT (/63H NOISE OF PLANETARY GEARBOX NOT CALCULATED BECAUSE RPM     08/28/75
     1 RATIO OF,F5.2,13H LESS THAN 2.)                                   08/28/75
      RPMI     = RPMI / DA(3*I+ND)                                       08/28/75
      GO TO 160                                                          08/28/75
   96 TPWL     = 18.*ALOG10(BHP) + 76.                                   08/28/75
      FTC      = RPM * DA(3*I+ND-1) / 60. * (1.+DA(3*I+ND)) / (DA(3*I+ND)
     1-1.)
      WRITE (NP,100) BHP,RPMI,RPM,DA(3*I+ND-1),FTC
  100 FORMAT (/39H PLANETARY (FIXED RING) GEARBOX NOISE ,,F8.0,5H SHP,,F     08/28/75
     18.0,11H INPUT RPM,,F8.0,12H OUTPUT RPM,,F5.0,19H TEETH ON RING GEA     08/28/75
     2R/26H TOOTH CONTACT FREQUENCY =,F7.0,3H HZ)                        08/28/75
      GO TO 130
C     STAR (FIXED CAGE) SET
  110 TPWL     = 18.*ALOG10(BHP) + 82.                                   08/26/75
      FTC      = RPM * DA(3*I+ND-1) / 60.
      WRITE (NP,120) BHP,RPMI,RPM,DA(3*I+ND-1),FTC
  120 FORMAT (/34H STAR (FIXED CAGE) GEARBOX NOISE ,,F8.0,5H SHP,,F8.0,1     08/28/75
     11H INPUT RPM,,F8.0,12H OUTPUT RPM,,F5.0,19H TEETH ON RING GEAR/26H
     2 TOOTH CONTACT FREQUENCY =,F7.0,3H HZ)
  130 IFTC     = 0
  140 IFTC     = IFTC + 1
      IF (BLF(IFTC) .LE. FTC) GO TO 140
      DO 150 IF=1,30
  150 PWL(IF) = PWL(IF) + 10.**((TPWL+DPWL(MAX0(1,MIN0(16,IF-IFTC+7))))  09/04/75
     1 / 10.)
  160 RPM      = RPMI                                                    09/25/75
      IF (B .EQ. 0.) RPMG = RPM
      DO 170 IF=1,30
      DO 170 IA=1,15
      SPL(IA,IF) = 10.*ALOG10(PWL(IF))- ATTNT(IF)*ZO(IA) - DPWSP(IA)     08/27/75
      A        = 10.**(SPL(IA,IF)/10.)
```

```
      SPLT(IA,IF)  = SPLT(IA,IF)  + A
  17C PWLT(IA,IF)  = PWLT(IA,IF)  + A
      IF (DA(6) .NE. 0.) CALL PNLC(SPL)
      RETURN
      END
```

Subroutines GAAFPF, GAAFDS, and GAAFPM

These routines calculate the generalized design and off-design aerodynamic performance of fixed-pitch fans.

```
DESCRIPTION        GEN.AERO.ANAL.FIX-FAN

MASTER FILE        LIBR.G04
ADDED TO MASTER    09/11/75
LAST DATE COPIED     NONE
LAST UPDATE        04/14/76  1653        *** TEMPORARY UPDATE ***

PASSWORD           KWXB
PROGRAMMER         MENTHE
PROC PARAMETER     $NOJCL

      SUBROUTINE GAAFPF (TSDS,DIAM,STGNC,PRSTDS,HOT,
     1 TDEGF,PSOIA,TCVKTS,BLADN,STLD,IGVA,IOPTA,ERRA,
     2 SHPDS,TNETDS,ZM2,AE,PCTTH,VCKTS,TSO,PSO,PRSTOP,
     3 WFAN,VTOP,ZM2OP,ZMSTE,SHP,TNETOP,PRCRIT,PROP)
      DIMENSION PRSTDS(3),PRSTOP(3)
C     GAAFPF CALLS GAAFDS, GAAFPM; CALLED BY FPFAN, FPLFAN
C   I TSDS    DESIGN (TAKEOFF) TIP SPEED , FPS
C   I DIAM    DIAMETER , FT
C   I STGNC   NUMBER OF STAGES , 1.,2. OR 3.
C   I PRSTDS  DESIGN PRESSURE RATIO OF EACH STAGE
C   I HOT     HUB / TIP DIAMETER RATIO
C   I TDEGF   DESIGN AMBIENT TEMPERATURE , DEG. F
C   I PSOIA   DESIGN AMBIENT PRESSURE , PSIA
C   I TCVKTS  DESIGN FLIGHT SPEED , KNOTS
C     BLADN   NOT USED
C     STLD    NOT USED
C     IGVA    NOT USED
C   I IOPTA   =1 FOR DESIGN CASE , =2 FOR OPERATING CASE
C    O ERRA   =0. IF NO ERROR
C    O SHPDS  DESIGN (TAKEOFF) SHP
C    O TNETDS DESIGN (TAKEOFF) THRUST , LB
C    O ZM2    DESIGN FIRST STAGE INLET MACH NUMBER
C    O AE     EXIT AREA , SQ.FT.
C   I PCTTH   OPERATING THRUST / DESIGN THRUST
C   I VCKTS   OPERATING FLIGHT SPEED , KNOTS
C   I TSO     OPERATING AMBIENT TEMPERATURE , DEG F
C   I PSO     OPERATING AMBIENT PRESSURE , PSIA
C    O PRSTOP OPERATING STAGE PRESSURE RATIOS
C    O WFAN   OPERATING FAN FLOW RATE , LB/SEC
C    O VTOP   OPERATING TIP SPEED , FPS
C    O ZM2OP  OPERATING AXIAL FIRST STAGE INLET MACH NUMBER
C    O ZMSTE  OPERATING STATOR EXIT MACH NUMBER
C    O SHP    OPERATING SHP
C    O TNETOP OPERATING NET THRUST , LB
C    O PRCRIT CRITICAL PRESSURE RATIO
C    O PROP   OVERALL OPERATING PRESSURE RATIO
C
C
      IF (IOPTA .EQ. 1) CALL GAAFDS
```

```
     1 (TSDS,DIAM,STGNO,PRSTCS,HOT,TDEGF,PSOIA,TCVKTS,
     2  BLADN,STLD,IGVA,IOPTA,ERRA,SHPDS,TNETCS,ZM2,AE,
     3  PRCRIT,AR,PFCVER,PROP)
C
C
      IF (IOPTA .NE. 1) CALL GAAFPM
     1 (TSDS,DIAM,STGNO,PRSTDS,HCT,IGVA,IOPTA,SHPDS,
     2  TNETDS,ZM2,AE,PCTTH,VOKTS,TSC,PSO,PRSTCP,WFAN,
     3  VTOP,ZM2OP,ZPSTE,ERRA,AR,SHP,TNETOP,PROVER,PRCP)
C
C
      RETURN
      END
      SUBROUTINE GAAFDS
     1 (TS,DIAM,STGNO,PRSTG,HOT,TDEGF,PSOIA,TOVKTS,BLADN,
     2  STLD,IGVA,IOPTA,ERRA,SHP,TNET,ZM2,AE,PRCRIT,
     3  AR,PROVER,PROP)
      COMMON /PTREAT/NOWALI,DWODI(2),ZLWDI(2),NORINI,DRODI(5),ZLRODI(5),
     1              NOWALE,CWODE(2),ZLWDE(2),NORINE,CRODE(5),ZLRODE(5),
     2              ZTREAT,ZMTHR
C     GAAFDS CALLS GAAFM4 ; CALLED BY GAAFPF
C
      CIMENSION PRSTG(3)
      TSO1 = TDEGF + 459.6
      PSC1 = PSOIA
      ERRA = 0.
      ZM1  = TOVKTS/(29.04*SQRT(TSC1))
      THETAS=TSO1/518.6
      DELTAS = PSO1/14.696
      THETAT = THETAS * GAAFM(ZM1,1.0)
      DELTAT = CELTAS * GAAFM(ZM1,3.5)
      NSTG   = STGNO + .01
      PROVER = 1.0
      DO 1 I=1,NSTG
    1 FACVER = PROVER * PRSTG(I)
C
C
      HOT1 = HOT
      DWODI(1) = HOT1
      DWODE(1) = HOT1/.8
      IF (NORINI .LE. 0) GO TO 10
      DXX  = (1.-HOT1)/(NORINI + 1)
      DO 9 I=1,NORINI
      ZLRODI(I) = DXX + HOT1
    9 DXX = DXX + DXX
C
   10 IF (NORINE .LE. 0) GO TO 20
      DXX = (1.-HOT1/.8) / (NORINE + 1)
      DO 19 I=1,NORINE
      ZLRODE(I) = DXX + HOT1/.8
   19 DXX = DXX + DXX
```

```
C
 20     CONTINUE
        WCOR = 36.
C
        CALL GAA123 (ZM1,A,WCCR,B,TNETC,SHPCOR,4,NSTG,PRCVER,C,AR)
C
        IF (HCT .LE. C.) HOT = .4
        A21 = .785 * DIAM*DIAM*(1-HOT**2)
        WFAN = WCOR * A21 * DELTAT / (SQRT(THETAT))
        TNET = TNETC * DELTAS * A21
        SHP = SHPCOR * DELTAS * SQRT(THETAS) * A21
        ZM2 = VMACH(1.C25*WCOR)
        AE = A21 * AR
        TT2 = TSO1 * GAAFM(ZM1,1.)
        TS2 = TT2 * GAAFM(ZM2,-1.)
        ZPTS = TS/(49.02*SQRT(TS2))
        PRCRIT = (PRSTG(1)-1.)*1.05063/(ZMTS**2 + ZM2**2) + 1.
        RETURN
        END
        SUBROUTINE GAAFPM
       1 (TSDS,DIAM,STGNO,PRSTCS,HOT,IGVA,ICFTA,SHPDS,TNETCS,
       2  ZM2,AE,PCTTH,VOKTS,TSO,PSO,PRSTOP,WFAN,TSCF,ZM2OP,
       3  ZMSTE,ERRA,AR,SHP,TNETOP,PFOVER,PRCP)
C       GAAFPM CALLS UNINT, GAAFN5 ; CALLED BY GAAFPF
        DIMENSION PRSTDS(3),PRSTOP(3)
        DIMENSION TNETS(25), WCORS(25)
        DATA WCORS/20.,21.,22.,23.,24.,25.,26.,27.,28.,29.,
       1    *        30.,31.,32.,33.,34.,35.,36.,37.,38.,39.,
       2             40.,41.,42.,43.,44. /
        TSO1 = TSO + 459.6
        PSC1 = PSO
        ERRA = 0.
        ZM1 = VOKTS/(29.04*SQRT(TSO1))
        THETAS = TSO1/518.6
        DELTAS = PSC1/14.696
        THETAT = THETAS * GAAFM(ZM1,1.0)
        DELTAT = DELTAS * GAAFM(ZM1,3.5)
C
        NSTG = STGNO + .01
C
        A21 = .785 * DIAM * DIAM * (1-HOT **2)
        DO 1 I=1,25
  1     CALL GAA123 (ZM1,AR,WCCRS(I),PRS,TNETS(I),SHPS,5,NSTG,A,B,C)
        TNETOP = PCTTH * TNETDS
        TNCS   = TNETCF/(A21*DELTAS)
        CALL UNINT (25,TNETS,WCORS,TNCS,WCOR,LIM)
        CALL GAA123 (ZM1,AR,WCOR,PROP,TNETCR,SHPCR,5,NSTG,A,B,C)
        SHP    = SHPCR*A21*DELTAS*SQRT(THETAS)
        WFAN   = WCCR * A21 * DELTAT/SQRT(THETAT)
        TSOP   = (SHP/SHPDS)**.33333  * TSCS
        ZM2OP  = VMACH (1.025 * WCOR)
```

```
      TS2TTO = GAAFM(ZM2CP,-1.0)
      CX2 = SQRT (518.6*THETAT*TS2TTO) * ZM2*49.02
      DTR = (PROP**.286-1.)/.83
      TS3 = (TS2TTC+DTR) * .98 * 518.6 * THETAT
      TT3 = (1.+CTR) * 518.6 * THETAT
      ZM3 = SQRT (5*(TT3/TS3-1.))
      ZMSTE = ZM3*1.05
      DC 2 I=1,NSTG
    2 PRSTOP(I) = PRSTDS(I) * PROP / PROVER
      RETURN
      END
```

Function TONE

Function TONE calculates the tone correction for determining PNLT.

```
DESCRIFTICN         FAR36 TONE CCRRECTICN TO PNL

MASTER FILE         LIBR.G04
ACDEC TC MASTER     09/05/72
LAST CATE COPIED      NCNE
LAST LPDATE         09/05/75  1927

PASSWCRD            NHCT
PROGRAMMER          F.W.EARRY
PROC FARAMETER      $NOJCL

      FUNCTICN TCNE(SPL)                                                    09/05/72
C     CCMPUTE TONE CORRECTICN TO ADD TO PNL TO GET PNLT
C       TCNE CORRECTICN C COMPUTED BY PRCCEDURE IN FAA-NO-68-34
      DIMENSION SPL(24),S(24),SPLP(24),SPLPP(24),SP(25),CIRCLE(24)          09/05/72
      EQUIVALENCE (S(1),SPLP(1),SPLPP(1),F),(S(23),CIRCLE(1),SP(1))         09/05/75
      LCGICAL CIRCLE
C     STEP 1
      S(3)=0.                                                               09/05/72
      DO   100 I=4,24                                                       09/05/72
      S(I)=SPL(I)-SPL(I-1)                                                  09/05/72
  1CC CIRCLE(I)=.FALSE.                                                     09/05/72
      CIRCLE(3)=.FALSE.                                                     09/05/72
      DC   220 I=4,24                                                       09/05/72
C     STEP 2
      IF (ABS(S(I)-S(I-1))-5.)  220,  220,  120                             09/05/72
C     STEP 3
  120 IF (S(I))  140,  140,  180                                            09/05/72
  140 IF (S(I-1))  220,  220,  16C                                          09/05/72
  160 CIRCLE(I-1)=.TRUE.                                                    09/05/72
      GU TO   220
  180 IF (S(I)-S(I-1))  220,  220,  200                                     09/05/72
  200 CIRCLE(I)=.TRUE.                                                      09/05/72
  220 CCNTINUE
C     STEP 4
      DO   280 I=4,23                                                       09/05/72
      IF (CIRCLE(I)) GO TC  260                                             09/05/72
      SPLP(I)=SPL(I)                                                        09/05/72
      GO TC   280
  260 SPLP(I)=(SPL(I-1)+SPL(I+1))/2.                                        09/05/72
  280 CCNTINUE
      SPLP(3)=SPL(3)                                                        09/05/72
      SPLP(24)=SPL(24)                                                      09/05/72
C     ADDED 4/3/70 TC MATCH PAGE B3-2 OF FAR PART 36  11/3/69
      IF (CIRCLE(24)) SPLP(24)=SPL(23)+SPL(23)-SPL(22)                      09/05/72
C     STEP 5
      DC   300 I=4,24                                                       09/05/72
  300 SP(I)=SPLP(I)-SPLP(I-1)                                               09/05/72
      SP(3)=SP(4)                                                           09/05/72
      SP(25)=SP(24)                                                         09/05/72
```

```
C     STEPS 6 ANC 7
      DO   320 I=4,24                                         09/05/72
  320 SPLPP(I)=SPLPP(I-1)+(SP(I-1)+SP(I)+SP(I+1))/3.          09/05/72
C     STEPS 8 AND 9 , USE TCNE IN PLACE OF C
      TCNE=0.                                                 09/05/72
      DO  520 I=4,24                                          09/05/72
      F=SPL(I)-SPLPP(I)                                       09/05/72
      IF (F-3.) 520, 340, 340                                 09/05/72
  340 IF (I-11) 36C, 440, 440                                 09/05/72
  360 IF (F-20.) 400, 380, 380                                09/05/72
  380 TCNE=AMAX1(TCNE,3.333)                                  09/05/72
      GU TO  520
  4C0 F=F/6.                                                  09/05/72
  420 TONE=AMAX1(TONE,F)                                      09/05/72
      GC TO  520
  440 IF (I-21) 460, 460, 360                                 09/05/72
  460 IF (F-20.) 48C, 500, 500                                09/05/72
  480 F=F/3.                                                  09/05/72
      GO TO  420
  5C0 TCNE=AMAX1(TONE,6.667)                                  09/05/72
  520 CCNTINUE
      RETURN
      END
```

Subroutine NOYS

This subroutine calculates the NOY value of a given 1/3 octave band SPL.

```
DESCRIPTICN          NOY VALUES FROM SPL DB

MASTER FILE          LIPF.CC.G04
ADDED TC MASTER      11/C5/71
LAST CATE CCPIED       NCNE
LAST UPCATE            NCNE

PASSWCRC             XPPD
PROGRAMMER           F.W.BARRY
PRCC FARAMETER       $NOJCL

      SUBROUTINE NOYS(SPL,JJ,VNOYS)
C     CCMPUTES NOYS CORRESPONDING TO SPL IN CB FROM EQUATICNS IN
C       APPENDIX A UF FAA-NO-68-34
      DIMENSION VM1(10),SPLO(11),SPL1(11),SPL2(24),SPL(24),VNOYS(24)
      DATA  VM1/
     1 .10011,.093415,.C848C7,.C84807,.081364,.076752,.076752,.073800
     2,.C70632,.097365 /
      CATA  SPLO/
     1 91.,85.9,87.3,79.9,79.8,76.0,74.0,74.9,94.6,44.3,50.7 /
      DATA  SPL1/
     1 64.,60.,56.,53.,51.,48.,46.,44.,42.,37.,41. /
      CATA  SPL2/
     1 52.,51.,49.,47.,46.,45.,43.,42.,41.,4C.,4C.,40.,4C.,40.,38.,34.
     2,32.,30.,29.,29.,30.,31.,34.,37. /
      IF (JJ-10)50,10,10
   1C IF (JJ-23)20,70,70
   20 IF (JJ-16)30,40,40
   30 VNOYS(JJ)=EXP(.0693147*(SPL(JJ)-SPL2(JJ)))
      GO TO 90
   40 VNOYS(JJ)=EXP(.0689854*(SPL(JJ)-SPL2(JJ)))
      GC TO 90
   50 IF (SPL(JJ)-SPLO(JJ))60,30,30
   60 VNCYS(JJ)=EXP(VM1(JJ)*(SPL(JJ)-SPL1(JJ)))
      GO TO 90
   70 IF (SPL(JJ)-SPLC(JJ-13))8C,40,40
   80 VNOYS(JJ)=EXP(VM1(10)*(SPL(JJ)-SPL1(JJ-13)))
   90 RETURN
      END
```

Subroutine BESJH

This subroutine calculates an array of values for Bessel functions of the first kind of integer order and real arguments.

```
DESCRIPTICN          CALCULATES BESSEL FCN. ARRAY

MASTER FILE          LIBR.G01
ACDEC TO MASTER      12/16/71
LAST CATE COPIED     04/12/76
LAST UPCATE          10/03/73   1350

PASSWCRC             TCBG
PROGRAMMER           F.W.BARRY
PROC PARAMETER       $NOJCL


HISTORY CARDS FOR THIS MODULE

  10/C3/73           MOCIFIED TC BE CORRECT TO HIGHER CRDER ANC ARGUMENT


      SUBROUTINE BESJH (X,N,F,ER,L,IWR)                                 BESH0010
C-----------------------------------------------------------------------BESH0020
C     CCMPUTES ARRAY OF REGULAR BESSEL FUNCTIONS OF INTEGER ORDER AND   BESH0030
C      REAL ARGUMENT , JO(X) IN F(1) AND JN(X) IN F(N+1)      F.W.BARRY BESH0040
C-----------------------------------------------------------------------BESH0050
C     ARGUMENT CEFINITICN                                               BESH0060
C        X     IS THE ARGUMENT OF THE BESSEL FUNCTICN.                  BESH0070
C        N     IS THE HIGHEST ORDER TO BE CCMPUTED , ASSUMEC POSITIVE.  BESH0080
C        F     IS THE OLTPUT ARRAY OF BESSEL FUNCTIONS.                 BESH0090
C        ER    NORMALLY O. , IF NOT INCICATES JER(X) FCUND TO BE OUT OF BESH0100
C              BCUNDS OR NOT CALCULATED , JER(X) TO JN(X) THEN SET TO O. BESH0110
C        L     DIMENSICN OF F IN CALLING PRCGRAM.                       BESH0120
C        IWR   UNIT FOR WRITE STATEMENT.                                BESH0130
C-----------------------------------------------------------------------BESH0140
C     REFERENCES                                                        BESH0150
C        M. GOLDSTEIN ANC R.M. THALER, RECURRENCE TECHNIQUES FOR THE    BESH0160
C             CALCULATION OF BESSEL FUNCTICNS, MTAC, 1959.              BESH0170
C        M. GOLDSTEIN AND R. M. THALER, BESSEL FUNCTICNS FCR LARGE      BESH0180
C             ARGUMENTS, MTAC, 1958.                                    BESH0190
C        G.N. WATSCN, A TREATISE ON THE THEORY CF BESSEL FUNCTIONS,     BESH0200
C             CAMBRIDGE UNIVERSITY PRESS, 1948.                         BESH0210
C-----------------------------------------------------------------------BESH0220
      DIMENSICN F(1),C(5)                                               BESH0230
      DCUBLE PRECISION FU,DX,XXX,XX,OTT,DA,C,P,BT,PHI,F1,F2             BESH0240
      ER=0.                                                             BESH0250
      NN=IABS(N)                                                        BESH0260
      IF (NN+1.GT.L) GO TO 280                                          BESH0270
      CX=2./X                                                           BESH0280
      K=NN+1                                                            BESH0290        10/03/73
      IF (X.GT.50.) GO TO 190                                           BESH0300
      IF (X.LT.1.) GC TC 1C                                             BESH0310
      KK=39.*X**.33333333                                               BESH0320
      GO TO 20                                                          BESH0330
   10 KK=172.69388/(3.6888795-ALCG(X))                                  BESH0340
```

```
   20 M=MINO(KK,MAXO(IFIX(X+20.),NN+10))/2                                BESH0350
      K=M+M+1                                                             BESH0360
      IF (K+2.GT.L) GO TO 290                                             BESH0370
      F(K+1)=1.E-37                                                       BESH0380
      F(K+2)=0.                                                           BESH0390
      KK=K+1                                                              BESH0400
      DO 30 I=KK,NN                                                       BESH0410
   30 F(I+1)=0.                                                           BESH0420
      IF (K .LT. NN) ER=K                                                 BESH0430
      TT=KK                                                               BESH0440
      DC 40 I=1,K                                                         BESH0450
      J=KK-I                                                              BESH0460
      TT=TT-1.                                                            BESH0470
   40 F(J)=CX*TT*F(J+1)-F(J+2)                                            BESH0480
      IF (X.GT.10.) GO TO 190                                             BESH0490
      ALFA=F(1)+F(3)+F(3)                                                 BESH0500
      DO 50 I=2,M                                                         BESH0510
   50 ALFA=ALFA+F(2*I+1)+F(2*I+1)                                         BESH0520
      I1=1                                                                BESH0530
   60 DO 70 I=I1,K                                                        BESH0540
   70 F(I)=F(I)/ALFA                                                      BESH0550
C     CHECK VALIDITY OF BESSEL FUNCTIONS                                  BESH0560
   8C IF (X-2.4048256)90,110,120                                          BESH0570
C     IF X LESS THAN 2.405 JO(X) IS POSITIVE AND LESS THAN 1.             BESH0580
   90 IF (F(1).LE.1.0001.AND.F(1).GE.-.0001) GO TO 130                    BESH0590
  100 I=1                                                                 BESH0600
      F(1)=0.                                                             BESH0610
  103 ER=AMINO(I,K)                                                       BESH0620
      DO 106 J=I,NN                                                       BESH0630
  1C6 F(J+1)=0.                                                           BESH0640
      RETURN                                                              BESH0650
  110 F(1)=0.                                                             BESH0660
      GC TO 130                                                           BESH0670
C     IF X GREATER THAN 2.405  JO(X) GT -.4028 AND LT .3002               BESH0680
  120 IF (F(1).LT.-.4028.OR.F(1).GT..3002) GO TO 100                      BESH0690
C     IF X GREATER THAN 2.405 ABS(JO(X)) LT .82 / SQRT(X)                 BESH0700
      IF (ABS(F(1)).GT..82/SQRT(X)) GO TO 100                             BESH0710
  130 IF (N.EQ.0) RETURN                                                  BESH0720
      TT=0.                                                               BESH0730
      DO 180 I=1,NN                                                       BESH0740
      TT=TT+1.                                                            BESH0750
      IF (X.GT.1.) GO TO 140                                              BESH0760
C     IF X LE 1  O LE JN(X) LT .4(1.359X/N)**N /SQRT(N)                   BESH0770
      IF (F(I+1).GE.0..AND.F(I+1).LT..4*((1.3591409*X/TT)**I)/SQRT(TT))  BESH0780
     1 GC TO 180                                                          BESH0790
      GO TO 103                                                           BESH0800
  140 IF (X-TT) 150,150,170                                               BESH0810
C     IF ARGUMENT LESS THAN CRDER JN(X) POSITIVE AND LESS THAN            BESH0820
C      .4473*10**(6.69(1-SQRT(1+((N-X)/4.3CBRT(X))**2)))/CBRT(N)          BESH0830
  150 IF(F(I+1).GE.0..AND.F(I+1).LT..4500/(TT**.33333333)*10.**(6.69*(1.BESH0840          10/03/73
     1 -SQRT(1.+((TT-X)/(4.3*X**.3333333))**2)))) GO TO 180               BESH0850
```

```
      GO TO 310                                                         BESH0860   10/03/73
C     IF ARGUMENT EXCEEDS ORDER -.42/N**.275 LT JN(X) LT .59/N**.275    BESH0870
  170 A=TT**.275                                                        BESH0880
      IF (F(I+1).LT.-.42/A.OR.F(I+1).GT..59/A) GO TO 103                BESH0890
  180 CONTINUE                                                          BESH0900
      RETURN                                                            BESH0910
C.....ASYMPTOTIC EXPANSION......                                         BESH0920
  190 KK=1                                                              BESH0930
      DX=DBLE(X)                                                        BESH0940
      FU=0.78539816339744831D0                                          BESH0950
      XXX=1.D0/DX                                                       BESH0960
      XX=XXX*XXX                                                        BESH0970
      DTT=1.D0/DSQRT(1.5707963267948966D0*DX)                           BESH0980
      DA=-.25D0                                                         BESH0990
  200 C(5)=.25D0                                                        BESH1000
      C(4)=.15625D0*DA-.375D0                                           BESH1010
      C(3)=(.1171875D0*DA-1.15625 D0)*DA+1.875D0                        BESH1020
      C(2)=((.09521484375D0*DA-2.3867187 5D0)*DA+14.2265625D0)*DA-19.6875BESH1030
     1D0                                                                BESH1040
      C(1)=(((.0809326171875D0*DA-4.1005859375D0)*DA+58.224609375D0)*DA-BESH1050
     1277.875D0)*DA+354.375D0                                           BESH1060
      P=C(1)                                                            BESH1070
      DO 210 I=2,5                                                      BESH1080
  210 P=P*XX+C(I)                                                       BESH1090
      BT=(P*DA*XX+1.D0)*DTT                                             BESH1100
      C(5)=.5D0                                                         BESH1110
      C(4)=.041666666666666667D0*DA-.25D0                               BESH1120
      C(3)=(.0125D0*DA-.35D0)*DA+.75D0                                  BESH1130
      C(2)=((.55803571428571428 6D-3*DA-.42410714285714286D0)*DA+       BESH1140
     13.6026785714285714D0)*DA-5.625D0                                  BESH1150
      C(1)=(((.30381944444444444D-2*DA-.48611111111111111D0)*DA+        BESH1160
     110.286458333333333D0)*DA-58.D0)*DA+78.75D0                        BESH1170
      P=C(1)                                                            BESH1180
      DO 220 I=2,5                                                      BESH1190
  220 P=P*XX+C(I)                                                       BESH1200
      PHI=DX+XXX*P*DA-FU                                                BESH1210
      IF (KK.EQ.2) GO TO 230                                            BESH1220
      F1=BT*DCOS(PHI)                                                   BESH1230
      DA=.75D0                                                          BESH1240
      FU=2.3561944901923449D0                                           BESH1250
      KK=2                                                              BESH1260
      GO TO 200                                                         BESH1270
  230 F2=BT*DCOS(PHI)                                                   BESH1280
      IF (X.GT.50.) GO TO 240                                           BESH1290
      IF (DABS(F1).LT.DABS(F2)) GO TO 260                               BESH1300
      ALFA=F(1)/SNGL(F1)                                                BESH1310
      GO TO 270                                                         BESH1320
  240 F(1)=SNGL(F1)                                                     BESH1330
      F(2)=SNGL(F2)                                                     BESH1340
      IF (N.LT.2) GO TO 80                                              BESH1350
      DO 250 I=2,NN                                                     BESH1360
```

```
      P=2.D0*F2*DFLOAT(I-1)/CX-F1                                 BESH1370
      F1=F2                                                       BESH1380
      F2=P                                                        BESH1390
  250 F(I+1)=SNGL(P)                                              BESH1400
      GO TO 80                                                    BESH1410
  260 ALFA=F(2)/SNGL(F2)                                          BESH1420
  270 F(1)=SNGL(F1)                                               BESH1430
      F(2)=SNGL(F2)                                               BESH1440
      I1=3                                                        BESH1450
      GO TO 60                                                    BESH1460
  280 K=NN-1                                                      BESH1470
  290 I=K+2                                                       BESH1480
      WRITE (IWR,300)I,L                                          BESH1490
  300 FORMAT (44HOBESSEL FUNCTION ARRAY REQUIRES DIMENSION OFI5,23H , CABESH1500
     1LLING PROGRAM USESI6,12H , RECOMPILE)                       BESH1510
      CALL EXIT                                                   BESH1520
C     APPROXIMATION FOR ORDER GREATER THAN ARGUMENT , EQN.9.3.3 OF AMS55BESH1530      10/03/73
  310 K=IFIX(X)+5                                                 BESH1540      10/03/73
      I=I-3                                                       BESH1550      10/03/73
      DO 340 J=I,NN                                               BESH1560      10/03/73
      IF(J.GT.K) GO TO 330                                        BESH1570      10/03/73
  320 F(J+1)=0.                                                   BESH1580      10/03/73
      GO TO 340                                                   BESH1590      10/03/73
  330 CX=FLOAT(J)                                                 BESH1600      10/03/73
       A=ALOG((CX/X)+SQRT((CX/X)**2-1.))                          BESH1610      10/03/73
      TT=TANH(A)                                                  BESH1620      10/03/73
      ALFA=CX*(TT-A)                                              BESH1630      10/03/73
      IF (ALFA.LT.-150.) GO TO 320                                BESH1640      10/03/73
      F(J+1)=EXP(ALFA)/SQRT(6.2831853*CX*TT)                      BESH1650      10/03/73
  340 CONTINUE                                                    BESH1660      10/03/73
      RETURN                                                      BESH1670      10/03/73
      END                                                         BESH1680
```

Subroutine BIQUAD

This subroutine interpolates over a four point interval and maintains continuity of slope between adjacent intervals.

```
RUN NO. 1821    DATE  04/14/76    TIME  1652          LISTING OF MODULE BIQUAD                                   PAGE   1

DESCRIPTION          BIQUADRATIC INTERPOLATION

MASTER FILE          LIBR.G01
ADDED TO MASTER      01/07/72
LAST DATE COPIED     07/29/75
LAST UPDATE          02/04/72  1253

PASSWORD             ZKNX
PROGRAMMER           HSSUBS3
PROC PARAMETER       $NCJCL

           SUBROUTINE  BIQUAD (T, I, XI, YI, Z, K)                                 02/04/72
        ENTRY          BIQUD  (T, I, XI, YI, Z, K)                                 02/04/72
  C
  C      THIS ROUTINE INTERPOLATES OVER A 4 POINT INTERVAL USING A
  C        VARIATION OF 2ND DEGREE INTERPOLATION TO PRODUCE A CONTINUITY
  C        OF SLOPE BETWEEN ADJACENT INTERVALS.
        DIMENSION T(1),XC(4), D(4), P(5), Y(4),C(4)                                02/04/72
  C
        EQUIVALENCE (XC(1), D(1))                                                  02/04/72
  C
  C     TABLE SET UP
  C        T(I)     = TABLE NUMBER                                                 02/04/72
  C        T(I+1)   = NUMBER OF (X) VALUES                                         02/04/72
  C        T(I+2)   = NUMBER OF (Y) VALUES  (0. FOR UNIVARIATE TABLE)              02/04/72
  C        T(I+3)   = VALUES OF (X) IN ASCENDING ORDER                             02/04/72
         NX = T(I+1)                                                               02/04/72
         NY = T(I+2)                                                               02/04/72
         J1 = I+3                                                                  02/04/72
         J2 = J1 + NX - 1                                                          02/04/72
         X = XI                                                                    02/04/72
  C     SEARCH IN X SENSE
         L = 0                                                                     02/04/72
           GO TO 1000
  C     RETURN HERE FROM SEARCH OF X
   100   K = KX                                                                    02/04/72
         JX= JX1                                                                   02/04/72
  C     THE FOLLOWING CODE PUTS X AND/OR Y VALUES IN XC BLOCK
   105     DO 110 J=1,4                                                            02/04/72
         XC(J) = T(JX1)                                                            02/04/72
   110   JX1 = JX1+1                                                               02/04/72
  C     GET COEFF. IN  X SENSE
           GO TO 2000
  C     RETURN HERE WITH COEFF.  TEST FOR UNIVARE OR BIVARIATE
   200     IF (NY)  300,210,300                                                    02/04/72
   210   Z=0.                                                                      02/04/72
         JY = JX+NX                                                                02/04/72
            DO 220 J=1,4                                                           02/04/72
         Z= Z + C(J)*T(JY)                                                         02/04/72
   220   JY = JY+1                                                                 02/04/72
```

```
          GC TO 5599                                                00000400
C                                                                   03000410
C      BIVARIATE TABLE                                              03000420
 300      L=1                                                       00000430   02/04/72
        X = YI                                                      00000440   02/04/72
        J1 = J2+1                                                   C0000450   02/04/72
        J2 = J1+NY-1                                                00000460   02/04/72
C      SEARCH IN  Y SENSE  JX1 = SUBSCRIPT OF 1ST Y                 00000470   02/04/72
          GO TO 1C00                                                03000480
 5CC   K = K+3*KX                                                   C0000490   02/04/72
C      INTERPOLATE IN X SENSE                                       C0000500
C      SUBSCRIPT - BASE    NO. OF COL.      NO. OF YS               000C0510
        JY  =      J2+1    + (JX-I-3)*NY   + JX1-J1                 00000520   02/04/72
          DO 550 M=1,4                                              C0000530   02/04/72
        JX  = JY                                                    00000540   02/04/72
        Y(M) = 0.                                                   00000550   02/04/72
          CO  520 J=1,4                                             C0000560   02/04/72
        Y(M) = Y(M) + C(J)*T(JX)                                    C0000570   02/04/72
 520    JX = JX+NY                                                  CCC00580   02/04/72
 550    JY = JY+1                                                   00000590   02/04/72
C                                                                   00000600
C      GET COEFF. IN Y SENSE                                        00000610
          GO TO 105                                                 00000620
 60C    Z = 0.                                                      CCCC0630   02/04/72
          DO 700 J=1,4                                              00000640   02/04/72
 70C    Z = Z + C(J)*Y(J)                                           00000650   02/04/72
 9999   RETURN                                                      C0000660
C                                                                   00000670
C      SEARCH ROUTINE - INPUT J1,J2,X                               C0000680
C                      -OUTPUT RA,RB,KX,JX1                         00000690
 1000   KX = 0                                                      C0000700   02/04/72
          DO 1010 J=J1,J2                                           00000710   02/04/72
          IF (T(J)- X) 1010,1050,1050                               00000720   02/04/72
 1010   CCNTINUE                                                    C0000730
C      OFF HIGH END                                                 00000740
        X = T(J2)                                                   03000750   02/04/72
        KX = 2                                                      C3000760   02/04/72
C      USE LAST 4 POINTS AND CURVE B                                00000770
 1020   JX1 = J2-3                                                  C00C0780   02/04/72
        RA = 0.                                                     00000790   02/04/72
          GC TO 16C0                                                00000800
C      TEST FOR  - -  OFF LOW END,  FIRST INTERVAL, CTHER           00000810
 1C5C     IF(J-J1-1)       1080     ,       1090         , 1100     00000820   02/04/72
 1C80    IF(T(J)-X) 1C82,1C90,1C82                                  CC0C0830   02/04/72
 1C82   KX = 1                                                      03000840   02/04/72
        X = T(J1)                                                   C0000850   02/04/72
 1090   JX1 = J1                                                    00000860   02/04/72
        RA = 1.                                                     00000870   02/04/72
          GC TO 1600                                                C0000880
C      TEST  FOR LAST  INTERVAL  NO, YES, NO                        00000890
 1100     IF (J - J2)           15CC,1020,1500                      00000900   02/04/72
```

```
  15CC  JX1 = J-2                                                    02/04/72
        RA = (T(J) - X )/(T(J) - T(J-1) )                            02/04/72
  1600  RB = 1. - RA                                                 02/04/72
 C
 C      RETURN BACK TO MAIN BODY
           IF (L)  50C. 100. 500                                     02/04/72
 C
 C      COEFFICINT RUUT:NE - INPUT  X, X1, X2, X3, X4, RA, RB
  2CCO     DO 2010 J=1,3                                             02/04/72
  2010  P(J) = XC(J+1)-XC(J)                                         02/04/72
         P(4)=P(1)+P(2)                                              02/04/72
         P(5)=P(2)+P(3)                                              02/04/72
           CO 2020 J=1,4                                             02/04/72
  2C2C  D(J) = X-XC(J)                                               02/04/72
        C(1)=(RA/P(1))*(D(2)/P(4))*D(3)                              02/04/72
        C(2)=(-RA/P(1))*(D(1)/P(2))*C(3)+(RB/P(2))*(D(3)/P(5))*D(4)  02/04/72
        C(3)=(RA/P(2))*(D(1)/P(4))*D(2)-(RB/P(2))*(D(2)/P(3))*D(4)   02/04/72
        C(4)=(RB/P(5))*(D(2)/P(3))*D(3)                              02/04/72
 C      RETURN TO MAIN BODY
           IF(L)  600,200,500                                        02/04/72
          END
```

Subroutine LOAD

This subroutine reads a set of input data cards in a specified format. The input data affects only the locations specified as having data input to them. The input is terminated when a card with an 0 in column 1 and -1. in columns 3 to 5 is read.

```
DESCRIPTION          STANDARD LCAD ROUTINE

MASTER FILE          LIBR.G01
ADDED TC MASTER      01/1C/72
LAST CATE CCPIED       NCNE
LAST UPDATE          02/C4/72  1253

PASSWORC             XGTP
FRCGRAMMER           HSSUBS4
PROC PARAMETER       $NOJCL

      SUBROUTINE LOAD(CATA)                                          02/04/72
      DIMENSICN DATA(1),BUFR(5)                                      02/04/72
C     ***
 1000 READ(5,9990) NDATA,FLOC,(BUFR(I),I=1,NDATA)                    02/04/72
      IF (NDATA) 1010,1050,1C10                                      02/04/72
 1010 IF (FLOC) 1020,1030,1020                                       02/04/72
 1020 LOC=ABS(FLCC)+.1                                               02/04/72
 1C30 DO 1040 I=1,NCATA                                              02/04/72
      CATA(LOC)=BUFR(I)                                              02/04/72
 1040 LCC=LUC+1                                                      02/04/72
 1C50 IF (FLOC) 1060,1000,1000                                       02/04/72
 1C60 RETURN
C     ***
 9990 FORMAT (I1,F11.9,5E12.0)                                       02/04/72
      END
```

Subroutine UNBAR

This subroutine performs linear, quadratic, or cubic interpolation in an array. The degree of interpolation is specified by the user.

```
DESCRIPTICN          LIN.,QUAD.& CUBIC INTERPCLATN.

MASTER FILE          LIBR.G01
ADDED TC MASTER      01/10/72
LAST CATE CCPIED     12/17/75
LAST UPCATE          02/C4/72  1253

PASSWORC             HJPD
PROGRAMMER           HSSUBS3
PROC PARAMETER       $NCJCL

      SUBROUTINE  UNBAR(T,IK,XIN,YIN,ZZ,KK)                 02/04/72
C   LNEAR WITH DEGREE CHOICE
      DIMENSION T(1),X(6),Y(6),A(6)                         02/04/72
C   ------------------  MARCH 4, 1961  -------------
      II = IK+1                                             02/04/72
      N = 3                                                 02/04/72
      N2= 2                                                 02/04/72
            IF (T(II)-3.) 700,701,702                       02/04/72
 70C        IF (T(II)+0.) 60,701,704                        02/04/72
 7C4        IF (T(II)-2.) 705,706,701                       02/04/72
 705  N = 1                                                 02/04/72
            GO TO 707
 7C6  N = 2                                                 02/04/72
 707  N2= 1                                                 02/04/72
 7C1  II = II+1                                             02/04/72
 702  N1 = N +1                                             02/04/72
            CO 50 L = II,II                                 02/04/72
            IF ( T(L) + 0. ) 60,60,51                       02/04/72
 60    KK = -1                                              02/04/72
       ZZ = 0.                                              02/04/72
         GO TO 9999
 51   NX = T(L)                                             02/04/72
            IF (T(L+1) + 0. ) 60,52,50                      02/04/72
 52   NY = 0                                                02/04/72
           GO TO 53
 50   NY = T(L+1)                                           02/04/72
 53       CONTINUE
      KK  = 0                                               02/04/72
      KY  = 0                                               02/04/72
      XX  = XIN                                             02/04/72
      J1  = II+2                                            02/04/72
      J2  = NX+II+1                                         02/04/72
      IF(XX-T(J1))301,306,400                               02/04/72
 400        DO 302 J=J1,J2                                  02/04/72
            IF (XX-T(J)) 304,304,302                        02/04/72
 302  CCNTINUE
 309  KK  = 2                                               02/04/72
      XX  = T(J2)                                           02/04/72
 308  JX1 = J2-N                                            02/04/72
```

```
      GO TO 305
301  KK  = 1                                     02/04/72
     XX  = T(J1)                                 02/04/72
306  JX1 = J1                                    02/04/72
      GO TO 305
304       IF (J-J1-1) 301,306,307                02/04/72
307       IF (J-J2)   303,308,309                02/04/72
303  JX1 = J-N2                                  02/04/72
305  CONTINUE
     XINT  = XX                                  02/04/72
       IF (NY) 1500, 1500, 3000                  02/04/72
1500      DO 1599 L=1,N1                         02/04/72
           X(L) = T(JX1)                         02/04/72
           LY = JX1 + NX                         02/04/72
           Y(L) = T(LY)                          02/04/72
1599   JX1 = JX1+1                               02/04/72
     I = 1                                       02/04/72
     GO TO 54
3000 J1  = J1+NX                                 02/04/72
     J2  = J2+NY                                 02/04/72
     YY  = YIN                                   02/04/72
     IF(YY-T(J1))311,316,401                     02/04/72
401       DO 312 J=J1,J2                         02/04/72
          IF (YY-T(J)) 314,314,312               02/04/72
312  CONTINUE
319  KY  = 6                                     02/04/72
     YY  = T(J2)                                 02/04/72
318  JY1 = J2-N                                  02/04/72
      GO TO 315
311  KY  = 3                                     02/04/72
     YY  = T(J1)                                 02/04/72
316  JY1 = J1                                    02/04/72
      GO TO 315
314       IF (J-J1-1) 311,316,317                02/04/72
317       IF (J-J2)   313,318,319                02/04/72
313  JY1 = J-N2                                  02/04/72
315  CONTINUE
     JX2  = JX1                                  02/04/72
     LY   = JY1 + NY*(JX2-II-1)                  02/04/72
     LY1 = LY                                    02/04/72
          DO 3099 L=1,N1                         02/04/72
     X(L) = T(JX2)                               02/04/72
     Y(L) = T(LY1)                               02/04/72
     LY1  = LY1+NY                               02/04/72
3099 JX2  = JX2+1                                02/04/72
     I    = 0                                    02/04/72
          GO TO 54
3098  Y(1)  = ZZ                                 02/04/72
          DO 4400 I=1,N                          02/04/72
     LY1 = LY+I                                  02/04/72
     Y(I+1) = 0.                                 02/04/72
```

```
           DO 4050 MM=1,N1                                        00000910      02/04/72
      Y(I+1) = Y(I+1) + T(LY1)*X(MM)                              00000920      02/04/72
 4050 LY1 = LY1+NY                                                00000930      02/04/72
 4400  CONTINUE                                                   00000940
           DO 4199 L=1,N1                                         00000950      02/04/72
      X(L) = T(JY1)                                               00000960      02/04/72
 4199 JY1  = JY1+1                                                00000970      02/04/72
      XINT = YY                                                   00000980      02/04/72
      I=  1                                                       00000990      02/04/72
 54   D  = 1.                                                     00001000      02/04/72
      X(N+2) = X(1)                                               00001010      02/04/72
      X(N+3) = X(2)                                               00001020      02/04/72
           DO 55 J=1,N1                                           00001030      02/04/72
      A(J+1) = X(J+1) - X(J)                                      00001040      02/04/72
      TPAL1  = XINT - X(J)                                        00001050      02/04/72
       IF ( TPAL1 ) 57,58,57                                      00001060      02/04/72
 58     ZZ = Y (J)                                                00001070      02/04/72
       X(1) = 0.                                                  00001080      02/04/72
       X(2) = 0.                                                  00001090      02/04/72
       X(3) = 0.                                                  00001100      02/04/72
       X(4) = 0.                                                  00001110      02/04/72
       X(J) = 1.0                                                 00001120      02/04/72
       GO TO 59                                                   00001130
 57   D = D * TPAL1                                               00001140      02/04/72
           GO TO (711,712,713) ,N                                 00001150      02/04/72
 711  X(J)   = TPAL1/A(J+1)                                       00001160      02/04/72
           GO TO 55                                               00001170
 712  X(J)   = -TPAL1                                             00001180      02/04/72
           GO TO 55                                               00001190
 713  X(J)   = (X(J+2)-X(J))*TPAL1                                00001200      02/04/72
 55      CONTINUE                                                 00001210
      A(1) = A(N+2)                                               00001220      02/04/72
      ZZ = 0.                                                     00001230      02/04/72
         DO 56 J=1,N1                                             00001240      02/04/72
        X(J) = D/(A(J)*A(J+1)*  X(J))                             00001250      02/04/72
      ZZ = ZZ + Y(J)*  X(J)                                       00001260      02/04/72
 56      CONTINUE                                                 00001270
 59          IF (I) 3058,3058,9999                                00001280      02/04/72
 9999 KK  = KK+KY                                                 00001290      02/04/72
         RETURN                                                   00001300
        END                                                       00001310
```

Subroutine UNINT

This subroutine interpolates over a four point interval and maintains continuity of slope between adjacent intervals. The interpolation may be done in a one or two dimension array.

```
DESCRIPTION         BIQUAD. INTERP. - UNIV. CURVES

MASTER FILE         LIBR.G01
ADDED TO MASTER     01/10/72
LAST DATE COPIED    07/29/75
LAST UPDATE         02/04/72  1253

PASSWORD            HVTV
PROGRAMMER          HSSUBS3
PROC PARAMETER      $NOJCL

      SUBROUTINE UNINT ( N, XA, YA, X , Y, L)                          00000010   02/04/72
C     REWRITTEN    SEPTEMBER 18, 1967                                  00000020
C     UNIVARIATE TABLE ROUTINE WITH SEPERATE ARRAYS FCR X AND Y - S 66 00000030
C                                                                      00000040
C                                                                      00000050
C     THIS ROUTINE INTERPOLATES OVER A 4 POINT INTERVAL USING A        00000060
C     VARIATION OF 2ND DEGREE INTERPOLATION TO PRODUCE A CONTINUITY    00000070
C     OF SLOPE BETWEEN ADJACENT INTERVALS.                             00000080
C                                                                      00000090
      DIMENSION  XA(1), YA(1), D(4), F(5)                              00000100   02/04/72
       L=0                                                             00000110   02/04/72
       I=1                                                             00000120   02/04/72
C     TEST FOR OFF LOW END   NO   =  YES                               00000130   02/04/72
         IF ( XA(1)-X )   100, 150,  10                                00000140   02/04/72
 10    L=1                                                             00000150   02/04/72
         GO TO 150                                                     00000160
 100     DO 120 I=2,N                                                  00000170   02/04/72
         IF ( XA(I)-X)  120, 150, 200                                  00000180   02/04/72
 120  CONTINUE                                                         00000190
C     OFF HIGH END                                                     00000200
       I = N                                                           00000210   02/04/72
       L= 2                                                            00000220   02/04/72
 150   Y= YA(I)                                                        00000230   02/04/72
         GO TO 999                                                     00000240
C     TEST FOR FIRST INTERVAL                                          00000250
 200     IF(I-2) 240,220,240                                           00000260   02/04/72
C     FIRST INTERVAL                                                   00000270
 220   JX1 = 1                                                         00000280   02/04/72
       RA = 1.                                                         00000290   02/04/72
         GO TO 400                                                     00000300
C     TEST FCR LAST INTERVAL                                           00000310
 240     IF(I-N) 300, 250, 300                                         00000320   02/04/72
C     LAST INTERVAL                                                    00000330
 250   JX1 = N-3                                                       00000340   02/04/72
       RA = 0.                                                         00000350   02/04/72
         GO TO 400                                                     00000360
 300   JX1 = I-2                                                       00000370   02/04/72
       RA = (XA(I)-X) /(XA(I)-XA(I-1) )                                00000380   02/04/72
 400   RB = 1. - RA                                                    00000390   02/04/72
```

```
C
C     GET COEFFICIENTS AND RESULTS
       J = JX1                                                         02/04/72
         DC 500 I=1,3                                                  02/04/72
       P(I) = XA(J+1) - XA(J)                                          02/04/72
       D(I) = X - XA(J)                                                02/04/72
 500   J = J+1                                                         02/04/72
      D(4) = X - XA(J)                                                 02/04/72
      P(4) = P(1) + P(2)                                               02/04/72
      P(5) = P(2) + P(3)                                               02/04/72
C     RESULT
      Y = YA(JX1) + RA/P(1) * D(2)/P(4) * C(3) +                       02/04/72
     1  YA(JX1+1) * (-RA/P.1) * C(1)/P(2) * D(3) + RB/P(2) * D(3)/P(5) 02/04/72
     2  *D(4)) + YA(JX1+2) *(RA/P(2) * D(1)/P(4) * D(2) - RB/P(2)      02/04/72
     3  * D(2)/P(3) * C(4)) + YA(JX1+3) * RB/P(5) * D(2)/P(3) * D(3)   02/04/72
 999   RETURN
        END
```

Subroutine WUNINT

This subroutine provides coefficients for quadratic interpolation in an array.

```
DESCRIPTION          BIQUAD. INTERP. COEFFICIENTS

MASTER FILE          LIBR.G01
ADDED TO MASTER      01/10/72
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LAST UPDATE          02/04/72  1253

PASSWORD             GFCF
PROGRAMMER           HSSUBS3
PROC PARAMETER       $NOJCL

      SUBROUTINE WUNINT(N,XA,X,L,C,JX1)                                02/04/72
C
C     THIS ROUTINE INTERPOLATES OVER A 4 POINT INTERVAL USING A
C     VARIATION OF 2ND DEGREE INTERPOLATION TO PRODUCE A CONTINUITY
C     OF SLOPE BETWEEN ADJACENT INTERVALS.
C
       DIMENSION  XA(1),  C(4), D(3), P(3)                             02/04/72
       L=0                                                             02/04/72
       I=1                                                             02/04/72
C     TEST FOR OFF LOW END    NO    =   YES                            02/04/72
         IF ( XA(1)-X )    100, 160,  10                               02/04/72
 10    L=1                                                             02/04/72
         GO TO 150
 100     DO 120 I=2,N                                                  02/04/72
         IF ( XA(I)-X)  120, 160, 200                                  02/04/72
 120  CONTINUE
C     OFF HIGH END
       I = N                                                           02/04/72
       L= 2                                                            02/04/72
 150  JX1 = I                                                          02/04/72
         GO TO 959
C     ON A POINT
 160  L=-1                                                             02/04/72
      GO TO 150
C     TEST FOR FIRST INTERVAL
 200     IF(I-2) 240,220,240                                           02/04/72
C     FIRST INTERVAL
 220   JX1 = 1                                                         02/04/72
       RA = 1.                                                         02/04/72
         GO TO 400
C     TEST FOR LAST INTERVAL
 240     IF(I-N) 300, 250, 300                                         02/04/72
C     LAST INTERVAL
 250   JX1 = N-3                                                       02/04/72
       RA = 0.                                                         02/04/72
         GO TO 400
 300   JX1 = I-2                                                       02/04/72
       RA = (XA(I)-X) /(XA(I)-XA(I-1) )                                02/04/72
 400   RB = 1. - RA                                                    02/04/72
```

```
C
C     GET COEFFICIENTS AND RESULTS
       J = JX1                                              02/04/72
         DO 500 I=1,3                                       02/04/72
       P(I) = XA(J+1) - XA(J)                               02/04/72
       D(I) = X - XA(J)                                     02/04/72
 500   J = J+1                                              02/04/72
       D4 = X - XA(J)                                       02/04/72
       P4 = P(1) + P(2)                                     02/04/72
       P5 = P(2) + P(3)                                     02/04/72
C     RESULT
      C(1) = RA/P(1)*D(2)/P4   *D(3)                        02/04/72
      C(2) =-RA/P(1)*C(1)/P(2)*D(3) + RB/P(2)*D(3)/P5  *D4  02/04/72
      C(3) = RA/P(2)*D(1)/P4   *D(2) - RB/P(2)*D(2)/P(3)*D4 02/04/72
      C(4) = RB/P5   *D(2)/P(3)*D(3)                        02/04/72
 999   RETURN
       END
```

REFERENCES

1. Standard Values of Atmospheric Absorption as a Function of Temperature and Humidity, Proposed reissue of SAE Aerospace Recommended Practice ARP 866, October 1973.

2. Federal Aviation Regulations, Volume III, Part 36 - Noise Standards: Aircraft Type Certification.