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AEROJET SOLID PROPULSION CO SACRAMENTO CA PROPELLANT --ETC F/G 21/2
MANUAL FOR USE OF COMPUTER PROGRAM S6005 PLUME VISIBILITY AND L--ETC(U)

DEC 76 R M SMITH, J P COUGHLIN, W J REUSS

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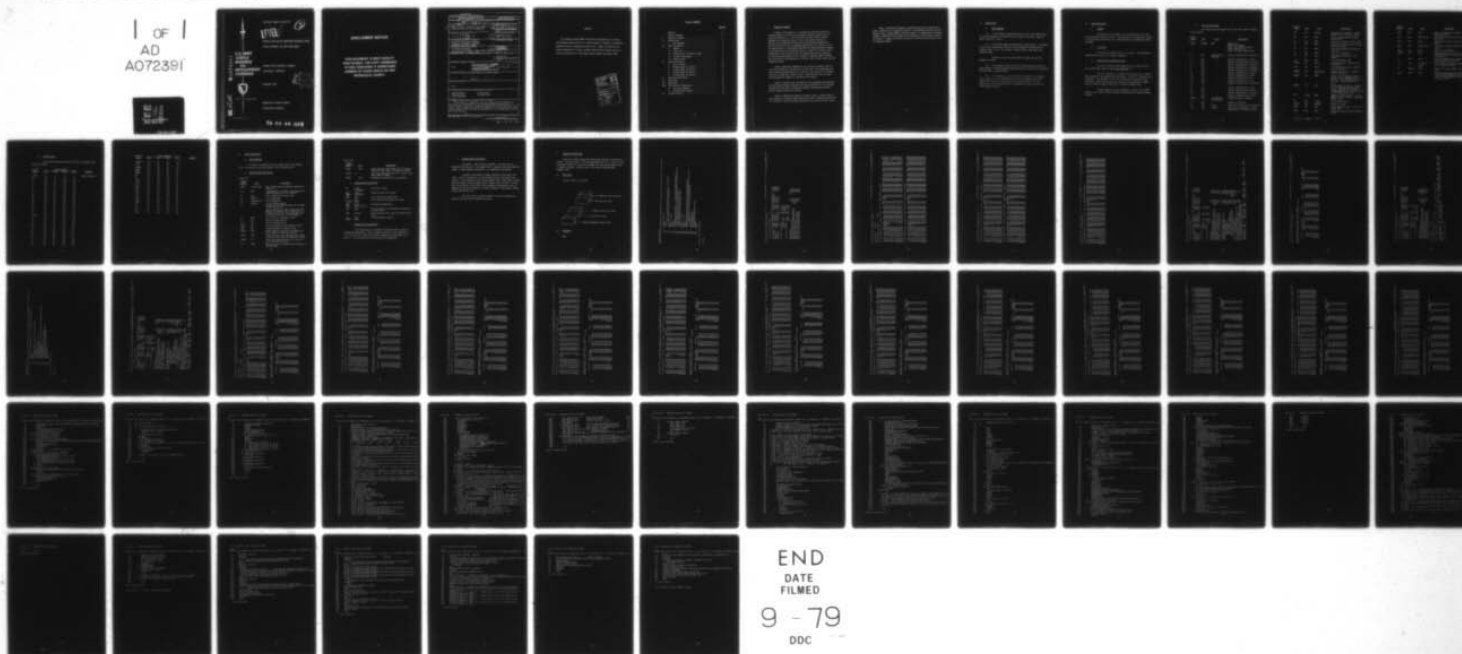
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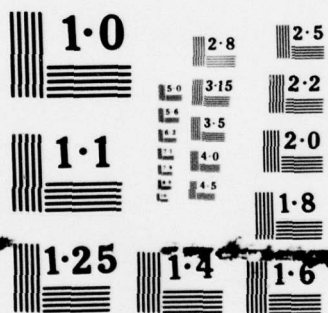
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MICROCOPY RESOLUTION TEST CHART

Technical Report TK-CR-77-2

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MANUAL FOR USE OF COMPUTER PROGRAM SG005

Plume Visibility and Light Attenuation

AD A072391

**U.S. ARMY
MISSILE
RESEARCH
AND
DEVELOPMENT
COMMAND**

Aerojet Solid Propulsion Company

Sacramento, California

December 1976

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This manual is intended for use of the Computer Program SG005 which calculates the concentrations of primary and secondary smoke particles in a rocket exhaust as functions of propellant composition and air-propellant dilution ratio. Output includes time and distance separation of visible secondary smoke from the rocket nozzle exit plane and attenuation of light beams passing through the exhaust plume.		

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ABSTRACT

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I. PURPOSE OF PROGRAM

Purpose of the program is to evaluate the conditions under which secondary smoke will form as solid propellant exhaust products cool by mixing with ambient air. The first portion of this two-part program determines the saturation point of the air-propellant mixture as a function of air:propellant dilution ratio and propellant composition, and the variation of liquid condensate concentration with dilution ratio. The second portion of the program determines the three-dimensional geometry of the propellant-air mixing plume, also as a function of dilution ratio. Combinations of the two portions of the program then permits evaluation of time and distance delays to the incidence of secondary smoke formation and calculation of the attenuation of visible light or laser signals passing through the plume.

Option 0 determines temperature, H_2O saturation pressure, NFRH (no fog relative humidity), concentration of solid and liquid condensates and light transmission coefficient for a series of input values of air temperature and air:propellant dilution ratios. Other required input variables include propellant composition and ambient air pressure.

Option 1 considers only the plume-air mixing geometry and determines time and distance delays associated with the propellant-air mixing process. Required input variables include motor geometry and operating pressure, ambient pressure and missile velocity.

Option 2 combines the features of Options 0 and 1, yielding data of the incidence of secondary smoke formation and light transmission coefficient as a function of time and distance separations from the missile exit plane.

Option 3 determines transmission coefficient and total transmissivity under a specific set of conditions existing in the AMICOM closed test facility. Required input includes ROOMCP, propellant weight, air temperature and relative humidity, transmission path length and the remainder of the variables required for Option 0 - except for dilution ratio which is derived from the input value of propellant weight.

II. RESTRICTIONS

A. ERROR MESSAGES

A.1 If the chemical concentration doesn't total 100.0 grams atoms $\pm$ 0.1 an error message is printed and the next case will be read. (Routine INPUT) (Option 0, 2 and 3).

A.2 If the table input for plume analysis under Option 1 is exceeded by the linear interpolation function an error message is printed and the function value is set to the minimum or maximum value of the table input. (Routine FINTR).

The above is also true under Option 2 except that no error message is printed.

A.3 If the program cannot find the all gas-to-gas/liquid point an error message is printed and the program continues with the next air-propellant dilution ratio. (Routine SEEF0G)

A.4 If the apparent activity of H₂O is less than 0.01 or greater than or equal to 1.0; or the temperature of the air-propellant mixture is greater than 343.16K; an error flag is set (Routine CALCXX). An error message will be printed and the next air-propellant dilution ratio will be tried (Options 0 and 2).

III. INPUT DESCRIPTION

A. GENERAL

The input for this program is in card form and as many cases as desired may be input in one run. The input set for a single case includes: a title card and the namelist set of cards beginning with \$INPUTD and ending with \$END.

A.1 Title Card

The first card of each case is a title card. Any alphanumeric information may be input in columns 1 through 72.

A.2 General Rules for Namelist Input

The first character on each namelist card is always ignored. Thus, always begin namelist input after column one (1).

The first character of a namelist card set must be a \$ immediately followed by the namelist name and a blank. The first 7 characters must be \$INPUTD. The remainder of the first card and the following cards may contain any combination of legal data items which are separated by commas. The last item of a namelist data set is a blank followed by \$END.

Although namelist input can generally be used in any FORTRAN program, users should be aware that minor differences exist between computer machines.

A.3 Variable Input Names

The following variable names can be input under namelist \$INPUTD in this program:

<u>Variable Name</u>	<u>Type</u>	<u>Units</u>	<u>Description</u>
IFLAG	Integer	None	Option Flag Enter 0 for option 0 Enter 1 for plume only option Enter 2 for option 2 Enter 3 for test chamber option
AL	real	gram-atoms per 100 grams	Chemical Concentration of Aluminum
C	real	"	Chemical Concentration of Carbon
CL	real	"	Chemical Concentration of Chlorine
F	real	"	Chemical Concentration of Fluorine
H	real	"	Chemical Concentration of Hydrogen
N	real	"	Chemical Concentration of Nitrogen
O	real	"	Chemical Concentration of Oxygen
PB	real	"	Chemical Concentration of Lead
SN	real	"	Chemical Concentration of Tin
ZN	real	"	Chemical Concentration of Zinc
ZR	real		Chemical Concentration of Zirconium
FE	real	"	Chemical Concentration of Iron
CU	real	"	Chemical Concentration of Copper
CR	real	"	Chemical Concentration of Chromium
S	real	"	Chemical Concentration of Sulfur
DELHF	real	Kilocalories per 100 grams	Propellant heat of formation
P1	real		Ambient air pressure
R1	real	None	Ambient air percent relative humidity
DP	real	microns	Solid particle diameter. Program defaults to 1.0 if value is zero.

<u>Variable Name</u>	<u>Type</u>	<u>Units</u>	<u>Description</u>
DPL	real	microns	Liquid particle diameter. Program defaults to 1.0 if value is zero.
A3	real	None	Initial air-to-propellant weight mixture ratio.
A4	real	None	Step size of mixture ratio to 1000
A5	real	None	Step size of mixture ratio from 1000 to final value A6
A6	real	None	Final air-to-propellant weight mixture ratio
T5	real	Deg F	Initial air temperature
T6	real	Deg F	Temperature increments to final value T7
T7	real	Deg F	Final temperature value
PROPWT	real	grams	Propellant weight. Required only for Option 3.
PTHL	real	meters	Light transmission path. Required only for Option 3.
ROOMCP	real	calories per Deg C	Chamber heat capacity. Required only for Option 3.
WAWPO	real	None	Initial air-to-propellant weight mixture ratio. Required only for Option 1. Program defaults to 1.25 if value is zero under Option 2 only.
DWAWP	real	None	Multiplication factor for succeeding air-to-propellant weight mixture ratios. Required only for Option 1. Program defaults to 1.1892071 if value is zero under Option 2 only. (1)
NW	Integer	None	Number of multiplications. Program defaults to 40 if value is zero under Option 2 only.
RT	real	inches	Nozzle throat radius
ALPHA	real	degrees	Nozzle half angle
EXPR	real	None	Nozzle expansion ratio, exit area to throat area.
EXPO	real	None	Theoretical optimum nozzle expansion ratio

Note (1): $1.1892071 = \sqrt[4]{5}$

<u>Variable Name</u>	<u>Type</u>	<u>Units</u>	<u>Description</u>
PEPA	real	None	Nozzle exit pressure calculated : Ambient pressure.
UJET	real	feet per sec	Calculated jet velocity at nozzle exit plane.
TJET	real	Deg R	Temperature of jet at nozzle exit plane.
UAIR	real	feet per sec	Velocity of airstream relative to missile.
TAIR	real	Deg R	Ambient air temperature
WAWGT	real	None	Weight fraction of air in air-propellant mixture. Maximum number of values 20.
TT	real	Deg R	Calculated temperature at WAWGT. Maximum number of values 20.
CPG	real	cal deg C ⁻¹ gram ⁻¹	Shifting heat capacities at WAWGT. Maximum number of values 20.
NT	Integer	None	Number of values of WAWGT, TT, and CPG.
TREF	real	Deg R	Reference temperature for correcting equilibrium temperature of mixtures. Program defaults to 536.7 if value is zero.

A.4 Required Input

The following variable names are listed as a function of the option flag IFLAG:

<u>Variable Name</u>	<u>Input Required</u>				<u>Comments</u>
	<u>Opt 0</u>	<u>Opt 1</u>	<u>Opt 2</u>	<u>Opt 3</u>	
IFLAG	0	1	2	3	Always required.
AL	Yes	No	Yes	Yes	
CL	Yes	No	Yes	Yes	
F	Yes	No	Yes	Yes	
H	Yes	No	Yes	Yes	
N	Yes	No	Yes	Yes	
O	Yes	No	Yes	Yes	
PB	Yes	No	Yes	Yes	
SN	Yes	No	Yes	Yes	
ZN	Yes	No	Yes	Yes	
ZR	Yes	No	Yes	Yes	
FE	Yes	No	Yes	Yes	
CU	Yes	No	Yes	Yes	
CR	Yes	No	Yes	Yes	
S	Yes	No	Yes	Yes	
DELHF	Yes	No	Yes	Yes	
P1	Yes	No	Yes	Yes	
R1	Yes	No	Yes	Yes	
DP	Yes	No	Yes	Yes	
DPL	Yes	No	Yes	Yes	
A3	Yes	No	Yes	No	
A4	Yes	No	Yes	No	
A5	Yes	No	Yes	No	
A6	Yes	No	Yes	No	
T5	Yes	No	Yes	Yes	
T6	Yes	No	Yes	Yes	
T7	Yes	No	Yes	Yes	

Variable Name	Input Required				Comments
	Opt 0	Opt 1	Opt 2	Opt 3	
PROPWT	No	No	No	Yes	
PTHL	No	No	No	Yes	
ROOMCP	No	No	No	Yes	
WAWPO	No	Yes	No	No	
DWAWP	No	Yes	No	No	
NW	No	Yes	No	No	
RT	No	Yes	Yes	No	
ALPHA	No	Yes	Yes	No	
EXPR	No	Yes	Yes	No	
EXPO	No	Yes	Yes	No	
PEPA	No	Yes	Yes	No	
UJET	No	Yes	Yes	No	
TJET	No	Yes	Yes	No	
UAIR	No	Yes	Yes	No	
TAIR	No	Yes	No	No	
WAWGT	No	Yes	Yes	No	
TT	No	Yes	Yes	No	
CPG	No	Yes	Yes	No	
NT	No	Yes	Yes	No	
TREF	No	Yes	Yes	No	

IV. OUTPUT DESCRIPTION

A. INPUT PRINTING

All input is printed on the first page of each case executed. This is followed by the printed output of the calculated values.

B. PRINTED OUTPUT FOR OPTION 0

<u>Print Title or Program Symbol</u>	<u>Units</u>	<u>Description</u>
HTREL	Kilocalories	Heat release based on complete combustion by ambient air.
A2	None	Stoichiometric air weight ratio required for complete combustion of all elements.
A1	None	Air to propellant dilution ratio.
T4	Degree F	Final temperature.
T3	Degree Kelvin	Final temperature.
R2	Percent	No fog relative humidity. Percent relative humidity above which condensation should occur. Once R2 becomes more than 2% above the input ambient air humidity (R1) condensation is allowed to occur until the calculated value R2 is within 2% of R1, or sign changes.
Y1	None	H ₂ O activity or suppression factor.
P4	mm	Partial pressure HCL gas.
P5	mm	Partial pressure HF gas.
H ₂ OPP	mm	Partial pressure H ₂ O from propellant only.
Y1P6	mm	Saturation partial pressure of H ₂ O.
WTFSOL	None	Weight fraction times 10 ⁶ ; milligrams solid per kilogram air-propellant mixture.
VFSOL	None	Volume fraction solid times 10 ⁶ ; milliliters solids per cubic meter air-propellant mixture.
XSCTAS	m ²	Total cross sectional area of all solids in one cubic meter of volume.
XX	None	Weight fraction of H ₂ O-HCL-HF gas remaining in the gas phase.

<u>Print Title or Program Symbol</u>	<u>Units</u>	<u>Description</u>
VFLIQ	None	Volume fraction liquid times 10^6 ; milliliters liquid per cubic meter air propellant mixture.
XSCTAL	m^2	Total cross-sectional area of all liquid in one cubic meter of volume.
TRFACT	None	Transmission coefficient (I/I_0 per meter).

C. PRINTED OUTPUT FOR OPTION 1

RN	inches centimeters	Nozzle exit radius.
REFF XMREFF	inches centimeters	Effective nozzle exit radius.
WAWP	None	Air to propellant weight ratio.
X X METER	feet meters	Axial distance from nozzle exit plane.
TEMP TKELV	Deg R Degree Kelvins	Afterburning temperature.
UCUJ	None	Ratio of velocity of airstream to exhaust jet at nozzle exit.
TIME	seconds	Time from nozzle exit plane to achieve mixture ratio.
XV SVMETR	feet meters	Distance moved by vehicle.

D. PRINTED OUTPUT FOR OPTION 2

Calculations being as in Option 0 yielding a table at each air temperature and pressure. The air-propellant dilution ratios generated in this first table are stored and utilized to generate a second table as in Option 1, thus two tables are created at each air temperature.

E. PRINTED OUTPUT FOR OPTION 3

The output is again similar to Option 0. But only one air-propellant dilution ratio is considered which is based on the input propellant weight, a stored chamber volume (680.), air temperature and pressure.

The table (using Option 0 format) consists of only one or two lines. The first line prints all the variables with no liquid phase considered. If the computed no fog relative humidity (R2) is more than 2 percent below the ambient relative humidity (R1) a second line is printed. The variables in the second line are with liquid condensate considered so that the computed no fog relative humidity is within 2 percent of the ambient relative humidity ABS (R2-R1) ≤ 2.0 .

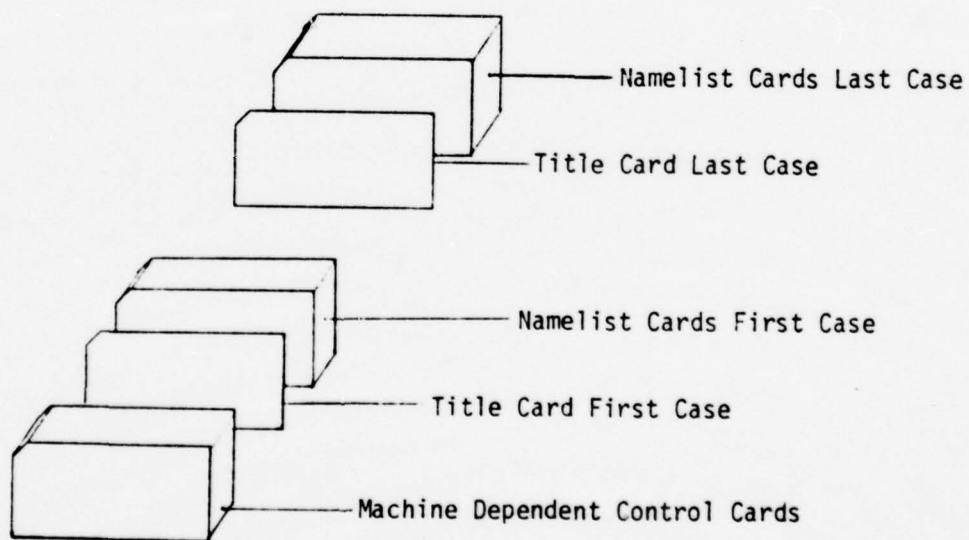
One final value is printed on Option 3 for the transmissivity based on the input total transmission distance.

V. OPERATING INSTRUCTIONS

There are no special operating instructions required to execute this program. Card input unit is 5 and printed output unit is 6. Total run time and printed output will vary with the number of cases and the options used. In general, execution time per cases in less than 5 system seconds. (UNIVAC & CDC).

VI. DECK SETUP

The deck setup is as follows:



VII. REFERENCES

None.

(CYCLES)

```

1.  EXPLAMF A IFIAG=0
2.  SIMPLYN
3.  IFIAG=0
4.  C=1.6576,I=3.2171,I=2.2A09,C=2.8059,DELTF=-7.73,PJ=258.4,
5.  A3=100,A4=100,A5=1900,A6=10000,I5=-6,I6=9177=-22
6.  SEND
7.  EXPLAMF B IFIAG=1
8.  SIMPLYN
9.  IFIAG=1
10. C=0,I=0,N=0,U=0,DELTF=0,P1=0      A3=0,A4=0,A5=0,I5=0,I6=0,I7=0
11. WAFO=0,OWAMP=2,I4=10,I1=5,ALPHA=15,EXPR=5,FXPO=9,UJET=8350,IJET=2500,
12. LAIR=0,TAIR=56.7,WAIR=7.75,M=65.5,95.1,
13. I1=2816,3456,3006,2475,1926,1305,536.7,
14. C6=2.403,348,326,308,289,267,240,      I1=7,
15. SEND
16. EXPLAMF C IFIAG=3
17. SIMPLYN
18. IFIAG=3
19. WAFC=0,OWAMP=0,I4=0,I1=0,ALPHA=0,EXPR=0,FXPO=0,UJET=0,IJET=0
20. UATN=0,IATN=0,WAIR=0,I4=0,U4=0,I1=0,I0=0,Q4=0,C6=0,0,0,0,0,N1=0,
21. C=1.6233,I=3.4557,C=2.9170,I=1.8928,CL=0,1192
22. DELTF=-21.04
23. A3=0,A4=0,A5=0,A6=0
24. I5=-40,I6=1.0,I7=-40,
25. PROJKT=2.1,PCOMP=6020,PTL=5.324
26. P1=760,U,
27. SEND

```

ENC 111. TIME: 0.1344 SECONDS.

ACT PAIR

MAJOR CONTROL FLAG (IFLAG) = 0

-----CHEMICAL CONCENTRATION (GRAM AICPS/100 GRAMS)-----
ALUMINUM (AL) .00000 CARBON (C) 1.65740 CHLORINE (CL) .00000
FLUORINE (F) .00000 HYDROGEN (H) 3.21710 NITROGEN (N) 2.28090
OXYGEN (O) 2.80490 LEAD (PB) .00000 TIN (SN) .00000
ZINC (ZN) .00000 ZIRCONIUM (Zr) .00000 THOR (FE) .00000
COPPER (CU) .00000 CHROMIUM (CR) .00000 SULFUR (S) .00000

DILUTION RATIO INITIAL A= 100.00
STEPS TO 1000 A= 100.00
STEPS TO FINAL A= 1500.00
FINAL A=10000.00
AIR TEMPERATURE (DEG F) INITIAL T= -28.00
STEPS T= 9.00
FINAL T= -22.00

PRESSURE (MM) P1= 256.400
RELATIVE HUMIDITY OF AIR R1= .000
HEAT OF FORMATION (KILOCALORIES/100GRAMS) FLMF= -7.730
HEAT CAPACITY OF LAB ROOM (CALORIES/DEG C) ROOMCP= .000
PROPellant WEIGHT (GRAMS) PROCP= .000
PATH LENGTH OF LIGHT SIGNAL (METERS) PTHL= .000
DIAMETER OF SOLID PARTICLE (MICRONS) CPE= 1.000
DIAMETER OF LIQUID PARTICLE (MICRONS) NPL= 1.000

HEAT RELEASE= -241.141

STOICHIOMETRIC AIR RATIO 1.46233

AIR TEMPERATURE(REF F)= -58.00 (REF M)= 223.16 PRESSURE(MP)= 258.400

A1	I4	I3	F2	Y1	P4	F5	H2OPF	YIP6	WFESOL	VFSOL	XSCIAS	XX	VFLIG	XSCIAL	TRFACI
100.0	129.44	322.2929320.8	1.0000	1.0000	0.000	0.000	1.154	08.504	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
200.0	21.74	273.02	13556.8	1.0000	0.000	0.000	1.154	4.526	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
300.0	1.54	256.46	2225.4	1.0000	0.000	0.000	.400	1.057	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
400.0	-13.00	245.16	582.5	1.0000	0.000	0.000	.301	.474	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
500.0	-21.50	243.17	150.5	1.0000	0.000	0.000	.241	.285	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
550.0	-27.52	239.47	.5	1.0000	0.000	0.000	.201	.201	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
600.0	-27.57	239.44	-.4	1.0000	0.000	0.000	.201	.200	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
700.0	-32.25	237.46	.9	1.0000	0.000	0.000	.155	.155	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
800.0	-35.47	235.68	-1.8	1.0000	0.000	0.000	.128	.127	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
900.0	-37.57	234.29	1.7	1.0000	0.000	0.000	.109	.109	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
1000.0	-39.57	233.18	-.2	1.0000	0.000	0.000	.086	.086	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
2000.0	-51.78	226.62	11.2	1.0000	0.000	0.000	.042	.045	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
4000.0	-54.24	225.25	43.2	1.0000	0.000	0.000	.025	.038	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
6700.0	-55.31	224.66	59.1	1.0000	0.000	0.000	.018	.035	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
8600.0	-55.50	224.33	67.8	1.0000	0.000	0.000	.014	.034	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000

AIR TEMPERATURE(REF F)= -57.00 (REF M)= 228.16 PRESSURE(MP)= 258.400

A1	I4	I3	F2	Y1	P4	F5	H2OPF	YIP6	WFESOL	VFSOL	XSCIAS	XX	VFLIG	XSCIAL	TRFACI
100.0	129.44	327.2921100A.9	1.0000	1.0000	0.000	0.000	1.154	113.816	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
200.0	40.74	278.02	10667.4	1.0000	0.000	0.000	.600	6.428	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
300.0	10.54	261.46	2366.2	1.0000	0.000	0.000	.400	1.672	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
400.0	-4.00	253.16	878.4	1.0000	0.000	0.000	.301	.773	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
500.0	-12.50	248.17	434.2	1.0000	0.000	0.000	.241	.474	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
600.0	-18.57	244.44	256.3	1.0000	0.000	0.000	.201	.338	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
700.0	-23.25	242.46	172.0	1.0000	0.000	0.000	.172	.265	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
800.0	-26.47	240.68	127.5	1.0000	0.000	0.000	.150	.219	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
900.0	-28.57	239.29	102.4	1.0000	0.000	0.000	.134	.189	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
1000.0	-30.57	238.16	87.5	1.0000	0.000	0.000	.120	.168	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
2000.0	-42.78	231.62	72.5	1.0000	0.000	0.000	.082	.081	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
4000.0	-45.24	230.25	61.1	1.0000	0.000	0.000	.025	.069	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
6700.0	-46.31	229.66	85.8	1.0000	0.000	0.000	.018	.064	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
8600.0	-46.50	229.33	88.7	1.0000	0.000	0.000	.014	.062	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000

AIR TEMPERATURE(NEG F)= -40.00 (NEG M)= 233.16 PRESSURE(M)= 258.400

A1	T4	T3	R2	Y1	P4	P5	K2CPP	YIP6	WTF SOL	VFSOL	XSCIAS	XX	VFLIC	XSCIAL	TRFACT
100.0	176.44	332.29	128.9	1.0000	.0000	.0000	1.194	145.264	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
200.0	49.74	423.02	879.3	1.0000	.0000	.0000	.600	9.006	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
300.0	10.54	266.46	2256.6	1.0000	.0000	.0000	.400	2.606	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
400.0	5.00	258.16	977.4	1.0000	.0000	.0000	.301	1.217	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
500.0	2.58	253.17	555.3	1.0000	.0000	.0000	.241	.774	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
600.0	5.57	249.84	374.4	1.0000	.0000	.0000	.201	.560	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
700.0	14.25	247.46	281.1	1.0000	.0000	.0000	.172	.442	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
800.0	17.47	245.68	227.3	1.0000	.0000	.0000	.150	.369	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
900.0	19.57	244.29	183.7	1.0000	.0000	.0000	.134	.320	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
1000.0	21.57	243.18	171.4	1.0000	.0000	.0000	.120	.285	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
2000.0	33.78	236.62	103.8	1.0000	.0000	.0000	.042	.141	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
4000.0	36.24	235.25	100.3	1.0000	.0000	.0000	.025	.121	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
6700.0	37.31	234.66	59.6	1.0000	.0000	.0000	.018	.114	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
8000.0	37.50	234.33	59.3	1.0000	.0000	.0000	.014	.110	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000

AIR TEMPERATURE(NEG F)= -31.00 (NEG M)= 238.16 PRESSURE(M)= 258.400

A1	T4	T3	R2	Y1	P4	P5	K2CPP	YIP6	WTF SOL	VFSOL	XSCIAS	XX	VFLIC	XSCIAL	TRFACT
100.0	147.44	337.25	1104.6	1.0000	.0000	.0000	1.194	144.064	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
200.0	58.74	428.02	712.7	1.0000	.0000	.0000	.600	12.471	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
300.0	28.54	271.46	2146.6	1.0000	.0000	.0000	.400	3.978	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
400.0	14.00	263.16	986.3	1.0000	.0000	.0000	.301	1.946	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
500.0	5.02	258.17	558.1	1.0000	.0000	.0000	.241	1.239	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
600.0	5.57	254.84	423.4	1.0000	.0000	.0000	.201	.907	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
700.0	5.25	252.46	329.8	1.0000	.0000	.0000	.172	.723	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
800.0	8.47	250.68	273.7	1.0000	.0000	.0000	.150	.608	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
900.0	10.57	249.29	237.1	1.0000	.0000	.0000	.134	.530	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
1000.0	12.57	248.18	211.3	1.0000	.0000	.0000	.120	.474	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
2000.0	24.78	241.62	119.3	1.0000	.0000	.0000	.042	.242	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
4000.0	27.24	240.25	110.4	1.0000	.0000	.0000	.025	.209	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
6700.0	28.31	239.66	106.8	1.0000	.0000	.0000	.018	.196	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
8000.0	28.50	239.33	105.3	1.0000	.0000	.0000	.014	.190	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000

AIR TEMPERATURE(F)= -22.00 (NEG KI)= 243.16 PRESSURE(MM)= 256.400

A1	T4	T3	F2	Y1	P4	P5	H2OPP	YIP6	WTFSOL	VFSOL	XSTAS	XX	VFLIC	XSTAL	TRFACT
100.0	156.44	342.29	8175.5	1.0000	.0000	.0000	1.194	231.621	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
200.0	67.74	232.02	5821.5	1.0000	.0000	.0000	.600	17.078	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
300.0	37.54	276.46	1855.5	1.0000	.0000	.0000	.400	5.774	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
400.0	23.00	266.16	954.7	1.0000	.0000	.0000	.201	3.010	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
500.0	14.02	253.17	601.5	1.0000	.0000	.0000	.241	1.948	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
600.0	8.03	259.84	437.3	1.0000	.0000	.0000	.201	1.444	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
700.0	3.75	257.46	247.3	1.0000	.0000	.0000	.172	1.160	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
800.0	.53	255.68	252.6	1.0000	.0000	.0000	.150	.982	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
900.0	-1.57	254.29	253.3	1.0000	.0000	.0000	.134	.861	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
1000.0	-3.57	253.18	250.0	1.0000	.0000	.0000	.120	.774	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
2500.0	-15.78	246.62	128.0	1.0000	.0000	.0000	.042	.406	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
4800.0	-18.24	245.25	115.2	1.0000	.0000	.0000	.025	.333	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
6700.0	-18.21	244.66	110.4	1.0000	.0000	.0000	.018	.312	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
8600.0	-15.50	244.33	107.3	1.0000	.0000	.0000	.014	.321	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000

POZZLE EXIT RADII = 1.500(INCHES) 3.810(CM)
EFFECTIVE ACZZLE EXIT RADIUS = 1.500(INCHES) 3.810(CM)

W A I R / A P M C H	A X I A L L I S T A N C E F R O M E X I T P L A N E (F E E T)	T E M P E R A T U R E (D E G . F)	U / V L J E T	T I M E F R O M E X I T (S E C O N D S)	D I S T A N C E M O V E D B Y V E H I C L E (F E E T)	D I S T A N C E M O V E D B Y V E H I C L E (M E T E R)
.00	1.00	2500.00	1.0000	.0012	.00	.00
5.00	6.66	2652.00	.1667	.0015	.00	.00
10.00	8.98	1813.09	.0909	.0036	.00	.00
20.00	11.70	1268.41	.0476	.0067	.00	.00
40.00	14.82	911.48	.0244	.0194	.00	.00
80.00	19.20	726.40	.0123	.0450	.00	.00
160.00	25.57	632.14	.0062	.1347	.00	.00
320.00	34.83	584.57	.0031	.3816	.00	.00
640.00	48.17	560.67	.0016	1.0921	.00	.00
1280.00	67.24	548.70	.0008	3.1205	.00	.00
2560.00	94.35	542.70	.0004	8.8622	.00	.00

MAJOR CONTROL FLAG (JFLAG) = 3

-----CHEMICAL CONCENTRATION (GRAM ATOMS/100 GRAMS)-----
 ALUMINUM(AL) .00000 CARBON(C) 1.58330 CHLORINE(CL) .11920
 FLUORINE(F) .00000 HYDROGEN(H) 3.45970 NITROGEN(N) 1.89880
 OXYGEN(O) 2.91700 LEAD(PB) .00000 TIN(SN) .00000
 ZINC(ZN) .00000 ZIRCONIUM(ZR) .00000 IRON(IE) .00000
 COPPER(CU) .00000 CHROMIUM(CR) .00000 SULFUR(S) .00000

DILUTION RATIO INITIAL A3= .00
 STEPS TO 1000 A4= .00
 STEPS TO FINAL A5= .00
 FINAL A6= .00
 AIR TEMPERATURE(CEG F) INITIAL T5= -40.00
 STEPS T6= 1.00
 FINAL T7= -40.00

PRESSURE(MP) P1= 760.000
 RELATIVE HUMIDITY OF AIR A1= .000
 HEAT OF FORMATION(MILICALORIES/100GRAMS) DELHFE -21.040
 HEAT CAPACITY OF LAB ROOM(CALORIES/DEG C) ROOMCPE 6020.000
 PROPELLANT WEIGHT(GRAMS) PROPPATE 62.100
 PATH LENGTH OF LIGHT SIGNAL(METERS) PTHLE 5.334
 DIAMETER OF SOLID PARTICLE(MICRONS) CPE 1.000
 DIAMETER OF LIQUID PARTICLE(MICRONS) DPEL= 1.000

HEAT RELEASE= -227.039

STOICHIOMETRIC AIR RATIO 1.32561

AIR TEMPERATURE(CEG F)=-40.00 (CEG K)= 233.16 PRESSURE(MP)= 760.000

A1	T4	T3	H2	Y1	P4	P5	M20PF	Y1P6	WTSOL	VFSOL	XSCIAS	XX	VFLIQ	XSCIAL	TRFACI
470.0	-20.56	243.96	-715.6	.3086	.0548	.0000	.782	.095	.0000	.0000	.0000	1.0000	.0000	.0000	.0000
470.0	-19.17	244.73	1.4	.4241	.0093	.0000	.130	.131	.0000	.0000	.0000	.1660	.8806	1.3209	.0000

TRANSMISSIVITY = .00001 FOR PATH LENGTH P1H1)

END OF ALL INPUT DATA STOP

FLY, I INSTCASE/0
 PROCESSED BY UNIVAC 1100 SERIES ELT PROCESSOR LEVEL 4A AT 11:57:26 AM ON TUESDAY, DECEMBER 14, 1976 (CYCLE 0)

1. SMOKELESS PROCP.B(15XAP)AIR VEL.=0.5FA LEVFL*THROAT D=1.0*OPTION 2
 2. IIRPUT0
 3. IFLAG=2
 4. C=1.4550,C1=0.1277, H=2.2226, A=2.0034, O=2.9111
 5. F1=160.41=0.0P=0,
 6. DELHE=-17.67
 7. A3=100.44=100.45=1900.46=10000.
 8. TS=-0.416=9.417=49.
 9. MT=0.4ALPHA=15.4EXPR=10.4FXFC=A.26.PEPA=0.769.UJFI=8359.4TJET=2493.
 10. UAIR=0.4TAIR=533.7
 11. KAMEI=0.7.0.75.0.8.0.85.0.9.0.95.1.0
 12. TT=3816.43456.43006.42475.41526.41305.4536.7
 13. CPU=4403.4348.4326.4304.4284.4267.4240
 14. NT=7.4TRBF=0.0
 15. SEFC

END ELT. TIME: 0.0966 SECONDS.

XCT MAIN

MAJOR CONTROL FLAG (IFLAG) = 2

-----CHEMICAL CONCENTRATION (GRAM ATOMS/100 GRAMS)-----
 ALUMINUM(AL) .00000 CARBON(C) 1.45500 CHLORINE(CL) .12770
 FLUORINE(F) .00000 HYDROGEN(H) 3.32260 NITROGEN(N) 2.00340
 OXYGEN(O) 2.91130 LEAD(PB) .00000 TIN(SN) .00000
 ZINC(ZN) .00000 ZIRCONIUM(ZR) .00000 IRON(FE) .00000
 CUPPER(CU) .00000 CHROMIUM(CR) .00000 SILICON(SI) .00000

DILUTION RATIO INITIAL A3= 100.00
 STEPS TO 1000 A4= 100.00
 STEPS TO FINAL A5= 1500.00
 FINAL A6=10000.00
 AIR TEMPERATURE(DEC F) INITIAL T5= -59.00
 STEPS T6= 5.00
 FINAL T7= 45.00

PRESSURE(P) 760.000
 RELATIVE HUMIDITY OF AIR RH= .000
 HEAT OF FORMATION(MILOCALORIES/100GRAMS) OFLEH= -17.670
 HEAT CAPACITY OF LAB ROOMICALORIES/DEC C) RCOMCP= .000
 PROPELLANT WEIGHT(GRAMS) PROPRTE= .000
 PART LENGTH OF LIGHT SIGNAL(METERS) PTL= .000
 DIAMETER OF SOLID PARTICLE(MICRONS) CPE 1.000
 DIAMETER OF LIQUID PARTICLE(MICRONS) DPLE 1.000

INITIAL VALUE OF WAIN/WPHOP WAPRO= 1.250
 MULTIPLICATION FACTOR FOR WAIN/WPHOP DWAPRO= 1.189
 NOZZLE THROAT RADIUS(INCHES) RT= .500
 HALF ANGLE(DEGREE) ALPHA= 15.000
 EXPANSION RATIO EXPR= 10.000
 OPTIMUM EXPANSION RATIO EXPO= 8.260
 EXIT TO AMBIENT PRESSURE RATIO PERP= .769
 EXIT EXHAUST JET VELOCITY(FT/SEC) UJET= 4359.000
 EXIT EXHAUST TEMPERATURE(DEC F) TJET= 2493.000
 EXIT EXHAUST VELOCITY(FT/SEC) UATHE= .000
 AIR STREAM TEMPERATURE(DEC F) TATHE= 536.700

NUMBER OF VALUE FOR CALCULATION OF WAIN/WPHOP NWE 40
 NUMBER OF VALUES IN FOLLOWING TABLE NTE 7
 AIR TEMPERATURE USED IN CALC. OF TABLE(DEC.R) THREE
 TABLE AIR/EXHAUST MIXTURE TEMPERATURE(DEC.R) AND
 SPECIFIC HEAT(CEG) AS A FUNCTION OF WAINGT
 WAINGT TT CPG WAINGT TT CPG
 .7000 3810.00 .4020 1 .7500 3456.00 .3440 2
 .5000 1926.00 .2490 5 .9500 1305.00 .2670 6

WAINGT TT CPG
 .4500 2475.00 .3080 4
 1.0000 536.70 .2400 7

----- A R M Y M I S S I L E C O M M A N D M O N T G O M E R Y A L A B A M A ----- OPTION 2 -----

HEAT RELEASE= -214.222

STOICHIOMETRIC AIR RATIO 1.10210

AIR TEMPERATURE(°F)= -50.00 ICEE M)= 223.14 PRESSURE(PH)= 760.000

A1	T4	T3	F2	Y1	P4	P5	P20PP	Y1P6	WFSCL	VFSCL	XSCIAS	XX	VELIC	XSCIAL	TRFACI
100.0	100.60	311.2710527.4	.6936	.2747	.0000	3.447	4.267	1.941	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
180.4	30.36	472.25	-.7	.4469	.1551	.0000	1.941	1.941	.0000	.0000	.0000	1.0000	.0000	.0000	.0000
200.0	21.76	267.47	-.1	.4495	.1019	.0000	1.275	1.275	.0000	.0000	.0000	.7200	.5975	.8969	.1031
300.0	-4.72	252.76	-1.4	.4258	.0258	.0000	.317	.317	.0000	.0000	.0000	.2710	1.1324	1.6986	.0000
400.0	-16.00	245.38	1.4	.4137	.0118	.0000	.144	.144	.0000	.0000	.0000	.1600	.9953	1.4949	.0000
500.0	-26.58	240.95	.6	.4060	.0073	.0000	.091	.091	.0000	.0000	.0000	.1300	.8517	1.2776	.0000
600.0	-31.51	237.95	.6	.4009	.0052	.0000	.066	.066	.0000	.0000	.0000	.1120	.7337	1.1005	.0000
700.0	-35.12	235.87	1.3	.3976	.0041	.0000	.051	.052	.0000	.0000	.0000	.1020	.6416	.9627	.0374
800.0	-37.57	234.29	1.6	.3952	.0024	.0000	.043	.043	.0000	.0000	.0000	.0970	.5646	.8530	.1470
900.0	-40.20	233.05	.6	.3928	.0020	.0000	.037	.037	.0000	.0000	.0000	.0940	.5053	.7640	.2360
1000.0	-41.57	232.06	1.8	.3916	.0026	.0000	.033	.033	.0000	.0000	.0000	.0930	.4614	.6921	.3079
2900.0	-52.47	226.23	1.6	.3825	.0013	.0000	.016	.016	.0000	.0000	.0000	.1310	.1565	.2347	.7653
4200.0	-54.66	225.02	1.7	.3807	.0011	.0000	.014	.014	.0000	.0000	.0000	.1840	.0452	.1337	.8663
4700.0	-55.61	224.49	-.1	.3778	.0011	.0000	.013	.013	.0000	.0000	.0000	.2500	.0569	.0844	.9114
4600.0	-56.13	224.20	1.4	.3750	.0010	.0000	.012	.012	.0000	.0000	.0000	.3000	.0425	.0643	.9257

NOZZLE EXIT RADIUS = 1.281(INCHES) 4.016(ICP)
EFFECTIVE NOZZLE EXIT RADIUS = 1.694(INCHES) 4.302(ICP)

WAVELENGTH	AXIAL DISTANCE FROM EXIT PLANE (FEET)	TEMPERATURE (DEG.R)	U/UJET	TIME FROM EXIT (SECONDS)	DISTANCE MOVED BY VEHICLE (FEET)
100.00	21.41	558.00	.0099	.06851	.00
140.42	27.07	488.74	.0055	.15845	.00
200.00	28.26	480.30	.0050	.16610	.00
300.00	33.67	454.19	.0033	.34420	.00
400.00	38.50	441.10	.0025	.53600	.00
500.00	42.41	433.23	.0020	.75600	.00
600.00	46.15	427.98	.0017	1.00114	.00
700.00	49.60	424.23	.0014	1.26891	.00
800.00	52.83	421.42	.0012	1.57570	.00
900.00	55.66	419.23	.0011	1.85571	.00
1000.00	58.74	417.48	.0010	2.19215	.00
2000.00	98.39	407.14	.0003	9.90605	.00
4200.00	126.05	404.98	.0002	22.12707	.00
4700.00	148.63	404.05	.0001	37.57348	.00
4600.00	168.18	403.53	.0001	55.08203	.00

A M Y M I S I L F C O M A T U MONTSVILLE ALABAMA -----
 -----SPOKELESS PROP.(P)AIR VEL.=0SEA LEVEL+THCAT D=1,UAOPTIC 2
 AIR TEMPERATURE(DEG F)= -43.00 (DEG M)= 22F.16 PRESSURE(MM)= 760.000

A1	T4	T5	R2	Y1	P4	P5	P20PF	TYPE	WTF SOL	VFSOL	XSC TAS	XX	WFLG	XSCYAL	TRF ACT
100.0	105.60	314.27	80567.0	7212	.2787	.0000	3.487	44.297	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
200.0	30.76	272.47	452.1	4458	.1400	.0000	1.752	2.016	.0000	.0000	.0000	1.0300	.0000	.0000	1.0000
200.1	27.22	270.56	-0	4543	.1340	.0000	1.676	1.676	.0000	.0000	.0000	1.0000	.0000	.0000	.0000
300.0	4.28	257.76	1.1	4441	.0413	.0000	.517	.518	.0000	.0000	.0000	.4420	.8500	1.2749	.0000
400.0	-9.00	250.34	1.0	4221	.0199	.0000	.248	.249	.0000	.0000	.0000	.2350	.6435	1.2659	.0000
500.0	-16.58	244.95	.7	4146	.0125	.0000	.157	.157	.0000	.0000	.0000	.2230	.7452	1.1178	.0000
600.0	-22.21	242.99	1.9	4058	.0051	.0000	.114	.115	.0000	.0000	.0000	.1940	.6522	.9784	.0216
700.0	-26.14	240.47	1.7	4064	.0072	.0000	.090	.091	.0000	.0000	.0000	.1740	.5746	.8619	.1361
800.0	-28.57	239.29	1.1	4034	.0060	.0000	.076	.076	.0000	.0000	.0000	.1720	.5105	.7658	.2342
900.0	-31.20	238.05	1.3	4014	.0052	.0000	.066	.066	.0000	.0000	.0000	.1680	.4514	.6876	.3124
1000.0	-32.57	237.06	1.4	4000	.0047	.0000	.058	.059	.0000	.0000	.0000	.1660	.4153	.6230	.3770
2000.0	-43.47	231.23	-0	3490	.0024	.0000	.030	.030	.0000	.0000	.0000	.2500	.1321	.1982	.8014
4000.0	-45.66	230.02	.6	3482	.0021	.0000	.026	.026	.0000	.0000	.0000	.2500	.0696	.1043	.8957
6700.0	-46.61	229.49	1.3	3484	.0019	.0000	.024	.024	.0000	.0000	.0000	.2500	.0423	.0634	.9366
8600.0	-47.13	229.20	2.0	3484	.0018	.0000	.023	.024	.0000	.0000	.0000	.2520	.0265	.0403	.9597

NOZZLE EXIT RADII = 1.6911 INCHES 4.016 (CM)
 EFFECTIVE NOZZLE EXIT RADII = 1.6941 INCHES 4.302 (CM)

WATM/WPHOM	AXIAL DISTANCE FROM EXIT PLANE (FEET)	TEMPERATURE (DEG. R)	U/UJET	TIME FROM EXIT (SECOND)	DISTANCE MOVED BY VEHICLE (FEET)
100.00	21.57	566.80	.0092	.06938	.00
200.00	28.51	489.15	.0050	.18543	.00
209.06	29.05	485.77	.0048	.19874	.00
300.00	32.99	463.09	.0033	.34653	.00
400.00	34.60	450.02	.0025	.54060	.00
400.00	42.84	442.17	.0020	.76331	.00
600.00	46.62	436.94	.0017	1.01132	.00
700.00	50.12	433.15	.0014	1.28225	.00
800.00	53.34	430.38	.0012	1.57430	.00
900.00	56.45	428.20	.0011	1.88603	.00
1000.00	59.35	426.45	.0010	2.21626	.00
2500.00	59.46	416.13	.0003	10.01896	.00
4000.00	127.44	413.94	.0002	22.37682	.00
6700.00	150.26	413.04	.0001	37.79436	.00
8600.00	170.04	412.52	.0001	55.70130	.00

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AIR TEMPERATURE (CEG F) = -40.00    PRFSSURE (MM) = 760.000

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A1	T4	I3	H2	X1	P4	F2	L20P6	YIP6	WFSOL	VFSQL	XSCIAS	RX	VFLIC	XSCIAL	IMPACT
100.0	318.40	321.27	629.82	.7483	.2797	.0000	2.447	62.449	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
200.0	347.76	277.47	1429.2	.5036	.1400	.0000	1.752	3.118	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
201.1	27.59	248.49	- .0	.4511	.1116	.0000	1.396	1.356	.0000	.0000	.0000	1.0000	.0000	.0000	
300.0	17.28	262.76	1.0	.4421	.0663	.0000	.629	.630	.0000	.0000	.0000	.7090	.4348	.6522	.3478
400.0	- .00	258.5A	1.8	.4304	.0527	.0000	.409	.411	.0000	.0000	.0000	.4660	.6162	.5244	.0756E
500.0	- 7.5F	250.94	2.0	.4223	.0210	.0000	.262	.264	.0000	.0000	.0000	.3730	.5854	.6840	.3160
600.0	- 12.31	247.95	1.5	.4183	.0165	.0000	.193	.195	.0000	.0000	.0000	.3300	.5313	.7969	.2031
700.0	- 17.12	246.87	2.0	.4150	.0123	.0000	.154	.156	.0000	.0000	.0000	.3070	.4762	.7127	.3273
800.0	- 19.57	244.29	- .4	.4115	.011E	.0000	.132	.132	.0000	.0000	.0000	.3000	.4226	.6341	.3659
900.0	- 22.20	243.04	1.8	.4104	.0091	.0000	.114	.115	.0000	.0000	.0000	.2910	.3826	.6739	.4261
9800.0	- 23.57	242.06	1.7	.40E7	.00+2	.0000	.104	.104	.0000	.0000	.0000	.2900	.3463	.5194	.4806
9900.0	- 24.47	242.23	- .3	.3970	.00+4	.0000	.05E	.05E	.0000	.0000	.0000	.4500	.60948	.1423	.6777
4400.0	- 26.66	238.02	- 1.0	.3948	.00+8	.0000	.04A	.047	.0000	.0000	.0000	.6500	.0367	.0550	.8450
8700.0	- 37.61	234.94	- .7	.3942	.00+6	.0000	.04S	.044	.0000	.0000	.0000	.8500	.0113	.0169	.9431
6600.0	- 37.43	234.20	2.0	.34E9	.00+3	.0000	.04I	.04E	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000

AO7/LE EXIT RADIUS = 1.58 (INCHES) 4.016 (CM)
EFFECTIVE AC22LF EXIT RADIUS = 1.654 (INCHES) 4.302 (CM)

RAIN/WIND	AXIAL DISTANCE FROM EXIT PLANE (FEET)	TEMPERATURE (DEG. R)	U/LJET	TIME FROM EXIT (SECOND)	DISTANCE COVERED BY VEHICLE (FEET)
100.00	21.73	575.51	.0099	.07024	.00
200.00	26.76	498.01	.0050	.18781	.00
251.14	31.73	482.13	.0040	.26748	.00
300.00	34.31	471.59	.0033	.35253	.00
400.00	39.05	454.95	.0025	.54893	.00
500.00	43.26	451.12	.0020	.77427	.00
600.00	47.09	445.89	.0017	1.02316	.00
700.00	50.62	442.15	.0014	1.29922	.00
800.00	53.92	439.35	.0012	1.59461	.00
900.00	57.02	437.17	.0011	1.90990	.00
1000.00	59.97	435.42	.0010	2.24367	.00
2500.00	100.52	425.11	.0003	10.13360	.00
4200.00	128.40	39.26	.0002	22.62763	.00
6700.00	151.88	422.97	.0001	36.21439	.00
8700.00	171.67	421.52	.0001	56.51752	.00

-----M I S S I L E C O M P A T I D M U T I S V I L L E A L A B A M A -----OPTION: 2

-----S P E C I F I C P R O P . P A I R V E L . 0 S E A L E V E L . P R C A T D E 1 . 0 0 P I O I . 2

AIR TEMPERATURE (DEG F) = -11.00 (DEG M) = 234.16 PRESSURE (MM) = 760.000

A1	14	13	12	Y1	P4	P5	P2OPP	YIP6	WFSOL	VFSOL	XSCIAS	XX	VFLG	XSCIAL	IMFACT
100.0	127.60	326.27	44471.2	.7741	.2747	.0000	3.087	83.752	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
200.0	48.76	482.47	1770.6	.5408	.1400	.0000	1.752	4.698	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
300.0	22.28	267.76	56.8	.4476	.0915	.0000	1.170	1.331	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
322.2	18.65	249.74	.9	.4469	.0871	.0000	1.090	1.052	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
400.0	9.00	260.38	1.8	.4485	.0829	.0000	.662	.655	.0000	.0000	.0000	.7540	.2784	.4177	.5821
400.0	1.02	258.95	1.8	.4415	.0345	.0000	.432	.435	.0000	.0000	.0000	.6140	.3557	.5336	.4664
600.0	-4.71	272.59	1.5	.4266	.0258	.0000	.322	.324	.0000	.0000	.0000	.5160	.3252	.5246	.4754
700.0	-8.12	280.87	1.8	.4234	.0207	.0000	.259	.262	.0000	.0000	.0000	.5000	.2352	.4879	.5121
800.0	-10.57	288.25	1.7	.4208	.0176	.0000	.220	.223	.0000	.0000	.0000	.5000	.2555	.4439	.5561
900.0	-13.20	298.08	.5	.4182	.0156	.0000	.196	.196	.0000	.0000	.0000	.5000	.2644	.3966	.6034
1000.0	-14.57	297.06	.5	.4166	.0141	.0000	.176	.177	.0000	.0000	.0000	.5000	.2359	.3584	.6416
2000.0	-25.47	241.23	-1.7	.4045	.0078	.0000	.097	.094	.0000	.0000	.0000	.8000	.0358	.0507	.5483
4000.0	-27.66	240.02	6.5	.4121	.0059	.0000	.073	.084	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
6700.0	-28.61	239.49	19.1	.4294	.0042	.0000	.053	.083	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
8000.0	-29.13	239.20	25.1	.4432	.0031	.0000	.041	.082	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000

NOZZLE EXIT RADIUS = 1.5811 (INCHES) 4.016 (CM)
EFFECTIVE NOZZLE EXIT RADIUS = 1.654 (INCHES) 4.302 (CM)

BATH/WEPOH	AXIAL DISTANCE FROM EXIT PLANE (FEET)	TEMPERATURE (DEG. R) (MELVITS)	U/JOFT	TIME FROM EXIT (SECONDS)	DISTANCE MOVED BY VEHICLE (FEET)
100.00	21.88	584.27	.0059	.07109	.00
200.00	29.01	506.86	.0050	.19016	.00
300.00	34.62	480.90	.0033	.35428	.00
222.27	35.75	477.50	.0031	.39630	.00
400.00	39.42	467.88	.0025	.55412	.00
500.00	43.68	460.06	.0020	.78205	.00
600.00	47.55	454.84	.0017	1.03580	.00
700.00	51.12	451.11	.0014	1.31295	.00
800.00	54.46	448.31	.0012	1.61125	.00
900.00	57.60	446.13	.0011	1.93045	.00
1000.00	60.57	444.39	.0010	2.26813	.00
2000.00	101.57	434.11	.0003	10.24234	.00
4000.00	130.16	431.56	.0002	22.87266	.00
6700.00	153.44	431.04	.0001	36.62662	.00
8000.00	173.66	430.52	.0001	56.92406	.00

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AIRG TEMPERATURE (REG F) = -22.00   (DEG K) = 243.16   PRESSURE (MM) = 760.000

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A1	T4	T3	H2	Y1	P4	F2	P20P	Y1P6	WFSOL	VFSQL	XCTAS	YK	VFELIC	XSTAL	INFAC7
100.0	136.60	331.27	3012.6	.7995	.2747	.0000	3.487	110.561	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
200.0	57.76	487.47	1239.2	.5777	.1400	.0000	1.752	6.558	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
300.0	31.22	472.76	338.4	.4965	.0915	.0000	1.170	2.000	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
400.0	14.00	265.58	73.5	.4493	.0702	.0000	.878	1.027	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
498.1	10.14	261.02	.0	.4353	.0564	.0000	.704	.706	.0000	.0000	.0000	1.0000	.0000	.0000	.0000
500.0	10.02	260.95	.0	.4250	.0462	.0000	.703	.701	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
600.0	4.65	257.99	.0	.4347	.0421	.0000	.527	.524	.0000	.0000	.0000	5000	.0762	.1143	.8457
700.0	.82	255.67	.0	.4316	.0301	.0000	.427	.432	.0000	.0000	.0000	.F500	.0966	.1482	.851A
800.0	-1.57	254.29	1.3	.4293	.0231	.0000	.364	.369	.0000	.0000	.0000	.8200	.0958	.1457	.8503
900.0	-4.120	253.05	2.0	.4274	.0257	.0000	.321	.327	.0000	.0000	.0000	.P220	.0923	.1384	.8616
9500.0	-5.57	252.0E	1.5	.4239	.0235	.0000	.295	.295	.0000	.0000	.0000	.8500	.0703	.1054	.8946
99900.0	-16.47	246.23	16.3	.4243	.0057	.0000	.121	.169	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
9A00.0	-18.66	245.02	29.6	.4573	.0059	.0000	.073	.158	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
97000.0	-20.61	244.49	36.0	.4749	.0042	.0000	.053	.175	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
97000.0	-20.113	244.20	40.1	.4490	.0033	.0000	.041	.155	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000

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AOZZLE EXIT RADIUS = 1.691(1A.CHFS)  4.016(CM)
EFFECTIVE ACZZLE EXIT RADIUS = 1.694(1A.CHFS)  4.302(CM)

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RAJIN/AFKOP	AXIAL DISTANCE FROM EXIT PLATE (FEET)	TEMPERATURE (DEG. R)	U/LJFT	TIME FROM EXIT (SECONDS)	DISTANCE MOVED BY VEHICLE (FEET)
100.00	22.04	592.95	0.099	0.07193	0.00
200.00	29.25	515.72	0.050	0.19248	0.00
300.00	34.93	489.80	0.033	0.35854	0.00
400.00	39.79	476.81	0.025	0.55552	0.00
496.10	44.02	469.12	0.020	0.78546	0.00
500.00	44.05	465.00	0.020	0.79011	0.00
600.00	46.01	463.79	0.017	1.04668	0.00
700.00	51.62	460.07	0.014	1.32688	0.00
800.00	54.99	457.27	0.012	1.62466	0.00
900.00	58.16	455.10	0.011	1.95113	0.00
1000.00	61.17	453.36	0.010	2.29248	0.00
2500.00	102.60	443.17	0.003	10.45346	0.00
4000.00	131.49	440.56	0.002	23.11543	0.00
6700.00	155.07	440.02	0.001	39.03525	0.00
8000.00	175.48	439.51	0.001	57.52453	0.00

OPTION 2

A R I Y M I S S I L E C O M P A N D HUNTSVILLE ALABAMA
 SPOCKETLESS PROP. R (153AP) AIR VEL. = 0.5 SEA LEVEL THROAT DEL. U
 AIR TEMPERATURE (F) = -13.00 (C) = 240.16 PRESSURE (MM) = 760.000

A1	T4	T3	R2	Y1	P4	F5	P2OPP	Y1FF	WFSOL	VFSOL	XSCIAS	XX	VFILIC	XSCIAL	TRFACI
100.0	145.60	356.27	29919.7	.8155	.2787	.0000	3.487	143.813	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
200.0	66.76	292.47	1779.7	.6137	.1400	.0000	1.752	10.135	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
300.0	40.28	277.76	467.3	.5145	.0915	.0000	1.170	3.376	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
400.0	27.00	270.38	157.5	.4984	.0702	.0000	.878	1.811	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
500.0	15.02	265.95	103.4	.4791	.0562	.0000	.703	1.151	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
600.0	13.65	262.99	65.7	.4681	.0468	.0000	.586	.697	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
700.0	5.28	260.87	48.8	.4617	.0402	.0000	.502	.732	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
800.0	7.03	259.29	35.4	.4679	.0351	.0000	.440	.628	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
900.0	4.80	258.05	28.4	.4658	.0312	.0000	.391	.558	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
1000.0	3.03	257.06	23.1	.4648	.0281	.0000	.352	.508	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
2500.0	-7.47	251.23	35.1	.4780	.0047	.0000	.121	.307	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
4000.0	-5.66	250.02	44.8	.5016	.0029	.0000	.073	.266	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
6700.0	-10.61	249.49	48.1	.5150	.0042	.0000	.053	.281	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
8600.0	-13.13	249.20	50.4	.5128	.0033	.0000	.041	.280	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000

NOZZLE EXIT RADIUS = 1.2811 (INCHES) 4.016 (CM)
 EFFECTIVE NOZZLE EXIT RADIUS = 1.694 (INCHES) 4.302 (CM)

WAIN/WFROM	AXIAL DISTANCE FROM EXIT PLANE (FEET)	TEMPERATURE (DEGR)	U/UJET	TIME FROM EXIT (SECOND)	DISTANCE MOVED BY VEHICLE (FEET)
100.00	22.20	6.77	.0099	.07277	.00
200.00	25.50	8.96	.0050	.19478	.00
300.00	35.24	10.74	.0033	.36276	.00
400.00	40.15	12.24	.0025	.56600	.00
500.00	44.50	13.57	.0020	.79904	.00
600.00	48.46	14.77	.0017	1.05841	.00
700.00	52.11	15.88	.0014	1.34164	.00
800.00	55.52	16.92	.0012	1.64683	.00
900.00	58.73	17.90	.0011	1.97256	.00
1000.00	61.76	18.83	.0010	2.31754	.00
2500.00	103.63	31.59	.0003	10.46279	.00
4000.00	142.82	40.48	.0002	23.35664	.00
6700.00	156.63	47.74	.0001	39.44041	.00
8600.00	177.26	54.03	.0001	58.11560	.00

----- A R M Y M I S S I L E C O M M A N D HUNTSVILLE ALABAMA -----CASE 1 PAGE 8
 -----SPORTE(FSD PROP,R(155AP1)AIR VEL=0.0SEA LEVEL,HMOAT D=1.0,OPTION, 2 -----

AIR TEMPERATURE(REF F)= -4.00 (REF MI= 23.14 PRESSURE(MM)= 760.000

A1	T4	T3	R2	Y1	P4	P5	P3CPP	YIP6	WTFOL	VFSOL	XSCTAS	XX	VFLIC	XSCTAL	TRFART
100.0	154.60	343.27	2378.4	.6191	.2747	.0000	3.487	185.546	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
200.0	75.76	297.47	1642.4	.6489	.1400	.0000	1.752	14.537	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
300.0	45.28	242.76	505.7	.5721	.0935	.0000	1.170	5.065	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
400.0	36.00	276.39	259.0	.5368	.0702	.0000	.678	2.874	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
500.0	28.02	270.95	165.0	.5183	.0562	.0000	.703	1.975	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
600.0	22.69	267.99	119.5	.5074	.0468	.0000	.586	1.506	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
700.0	18.68	265.47	55.6	.5020	.0402	.0000	.502	1.240	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
800.0	16.03	264.29	31.2	.4986	.0351	.0000	.440	1.072	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
900.0	13.00	263.05	13.4	.4968	.0312	.0000	.341	.958	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
1000.0	12.03	262.06	67.0	.4960	.0281	.0000	.312	.875	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
2000.0	1.23	256.23	24.0	.5204	.0097	.0000	.121	.538	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
4000.0	-.66	251.02	25.4	.5435	.0059	.0000	.073	.502	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
6700.0	-1.61	244.49	27.0	.5617	.0042	.0000	.053	.493	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
8600.0	-2.13	244.20	28.5	.5759	.0033	.0000	.041	.491	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000

NOZZLE EXIT RADIUS = 1.2311 INCHES) 4.014 (CM)
 EFFECTIVE NOZZLE EXIT RADIUS = 1.694 INCHES) 4.302 (CM)

WAIM/KPHOF	AXIAL DISTANCE FROM EXIT PLANE (FEET)	TEMPERATURE (DEG.R)	U/UJET	TIME FROM EXIT (SECONDS)	DISTANCE FROM VEHICLE (FEET)	DISTANCE MOVED BY VEHICLE (FEET)
100.00	22.35	610.34	.0099	.07360	.00	.00
200.00	29.74	533.43	.0050	.19706	.00	.00
300.00	35.55	507.61	.0033	.36693	.00	.00
400.00	40.51	494.66	.0025	.57240	.00	.00
500.00	44.91	486.82	.0020	.80796	.00	.00
600.00	48.91	481.69	.0017	1.07003	.00	.00
700.00	52.60	477.98	.0014	1.35631	.00	.00
800.00	56.04	475.20	.0012	1.66473	.00	.00
900.00	59.28	473.04	.0011	1.99385	.00	.00
1000.00	62.35	471.30	.0010	2.34241	.00	.00
2500.00	104.65	461.04	.0003	10.57107	.00	.00
4000.00	134.13	458.95	.0002	23.59547	.00	.00
6700.00	158.19	458.02	.0001	39.84154	.00	.00
8600.00	179.02	457.51	.0001	58.70910	.00	.00

ATM TEMPERATURE (DEG F) = 50.00 (DEG M) = 25.00 PRESSURE (MM Hg) = 760.000
 WTSOL VFSOL XSTAS XX VFLG XSTAL TMFACT
 100.0 163.60 346.27 1529.0 6.441 .2747 .0000 3.4870** OUTSIDE DATA RANGE .0000 1.0000 .0000 1.0000
 200.0 147.76 302.47 1529.0 6.441 .2747 .0000 3.4870** OUTSIDE DATA RANGE .0000 1.0000 .0000 1.0000
 300.0 132.28 277.76 1529.0 6.441 .2747 .0000 3.4870** OUTSIDE DATA RANGE .0000 1.0000 .0000 1.0000
 400.0 117.76 252.47 1529.0 6.441 .2747 .0000 3.4870** OUTSIDE DATA RANGE .0000 1.0000 .0000 1.0000
 500.0 102.28 227.76 1529.0 6.441 .2747 .0000 3.4870** OUTSIDE DATA RANGE .0000 1.0000 .0000 1.0000
 600.0 87.76 202.47 1529.0 6.441 .2747 .0000 3.4870** OUTSIDE DATA RANGE .0000 1.0000 .0000 1.0000
 700.0 72.28 177.76 1529.0 6.441 .2747 .0000 3.4870** OUTSIDE DATA RANGE .0000 1.0000 .0000 1.0000
 800.0 57.76 152.47 1529.0 6.441 .2747 .0000 3.4870** OUTSIDE DATA RANGE .0000 1.0000 .0000 1.0000
 900.0 42.28 127.76 1529.0 6.441 .2747 .0000 3.4870** OUTSIDE DATA RANGE .0000 1.0000 .0000 1.0000
 1000.0 27.76 102.47 1529.0 6.441 .2747 .0000 3.4870** OUTSIDE DATA RANGE .0000 1.0000 .0000 1.0000
 2000.0 12.28 77.76 1529.0 6.441 .2747 .0000 3.4870** OUTSIDE DATA RANGE .0000 1.0000 .0000 1.0000
 3000.0 -3.28 52.47 1529.0 6.441 .2747 .0000 3.4870** OUTSIDE DATA RANGE .0000 1.0000 .0000 1.0000
 4000.0 -18.76 27.76 1529.0 6.441 .2747 .0000 3.4870** OUTSIDE DATA RANGE .0000 1.0000 .0000 1.0000
 5000.0 -34.28 2.47 1529.0 6.441 .2747 .0000 3.4870** OUTSIDE DATA RANGE .0000 1.0000 .0000 1.0000
 6000.0 -49.76 -2.47 1529.0 6.441 .2747 .0000 3.4870** OUTSIDE DATA RANGE .0000 1.0000 .0000 1.0000
 7000.0 -65.28 -27.76 1529.0 6.441 .2747 .0000 3.4870** OUTSIDE DATA RANGE .0000 1.0000 .0000 1.0000
 8000.0 -80.76 -52.47 1529.0 6.441 .2747 .0000 3.4870** OUTSIDE DATA RANGE .0000 1.0000 .0000 1.0000
 9000.0 -96.28 -77.76 1529.0 6.441 .2747 .0000 3.4870** OUTSIDE DATA RANGE .0000 1.0000 .0000 1.0000
 10000.0 -111.76 -102.47 1529.0 6.441 .2747 .0000 3.4870** OUTSIDE DATA RANGE .0000 1.0000 .0000 1.0000

NOZZLE EXIT RADIUS = 1.281 (INCHES) 4.018 (CM)
 EFFECTIVE NOZZLE EXIT RADIUS = 1.654 (INCHES) 4.302 (CM)

WAVELENGTH	AXIAL DISTANCE FROM EXIT PLANE (FEET)	TEMPERATURE (DEG R)	WAVELENGTH (METERS)	TIME FROM EXIT (SECONDS)	DISTANCE MOVED BY VEHICLE (METERS)
100.00	22.50	619.10	383.94	.07442	.00
200.00	25.97	542.25	501.27	.19932	.00
300.00	45.82	516.51	286.55	.37106	.00
400.00	40.86	503.56	279.77	.57874	.00
500.00	45.31	495.82	275.46	.81678	.00
600.00	49.35	490.65	272.58	1.08163	.00
700.00	53.08	486.94	270.52	1.37083	.00
800.00	46.56	484.16	268.98	1.68243	.00
900.00	55.83	482.00	267.78	2.01491	.00
1000.00	62.91	480.27	266.82	2.36763	.00
2500.00	105.65	470.07	261.15	10.67827	.00
4000.00	135.43	467.94	259.97	23.83192	.00
6700.00	159.72	467.02	259.45	40.23867	.00
8000.00	180.76	466.50	259.17	59.29256	.00

A I R T E M P E R A T U R E (D E G F) = 1 4 . 0 0 (I F G M) = 2 6 3 . 1 6 P R E S S U R E (M M) = 7 6 0 . 0 0 0									
43	T4	T5	P2	Y1	P4	P5	P20PP	YIP6	WFSOL
100.0	172.60	251.27	127.6	7153	.2787	.0000	3.487	.0000	DATA RANGE
200.0	93.76	307.87	458.3	6446	.0935	.0000	1.752	28.625	.0000 .0000
300.0	67.28	252.76	286.4	6120	.0702	.0000	.878	10.856	.0000 .0000
400.0	54.00	405.58	204.1	5811	.0562	.0000	.703	6.438	.0000 .0000
500.0	46.02	240.95	163.2	5255	.0468	.0000	.586	4.268	.0000 .0000
600.0	40.69	277.99	129.6	5801	.0402	.0000	.502	3.756	.0000 .0000
700.0	36.88	275.87	124.6	5772	.0351	.0000	.440	3.215	.0000 .0000
800.0	34.03	274.29	114.4	5758	.0312	.0000	.351	2.862	.0000 .0000
900.0	31.20	273.05	105.7	5755	.0281	.0000	.352	2.614	.0000 .0000
1000.0	30.03	272.06	72.7	6026	.0057	.0000	.121	2.407	.0000 .0000
2000.0	10.53	266.23	70.0	6260	.0029	.0000	.073	1.536	.0000 .0000
4000.0	17.34	265.02	69.7	6435	.0042	.0000	.053	1.409	.0000 .0000
6000.0	16.29	264.49	70.0	6473	.0033	.0000	.041	1.402	.0000 .0000
8000.0	15.87	264.20							.0000 .0000

NOZZLE EXIT RADIUS = 1.2 (INCHES) 4.016 (CM)
 EFFECTIVE NOZZLE EXIT RADIUS = 1.694 (INCHES) 4.302 (CM)

W A I R / V E H I C L E		A X I A L D I S T A N C E		T E M P E R A T U R E		U / A I R J E T		T I M E F R O M		D I S T A N C E M O V E D	
		FROM EXIT PLANE		(DEG.R)	(MILVTS)			EXIT		BY VEHICLE	
		(FEET)	(METER)					(SECONDS)		(FEET)	(METER)
100.00	22.65	6.90	627.81	348.70	.0099			.07524	.00	.00	.0000
200.00	30.21	9.21	551.15	306.19	.0050			.20152	.00	.00	.0000
300.00	36.15	11.02	525.42	291.90	.0033			.37515	.00	.00	.0000
400.00	41.22	12.56	512.52	284.73	.0025			.56501	.00	.00	.0000
500.00	45.71	13.93	504.77	280.43	.0020			.82554	.00	.00	.0000
600.00	49.79	15.18	499.60	277.85	.0017			1.09309	.00	.00	.0000
700.00	53.56	16.32	495.90	275.20	.0014			1.38121	.00	.00	.0000
800.00	57.07	17.40	493.13	273.96	.0012			1.69592	.00	.00	.0000
900.00	60.36	18.40	490.97	272.76	.0011			2.03576	.00	.00	.0000
1000.00	63.51	19.36	489.24	271.80	.0010			2.39140	.00	.00	.0000
2000.00	106.65	32.51	479.06	266.14	.0003			10.78440	.00	.00	.0000
4000.00	186.72	41.67	476.92	264.96	.0002			24.06605	.00	.00	.0000
6000.00	161.25	49.15	476.01	264.45	.0001			40.63194	.00	.00	.0000
8000.00	182.48	55.62	475.50	264.17	.0001			59.87033	.00	.00	.0000

----- A R M Y M I S S I L E C O M M A N D , H U N T S V I L L E A L A B A M A -----CASE 1 PAGE 13
 -----S M O K E L E S S P R O P . R (I S S A P) * A I R V E L . = 0 * S E A L E V E L * T H R C A T U = 1 * O P T I O N 2 -----

AIR TEMPERATURE (DEG F) = 23.00 (DEG K) = 26P.16 PRFSSUPP (MM) = 760.000

AL	T4	T5	R2	Y1	P4	P5	P200P	Y1P6	WIFOL	VESOL	XSCIAS	XX	VFLIG	XSCIAL	TRFACI
100.0	101.60	356.27	1249.7	7430	.2787	.0000	3.447	39.1PA	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
200.0	102.76	312.47	477.0	6803	.0935	.0000	1.170	15.503	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
300.0	76.28	297.76	283.5	6420	.0702	.0000	.678	9.350	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
400.0	63.00	290.38	206.1	6316	.0552	.0000	.703	6.294	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
500.0	51.02	285.95	166.0	6227	.0468	.0000	.566	5.598	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
600.0	49.69	282.99	143.8	6178	.0402	.0000	.502	4.823	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
700.0	45.88	280.87	128.7	6153	.0351	.0000	.440	4.314	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
800.0	43.03	279.69	118.6	6141	.0312	.0000	.391	3.580	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
900.0	35.03	277.06	111.2	6139	.0291	.0000	.352	3.696	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
1000.0	28.53	271.43	79.1	6412	.0097	.0000	.121	2.503	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
2000.0	26.34	270.02	75.5	6652	.0059	.0000	.073	2.344	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
4000.0	25.39	269.49	74.8	6831	.0042	.0000	.053	2.302	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
6000.0	24.87	269.20	74.8	6872	.0033	.0000	.041	2.252	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000

NOZZLE EXIT HEIGHT = 1.5411111111111111 4.014 (CM)
 EFFECTIVE NOZZLE EXIT RADIUS = 1.6941111111111111 4.302 (CM)

WAIN/WENOF	AXIAL DISTANCE FROM EXIT PLANE (FEET)	TEMPERATURE (DEG R)	(KELVINS)	U/I JET	TIME FROM EXIT (SECONDS)	DISTANCE MOVED BY VEHICLE (FEET)	(METER)
100.00	22.80	636.53	553.43	.0099	.07605	.00	.00
200.00	30.45	560.00	311.11	.0050	.20378	.00	.00
300.00	36.45	534.32	296.84	.0033	.27520	.00	.00
400.00	41.57	521.44	289.69	.0025	.39123	.00	.00
500.00	46.11	513.71	285.39	.0020	.53417	.00	.00
600.00	50.23	508.55	282.53	.0017	1.10443	.00	.00
700.00	54.03	504.84	280.48	.0014	1.35945	.00	.00
800.00	57.58	502.05	278.94	.0012	1.71729	.00	.00
900.00	60.92	499.94	277.74	.0011	2.05641	.00	.00
1000.00	64.08	498.22	276.79	.0010	2.41553	.00	.00
2000.00	107.64	488.05	271.14	.0003	10.88952	.00	.00
4000.00	137.99	485.93	269.96	.0002	24.29794	.00	.00
6000.00	162.75	485.01	269.45	.0001	41.02144	.00	.00
8000.00	184.14	484.50	269.16	.0001	60.44259	.00	.00

-----A R F Y M I S S I L E C O M M A N D HUNTSVILLE ALABAMA-----CAS 1 PAGE 12
 -----SMOKELISS PROP.R(158AP)AIR VEL=0.5FA LEVEL*THKCAT D=1.0*OPTION 2-----

AIR TEMPERATURE(REF F)= 32.00 (NEG K)= 273.16 PRESSURE(MM)= 760.000

AL	I4	I4	R2	Y1	P4	P5	P20PP	Y1P6	WFSOL	VFSOL	XSCAS	XX	VELIC	XSCAL	IRFACI
100.0	190.50	361.27	1126.3	.7700	.2787	.0000	3.487	.0000	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
200.0	111.76	317.47	452.2	.7129	.0955	.0000	1.752	.0000	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
300.0	85.28	302.76	276.5	.6940	.0702	.0000	.170	.0000	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
400.0	72.00	298.38	204.1	.6679	.0562	.0000	.703	.0000	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
500.0	64.02	290.95	166.7	.6593	.0468	.0000	.586	.0000	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
600.0	58.65	287.89	144.5	.6546	.0402	.0000	.502	.0000	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
700.0	54.48	285.87	130.1	.6522	.0351	.0000	.440	.0000	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
800.0	52.03	284.29	120.0	.6512	.0312	.0000	.391	.0000	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
900.0	49.80	283.05	112.7	.6512	.0281	.0000	.352	.0000	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
1000.0	48.03	282.06	81.7	.6797	.0057	.0000	.121	.0000	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
2500.0	37.13	276.23	78.6	.7037	.0059	.0000	.073	.0000	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
4000.0	35.14	275.02	77.5	.7154	.0042	.0000	.053	.0000	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
6700.0	34.39	274.49	77.5	.7154	.0042	.0000	.053	.0000	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000
8600.0	33.87	274.20	77.5	.7318	.0033	.0000	.041	.0000	.0000	.0000	.0000	1.0000	.0000	.0000	1.0000

ACZLE EXIT MAULS = 1.581(INCHES) 4.016(CM) 4.302(CM)
 EFFECTIVE ACZLE EXIT RADIUS = 1.694(INCHES)

WATH/WFROM	AXIAL DISTANCE FROM EXIT PLANE (FEET)	TEMPERATURE (DEG.R)	TEMPERATURE (KELVINS)	U/UJET	TIME FROM EXIT (SECONDS)	DISTANCE MOVED BY VEHICLE (FEET)
100.00	22.95	7.00	645.25	.0099	.07685	.00
200.00	30.68	9.35	560.88	.0050	.20596	.00
300.00	36.74	11.20	543.22	.0033	.38322	.00
400.00	41.91	12.78	530.37	.0025	.59738	.00
500.00	46.50	14.17	522.65	.0020	.84274	.00
600.00	50.66	15.44	517.50	.0017	1.11565	.00
700.00	54.50	16.61	513.82	.0014	1.41355	.00
800.00	58.09	17.70	511.06	.0012	1.73447	.00
900.00	61.46	18.73	508.91	.0011	2.07666	.00
1000.00	64.65	19.70	507.15	.0010	2.43943	.00
2500.00	108.62	33.11	497.04	.0003	10.99363	.00
4000.00	139.26	42.44	494.92	.0002	24.52764	.00
6700.00	164.25	50.06	494.00	.0001	41.40729	.00
8600.00	185.89	56.66	493.49	.0001	61.00550	.00

ARMY MISSILE COMMAND, HANESVILLE ALABAMA ---OPTION 2
 SKETCHES PROP. BURNING AIR VFL=SEA LEVEL TARGET=1.0 OPTION 2

AIR TEMPERATURE DEG F= 41.00 (DEG K= 278.16 PRESSURE(MM)= 749.000

A1	T4	T3	R2	Y1	P4	P5	H2OPP YIP6	WTFOL VFSCL	VSCTAS	XX	VFLG	XSCTAL	TRFAC1
100.0	159.60	366.27	1074.0	7565	.2787	.0000	3.487000	DATA MAI GE	.0000	1.0000	.0000	.0000	1.0000
200.0	120.76	322.47	447.7	7412	.0925	.0000	1.752	.0000	.0000	.0000	.0000	.0000	1.0000
300.0	94.28	307.76	280.8	7162	.0702	.0000	1.170	.0000	.0000	.0000	.0000	.0000	1.0000
400.0	81.00	300.58	211.0	7035	.0562	.0000	.703	.0000	.0000	.0000	.0000	.0000	1.0000
500.0	73.02	298.95	174.0	6958	.0464	.0000	.466	.0000	.0000	.0000	.0000	.0000	1.0000
600.0	67.69	292.59	151.6	6913	.0402	.0000	.502	.0000	.0000	.0000	.0000	.0000	1.0000
700.0	63.88	290.87	126.8	6851	.0351	.0000	.440	.0000	.0000	.0000	.0000	.0000	1.0000
800.0	61.03	289.29	126.8	6851	.0351	.0000	.440	.0000	.0000	.0000	.0000	.0000	1.0000
900.0	58.80	288.05	119.1	6883	.0312	.0000	.391	.0000	.0000	.0000	.0000	.0000	1.0000
1000.0	57.03	287.06	119.1	6883	.0281	.0000	.352	.0000	.0000	.0000	.0000	.0000	1.0000
2500.0	46.53	281.23	86.5	7154	.0057	.0000	.121	.0000	.0000	.0000	.0000	.0000	1.0000
4000.0	44.24	280.02	82.5	7268	.0059	.0000	.073	.0000	.0000	.0000	.0000	.0000	1.0000
6700.0	43.29	279.49	81.8	7266	.0042	.0000	.053	.0000	.0000	.0000	.0000	.0000	1.0000
8600.0	42.87	278.20	81.5	7252	.0033	.0000	.041	.0000	.0000	.0000	.0000	.0000	1.0000

NOZZLE EXIT MAJUS = 1.2311(MHFS) 4.016(CM) 4.302(CM)
 EFFECTIVE NOZZLE EXIT MAJUS = 1.694(MHFS)

WAIN/WPROF	AXIAL DISTANCE FROM EXIT PLANE (FEET)	TEMPERATURE (DEG K)	TEMPERATURE (DEG F)	TIME FROM EXIT (SECOND)	DISTANCE MOVED BY VEHICLE (FEET)
100.00	23.10	7.04	653.56	.07764	.00
200.00	30.91	9.42	577.71	.20813	.00
300.00	37.04	11.29	552.17	.38715	.00
400.00	42.26	12.88	539.30	.60340	.00
500.00	46.89	14.29	531.55	.85123	.00
600.00	51.09	15.57	526.42	1.12677	.00
700.00	54.97	16.75	522.78	1.42751	.00
800.00	58.53	17.86	520.02	1.75147	.00
900.00	61.99	18.89	517.87	2.09712	.00
1000.00	65.21	19.88	516.17	2.46310	.00
2500.00	109.59	33.40	506.02	11.09677	.00
4000.00	140.51	42.88	503.52	24.75522	.00
6700.00	165.73	50.51	503.00	41.78958	.00
8600.00	187.57	57.17	502.49	61.57110	.00

----- PROGRAM LISTING OF S6005

XY

Y UNIVAC 1100 SERIES ELT PROCESSOR LEVEL W2 AT 11:56:33 AM ON TUESDAY, DECEMBER 14,

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1.      SUBROUTINE CALCXX (A1,H1,H2OPP,P2,P4,P5,P6,P2,S2,T3,Y1,Y2,IGC)
2.      REAL LPHF
3.      IGO=1
4.      IF ((P4+P5).EQ.0.0) GO TO 40
5.      IF (T3.GT.343.16) GO TO 30
6.      IF (P4.EQ.0.0) GO TO 10
7.      C----- HCL IS PRESENT
8.      CALL HCLXXX (P4,T3,Y1)
9.      IF (P5.EQ.0.0) GO TO 50
10.     C----- HF AND HCL ARE PRESENT
11.     LPHF=11.5066-2913.5/T3+(-3.63612+267.229/T3)*Y1+(-.167055+49.6686/
12.     1T3)/Y1
13.     ALPHF=EXP(LPHF*2.3026)
14.     PHX=P5+ALPHF
15.     GO TO 20
16.     C----- HF IS PRESENT AND NO HCL
17.     10 PHX=P5
18.     C----- HF AND HCL ARE PRESENT
19.     20 AA=-3.6312*T3+267.229
20.     BB=11.5066*T3-2913.5-T3*LOG(PHX)/2.3026
21.     CC=-.167055*T3+49.6686
22.     IF ((BB**2-4.*AA*CC).LT.0.0) GO TO 30
23.     Y1=(-BB-SQRT(BB**2-4.0*AA*CC))/(2.0*AA)
24.     IF (Y1.GT..01.AND.Y1.LT.1.0) GO TO 50
25.     30 IGO=2
26.     GO TO 60
27.     C----- NO HCL OR HF
28.     40 R2=(100/P2)*(P6-H2OPP)*S2/(A1*100*(1.0+H1)/29.0)
29.     Y1=1.0
30.     GO TO 60
31.     C----- PRINT INFORMATION NOW -----
32.     50 Y2=S2/(A1*100.0*(1+H1)/29.0)
33.     P7=(Y1*P6-H2OPP)*Y2
34.     P2=100.0*P7/P2
35.     60 RETURN
36.     C
37.     END

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TIME: 0.1324 SECONDS.

----- PROGRAM LISTING OF SG005

Y UNIVAC 1100 SERIES ELY PROCESSOR LEVEL WA AT 11:56:33 AM ON TUESDAY, DECEMBER 14,

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1.      C  FUNCTION FINTR
2.      C
3.      C  LINEAR INTERPOLATION FUNCTION
4.      C
5.          FUNCTION FINTR (AA,BB,CC,KPMAX,IFLAG)
6.          DIMENSION AA(1), BB(1)
7.          KPM=1
8.          IF (CC-BB(1)) 50,10,10
9.          10 KPM=0
10.         20 KPM=KPM+1
11.         IF (KPMAX-KPM) 50,30,30
12.         30 IF (CC-BB(KPM)) 40,20,20
13.         40 FINTR=AA(KPM-1)+(CC-BB(KPM-1))/(BB(KPM)-BB(KPM-1))*(AA(KPM)-AA(KPM-1))
14.         RETURN
15.         50 KPM=KPMAX
16.         60 IF (IFLAG.NE.2) WRITE (6,70) CC
17.         FINTR=AA(KPM)
18.         RETURN
19.      C
20.         70 FORMAT (2X,'RANGE OF TABLE EXCEEDED',F10.4)
21.      C
22.      END

```

TIME: 0.1312 SECONDS.

----- PROGRAM LISTING OF SG005

XX

Y LNTVAC 1100 SERIES ELT PROCESSOR LEVEL W8 AT 11:56:33 AM ON TUESDAY, DECEMBER 14,

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1.      SUBROUTINE HCLXXX (P4,T3,Y1)
2.      G=LOG(P4)/2.3026
3.      V1=0.9
4.      V2=0.8
5.      G1=10.608-3990.4/T3
6.      G2=11.169-3885.0/T3
7.      10 IF (G.LT.G2) GO TO 70
8.      IF (ABS(V1-.4).LT..01) GO TO 70
9.      V1=V2
10.     V2=V2-0.1
11.     G1=G2
12.     IF (V2.EQ.0.7) GO TO 20
13.     IF (ABS(V2-0.6).LT.0.01) GO TO 30
14.     IF (ABS(V2-0.5).LT.0.01) GO TO 40
15.     IF (ABS(V2-0.4).LT.0.01) GO TO 50
16.     IF (ABS(V2-0.3).LT.0.01) GO TO 60
17.     20 G2=11.639-3807.1/T3
18.     GO TO 10
19.     30 G2=11.663-3636.4/T3
20.     GO TO 10
21.     40 G2=11.825-3511.9/T3
22.     GO TO 10
23.     50 G2=12.150-3432.9/T3
24.     GO TO 10
25.     60 G2=12.842-3423.5/T3
26.     GO TO 10
27.     70 V=V2-(V2-V1)*(G2-G)/(G2-G1)
28.     Y1=V
29.     RETURN
30.     C
31.     END

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TIME: 0.1338 SECONDS.

----- PROGRAM LISTING OF SG005

T
Y LNTVAC 1100 SERIES EIT PROCESSOR LEVEL W8 AT 11:56:34 AM ON TUESDAY, DECEMBER 14,

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1.      SUBROUTINE INPLT (IFLAG)
2.      REAL MGAS,N
3.      COMMON/INPUTX/ ELEM(15),CELHF,R1,R1
4.      1,A3,A4,A5,A6,T5,T6,T7,ROOMCP,PROPW,PTHL,DPL,UP
5.      COMMON /INPUTP/ WAWPC,DWAWP,NW,RT,ALPHA,EXPR,EXPC,PEPA,UJET,TJET,C
6.      1AIR,TAIR,WAWGT(20),TT(20),CPG(20),NT,TREF
7.      COMMON /INPUTC/ AMASS,HTREL,EXTCX,HTSOL,VOLSOL,HTCAP,MGAS
8.      COMMON /ITITLE/ TITLE(12)
9.      DIMENSION NAME(15), EMASS(15), HTCCMB(15), EQUIV(15), GRAVF(15)
10.     DIMENSION SPVCL(15), CPPROD(15), GAS(15)
11.     DATA NAME /'AL','C','CL','F','H','N','S',
12.     10,'PH','SN','ZN','ZR','FE','CU','CR'
13.     2,'S'/'
14.     DATA EMASS /26.98,12.011,35.457,19.0,1.008,14.008,16.000,207.21,11
15.     13.7,65.38,91.22,55.85,63.54,52.01,32.066/
16.     DATA HTCCMB /-200.2,-94.05,6.84,-36.24,-29.9,0.0,0.0,-51.0,-68.35,
17.     1-43.25,-261.5,-98.4,0.0,-136.325,-70.95/
18.     DATA EQUIV /1.5,2.0,-0.5,-0.5,0.5,0.0,-1.0,1.0,1.0,1.0,2.0,1.5,0.0
19.     1,1.5,2.0/
20.     DATA GRAVF /1.89,0.0,0.0,0.0,0.0,0.0,0.0,1.077,1.135,1.125,1.175,1
21.     1.430,1.0,1.615,0.0/
22.     DATA SPVCL /0.2506,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,
23.     1.1953,0.1121,0.1919,0.0/
24.     DATA CPPROD /9.44,8.88,2.95,2.95,4.015,3.44,0.0,10.95,10.59,9.62,1
25.     13.42,12.40,5.86,14.19,9.53/
26.     DATA GAS /0.0,1.0,0.5,0.5,0.5,0.5,0.0,0.0,0.0,0.0,0.0,0.0,0.0,
27.     11.0/
28.     EQUIVALENCE (ELEM(1),AL), (ELEM(2),C), (ELEM(3),CL), (ELEM(4),F),
29.     1(ELEM(5),H), (ELEM(6),N), (ELEM(7),O), (ELEM(8),PH), (ELEM(9),SN),
30.     2 (ELEM(10),ZN), (ELEM(11),ZR), (ELEM(12),FE), (ELEM(13),CU), (ELEM
31.     3(14),CR), (ELEM(15),S)
32.     NAMELIST /INPUTX/ IFLAG,AL,C,CL,F,H,N,C,PH,SN,ZN,ZR,FE,CU,CR,S,CEL
33.     1HF,R1,R1,A3,A4,A5,A6,T5,T6,T7,WAWPC,DWAWP,NW,RT,ALPHA,EXPR,EXPC,P
34.     2EPA,UJET,TJET,LAIR,TAIR,WAWGT,TT,CPG,NT,TREF,ROOMCP,PROPW,PTHL,D
35.     3PL,UP
36.     10 READ (5,80,END=70) TITLE
37.     CALL TITLEA (2)
38.     READ (5,INPUTD)
39.     IF (CP.EQ.0.0) CP=1.0
40.     IF (DPL.EQ.0.0) DPL=1.0
41.     IF (IFLAG.EQ.2) GO TO 20
42.     IF (WAWPC.EQ.0.0) WAWPC=1.25
43.     IF (DWAWP.EQ.0.0) DWAWP=1.1892071
44.     IF (NW.EQ.0) NW=40
45.     20 WRITE (4,170) IFLAG
46.     WRITE (4,120)
47.     WRITE (4,130) AL,C,CL,F,H,N,C,PH,SN,ZN,ZR,FE,CU,CR,S
48.     WRITE (4,140) A3,A4,A5,A6
49.     WRITE (4,150) T5,T6,T7
50.     WRITE (4,160) R1,R1,CELHF,ROOMCP,PROPW,PTHL,DPL
51.     IF (IFLAG.EQ.0.OR.IFLAG.EQ.3) GO TO 30
52.     WRITE (4,180) WAWPC,DWAWP,RT,ALPHA,EXPR,EXPC
53.     WRITE (4,190) PEPA,UJET,TJET,LAIR,TAIR,NW
54.     WRITE (4,200) NT,TREF,(WAWGT(I),TT(I),CPG(I),I=1,NT)

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----- PROGRAM LISTING OF SG005

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55.      30 IF (IFLAG.NE.3) CALL IITLFA (1)
56.      IF (IFLAG.EQ.1) GO TO 50
57.      AMASS=0.0
58.      EXIOX=0.0
59.      WTSOL=0.0
60.      VOLSOL=0.0
61.      HTCAP=0.0
62.      MGAS=0.0
63.      HTREL=-DELHF
64.      DO 40 I=1,15
65.          IF (ELEM(I).EQ.0.0) GO TO 40
66.          AMASS=AMASS+ELEM(I)*EMASS(I)
67.          HTREL=HTREL+ELEM(I)*HTCONB(I)
68.          EXTOX=EXTOX+ELEM(I)*EGUIV(I)
69.          WTSOL=WTSOL+ELEM(I)*GRJVF(I)*EMASS(I)
70.          VOLSOL=VOLSOL+ELEM(I)*GRAVF(I)*EMASS(I)*SPVOL(I)
71.          HTCAP=HTCAP+ELEM(I)*CPRPCD(I)
72.          MGAS=MGAS+ELEM(I)*GAS(I)
73.      40 CONTINUE
74.      IF (ABS(AMASS-100.0).GT.0.1) GO TO 60
75.      WRITE (6,90) HTREL
76.      50 RETURN
77.      60 WRITE (6,100) AMASS
78.      GO TO 10
79.      70 WRITE (6,110)
80.      STOP
81.  C
82.      80 FORMAT (12A6)
83.      90 FORMAT (1H0,' HEAT RELEASE= ',G15.6)
84.      100 FORMAT ('0 PROPELLANT WEIGHT ERROR RE-CHECK INPUT FOR THIS CASE ',
85.          1F7.3)
86.      110 FORMAT ('0 END OF ALL INPUT DATA STOP ')
87.      120 FORMAT (1H0,5X,10(1H-),'CHEMICAL CONCENTRATION (GRAM ATOMS/100 G-
88.          1ATMS)',10(1H-))
89.      130 FORMAT (6X,'ALUMINUM(AL)',1X,F8.5,2X,'CARBON(C)',4X,F8.5,2X,'CHLOR-
90.          1INE(CL)',1X,F8.5,7,6X,'FLUORINE(F)',2X,F8.5,2X,'HYDROGEN(H)',2X,F8.
91.          2,5,2X,'NITROGEN(N)',2X,F8.5,7,6X,'OXYGEN(O)',4X,F8.5,2X,'LEAD(PB)',
92.          3,5X,F8.5,2X,'TIN(SN)',6X,F8.5,7,6X,'ZINC(ZN)',5X,F8.5,2X,'ZIRCONI-
93.          4UM(ZR)',F8.5,2X,'IRON(Fe)',5X,F8.5,7,6X,'COPPER(CU)',3X,F8.5,2X,'CH-
94.          3ROMIUM(CR)',1X,F8.5,2X,'SULFUR(S)',4X,F8.5)
95.      140 FORMAT (1H0,5X,'DILUTION RATIO INITIAL A3=',F8.2,7,21X,'
96.          1TFS TO 1000 A4=',F8.2,7,21X,'STEPS TO FINAL A5=',F8.2,7,21X,'
97.          2'FINAL A6=',F8.2)
98.      150 FORMAT (1H,5X,'AIR TEMPERATURE(DEG F) INITIAL TS=',F8.2,7,29X,'
99.          1TFS T6=',F8.2,7,29X,'FINAL T7=',F8.2)
100.     160 FORMAT (1H,5X,'PRESSURE(P)"',37X,'P1=',F12.3,7,6X,'RELATIVE HUMI-
101.         1ITY OF AIR R1=',F12.3,7,6X,'HEAT OF FORMS-
102.         2ION(KILOCALORIES/100GRAMS) DELHF=',F12.3,7,6X,'HEAT CAPACITY
103.         3OF LAB ROOM(CALORIES/DEG C) ROOMCP=',F12.3,7,6X,'PROPELLANT HEI-
104.         4GT(GRAMS) PROPT=',F12.3,7,6X,'PATH LENGTH OF L-
105.         5IGHT SIGNAL(METERS) PTHL=',F12.3,7,6X,'DIAMETER OF SPLY-
106.         6 PARTICLE(MICRONS) CP=',F12.3,7,6X,'DIAMETER OF LIQUI-
107.         7 PARTICLE(MICRONS) CPL=',F12.3)
108.     170 FORMAT (1H0,5X,'MAJOR CONTROL FLAG (IFLAG) =',I5)
109.     180 FORMAT (1H0,5X,'INITIAL VALUE OF WAIR/WPROP WA1=
110.         10=',F12.3,7,6X,'MULTIPLICATION FACTOR FOR WAIR/WPROP WA2=
111.         2P=',F12.3,7,6X,'NOZZLE THROAT RADIUS(INCHES)

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----- PROGRAM LISTING OF SG005

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112.      3T='F12.3,/,6X,'      HALF ANGLE(DEGREE)      ALPH
113.      4A='F12.3,/,6X,'      EXPANSION RATIO      EXP
114.      5R='F12.3,/,6X,'      OPTIMUM EXPANSION RATIO      EX
115.      6C='F12.3)
116.      190 FORMAT (1H,5X,'      EXIT TO AMBIENT PRESSURE RATIO      PER
117.      1A='F12.3,/,6X,'      EXIT EXHAUST JET VELOCITY(FT/SEC)      UES
118.      2T='F12.3,/,6X,'      EXIT EXHAUST TEMPERATURE(DEG R)      TUE
119.      3T='F12.3,/,6X,'AIR STREAM VELOCITY(FT/SEC)      UAI
120.      4R='F12.3,/,6X,'      TEMPERATURE(DEG R)      TAI
121.      5R='F12.3,/,6X,'NUMBER OF VALUE FOR CALCULATION OF WAIR/WPROP
122.      6W='I12)
123.      200 FORMAT (1H,5X,'NUMBER OF VALUES IN FOLLOWING TABLE
124.      1T='I12,/,6X,'AIR TEMPERATURE USED IN CALC. OF TABLE(DEG.R) TREF=
125.      2',F12.3,/,6X,'TABLE AIR/EXHAUST MIXTURE TEMPERATURE(TT)(DEG.R) TA
126.      3C ',/,11X,'SPECIFIC HEAT(CPG) AS A FUNCTION OF WAWGT ',/,6X,4('WA
127.      4GT',4X,'TT',6X,'CPG',7X),/, (5X,4(F7.4,F8.2,F7.4,I3,2X))
128.      C
129.      END

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TIME: 0.6324 SECONDS.

----- PROGRAM LISTING OF S6C05

IN
BY UNIVAC 1100 SERIES ELT PROCESSOR LEVEL WA AT 11:56:36 AM ON TUESDAY, DECEMBER 14.

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1.      10 CALL INPUT (IFLAG)
2.      CALL IACCF (10)
3.      CALL IACLF (10)
4.      CALL IACCF (10)
5.      IF (IFLAG.EQ.1) GO TO 20
6.      CALL SEFFOG (IFLAG)
7.      GO TO 10
8.      20 CALL PELME (IFLAG)
9.      GO TO 10
10.     C
11.     END
```

TIME: 0.0612 SECONDS.

----- PROGRAM LISTING OF SG005

LINE

BY UNIVAC 1100 SERIES ELT PROCESSOR LEVEL W8 AT 11:56:36 AM ON TUESDAY, DECEMBER 1-

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1.      SUBROUTINE PLUME (IFLAG)
2.      COMMON /INPUTP/ WAWPO,DWAWP,NW,RT,ALPHA,EXPR,EXPC,PEPA,UJET,TJET,
3.      1AIR,TAIR,WAWGT(20),TT(20),CPG(20),NT,TREF
4.      COMMON /IOPT2/ KKK,AAA(100),TAIR2
5.      C PROGRAM TO CALCULATE THE CENTERLINE DISTRIBUTIONS IN A ROCKET EXHAUST
6.      C JET MIXING WITH THE ADJACENT AIR STREAM (NWC ANALYSIS USED)
7.      C
8.      C *** WAWPO = INITIAL VALUE OF WAIR/WPROP
9.      C *** DWAWP = MULTIPLICATION FACTOR FOR SUCCEEDING VALUES OF WAIR/WPROP
10.     C *** NW = NO. OF WAIR/WPROP VALUES TO BE USED IN CALCULATIONS
11.     C *** RT = NOZZLE THROAT RADIUS (INCHES)
12.     C *** ALPHA = NOZZLE HALF ANGLE (DEG.)
13.     C *** EXPR = NOZZLE EXPANSION RATIO
14.     C *** EXPC = OPTIMUM NOZZLE EXPANSION RATIO (PE/PA=1.)
15.     C *** PEPA = RATIO OF NOZZLE EXIT PRESSURE TO AMBIENT PRESSURE
16.     C *** UJET = PROPELLANT EXHAUST JET VELOCITY AT NOZZLE EXIT (FT/SEC)
17.     C *** TJET = PROPELLANT EXHAUST STATIC TEMPERATURE AT NOZZLE EXIT (DEG.R)
18.     C *** UAIR = VELOCITY OF AIR STREAM (FT/SEC)
19.     C *** TAIR = STATIC TEMPERATURE OF AIRSTREAM (DEG.R)
20.     C ***      TABLE OF TT AND CPG AS FUNCTIONS OF WAWGT
21.     C *** WAWGT = WAIR/(WAIR+WPROP)
22.     C *** TT = STATIC TEMPERATURE OF AIR/EXHAUST MIXTURE (DEG.R)
23.     C *** CPG = SPECIFIC HEAT OF AIR/EXHAUST MIXTURE
24.     C *** TREF = AIR TEMPERATURE USED IN CALCULATING ABOVE TABLES (DEG.R)
25.     C      (IF NOT INPUT, 298.2 K (536.7 R) IS ASSUMED)
26.     C
27.     IF (IFLAG.EQ.2) TAIR=TAIR2*1.8
28.     CR=.0174533
29.     UCUU=UAIR/UJET
30.     IF (TREF.LT.1.) TREF=536.7
31.     DTAIR=TAIR-TREF
32.     RN=RT*SQRT(EXPR)
33.     RNNO=SQRT(EXPR/EXPC)
34.     YEX=(1./RNRC-1.)/TAN(ALPHA*CR)
35.     AR=1.3+(PEPA-1.)*(1.5+(PEPA-3.)*(-.025+(PEPA-5.)*(PEPA-7.)*.000521)
36.     1)
37.     IF (PEPA.LT.0.001) AR=1.0
38.     REFF=RN*AR/RNRC
39.     XMKN=RN*2.54
40.     XMKEFF=REFF*2.54
41.     WRITE (4,20) RN,XMKN,REFF,YMKEFF
42.     WRITE (4,60)
43.     IPLUME=0
44.     XPO=.044
45.     WAWP=WAWPO/DWAWP
46.     DO 40 N=1,NW
47.         IF (IFLAG.NE.2) GO TO 20
48.         IF (IPLUME.EQ.1) GO TO 10
49.         IF (WAWP.LT.AAA(1)) GO TO 20
50.         III=0
51.         IPLUMF=1
52.         10    IIT=III+1
53.         IF (IIT.GT.KKK) GO TO 50
54.         WAWP=AAA(IIT)

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----- PROGRAM LISTING OF SG005

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55.      20  IF (IPLUME.EG.0) WAWP=WAWP*OWAWP
56.      WAWG=WAWP/(1.+WAWP)
57.      CP=FINTR(CPG,WAWGT,WAWG,NT,IFLAG)
58.      TEMP=FINTR(TT,WAWGT,WAWG,NT,IFLAG)
59.      UHU=(UJET/3.28)**2/8372.*UEUJ*(UEUJ-2.)*WAWG*(1.-WAWG)
60.      UTU=OUU/CP
61.      UTA=WAWG*0.24/CP*CTAIR
62.      TEMP=TEMP+UTU+OTA
63.      UCUJ=(1.-WAWG)+WAWG*UEUJ
64.      XP=-1./(4.*ALOG(1.-((UEUJ-UCUJ)/(UEUJ-1.))))
65.      XAN=3A.2*SGRT(XPC/ABS(1.-UEUJ))
66.      XAF1=40.*SGRT((1.+UEUJ)/2.)/ABS(1.-UEUJ)*XPC/(.88+.89*XPC)
67.      CU=SGRT((UCUJ+UEUJ)/2.)/ABS(UCUJ-UEUJ)
68.      XAF2=40.*SGRT(TEMP/TJET)*CL*XP/(.88+.89*XP)
69.      XA=XAN+XAF2-XAF1
70.      IF (N.GT.1) GO TO 30
71.      AZ=(XAN/RNRC+XEX)*AR*RN/12.
72.      TIME=XZ/UJET
73.      UCZ=UJET
74.      Z=0.
75.      CZ=1.
76.      XV=UAIR*TIME
77.      TKELV=TJET/1.8
78.      XMETER=XZ*0.3048
79.      XVMETR=XV*0.3048
80.      IF (IFLAG.NE.2.CP,IPLUME.EG.1) WRITE (6,70) Z,XZ,XMETER,TJET,TK
81.      1LV,ZZ,TIME,XV,XVMETR
82.      30  X=(XA/RNRC+XEX)*AR*RN/12.
83.      UC=UCUJ*UJET
84.      UCB=(UC+UCZ)/2.
85.      TIME=TIME+ALOG(UC/UCZ)*(X-XZ)/(UC-UCZ)
86.      UCZ=UC
87.      XZ=X
88.      XV=UAIR*TIME
89.      TKELV=TEMP/1.8
90.      XMETER=X*0.3048
91.      XVMETR=XV*0.3048
92.      IF (IFLAG.NE.2.CP,IPLUME.EG.1) WRITE (6,70) WAWP,X,XMETER,TEMP,T
93.      1KFLV,UCUJ,TIME,XV,XVMETR
94.      IF (IPLUME.EG.1) GO TO 10
95.      40  CONTINUE
96.      50  RETURN
97.      C
98.      60  FORMAT (7X,'WATR/WRCR',3X,'AXIAL DISTANCE ',6X,'TEMPERATURE',7X,'
99.      1U/UJET',6X,'TIME FROM',6X,'DISTANCE MOVED',2X,'/20X','FROM EXIT PL
100.     25','36X,'EXIT',11X,'BY VEHICLE',/20X,'(FEET) (METER) (CPG.4) (-
101.     3ELVINS)',14X,'(SECOND)',2X,'(FEET)',2X,'(METER)')
102.     70  FORMAT (1X,F14.2,F10.2,F10.4,F13.5,F9.2,F9.2)
103.     80  FORMAT (//2X,'NOZZLE EXIT RADIUS =',F7.3,'(INCHES)',2X,F7.3,'(C
104.     1',/2X,'EFFECTIVE NOZZLE EXIT RADIUS =',F7.3,'(INCHES)',2X,F7.3,'(
105.     2CM'//)
106.      C
107.      END

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TIME: 0.5060 SECONDS.

----- PROGRAM LISTING OF SG005

T
BY UNIVAC 1100 SERIES ELT PROCESSOR LEVEL WA AT 11:56:37 AM ON TUESDAY, DECEMBER 14.

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1.      SUBROUTINE ROOT(N,X,CX,F,E,K)
2.      C
3.      C
4.      I=0
5.      IF=1
6.      J=1
7.      LL=0
8.      LLL=0
9.      NN=100
10.     FS=0.
11.     IF (N.LT.0) LL=1
12.     N=IABS(N)
13.     EP1=0.
14.     EP2=0.
15.     RETURN
16.     C
17.     ENTRY ROOTR (N,X,CX,F,E,K)
18.     E=ABS(E)
19.     IF (ABS(F).LT.0.0001*E) GO TO 30
20.     GO TO (10,50), IF
21.     10 IF (FS=F.LT.0.0) GO TO 30
22.     IF (LL.EQ.0) GO TO 20
23.     IF (J.EQ.1) EP1=F
24.     IF (J.EQ.2) EP2=F
25.     IF ((J.EQ.2).AND.(LL.EQ.1).AND.(ABS(EP2).GT.ABS(EP1)).AND.(EP2*EP1
26.     1.GT.0.0)) LLL=1
27.     IF (LLL.EQ.1) CX=-CX
28.     IF (LLL.EQ.1) LL=0
29.     J=J+1
30.     20 I=I+1
31.     IF (I.GT.N) GO TO 70
32.     XS=X
33.     X=X+CX
34.     FS=F
35.     K=2
36.     RETURN
37.     30 IF=2
38.     I=0
39.     40 XM=(X*FS-XS*F)/(FS-F)
40.     Z=F
41.     IF (ABS(Z).LE.E) GO TO 60
42.     XSS=X
43.     FSS=F
44.     Y=XM
45.     I=I+1
46.     IF (I.GT.NN) GO TO 80
47.     K=2
48.     RETURN
49.     50 IF (F*FS.LT.0.00) GO TO 40
50.     FS=FSS
51.     XS=XSS
52.     GO TO 40
53.     60 Y=XM
54.     K=U

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----- PROGRAM LISTING OF SG005

CG
Y UNIVAC 1100 SERIES ELT PROCESSOR LEVEL 4A AT 11:56:38 AM ON TUESDAY, DECEMBER 14,

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1.      SUBROUTINE SEEF0G (IFLAG)
2.      REAL *MGAS,N
3.      COMMON /INPUTX/ AL,C,CL,F,H,N,O,PH,SN,ZN,ZR,FE,CL,CR,S,DELHF,P1,R1
4.      1,A3,A4,A5,A6,T5,T6,T7,ROCMCP,PROCPWT,PTHCL,BPL,UP
5.      COMMON /INPUTC/ AMASS,HTREL,EXTOX,HTSOL,VCLSOL,HTCAP,MGAS
6.      COMMON /IOPT2/ KKK,AAA(100),TAIR2
7.      DATA C273 /273.16/
8.      IPAGE=0
9.      A2=EXTOX*14.5/21.0
10.     WRITE (A,190) A2
11.     C----- RANGE OF AIR TEMPERATURES T5 TO T7 IN STEPS OF T6 -----
12.     T1=T5
13.     10 T2=(T1+459.69)/1.8
14.     KKK=0
15.     WRITE (6,210) T1,T2,P1
16.     WRITE (A,220)
17.     IF (T2.GE.C273) P2=EXP(20.9484-5306.7/T2)
18.     IF (T2.LT.C273) P2=EXP(24.047-6153.0/T2)
19.     P1=P2*(R1/100.0)/(P1-P2)
20.     IF (IFLAG.NE.3) GO TO 20
21.     C---- VOLUME OF AMICOM TEST FACILITY = 680 CU FT
22.     AIRVOL=680.
23.     AIRMAS=AIRVOL*36.6406*C273/T2
24.     A1=AIRMAS/PROCPWT
25.     GO TO 30
26.     C----- AIR DILUTION RATIO A3 TO A6 STEPS OF A4 AND A4+A5 -----
27.     20 A1=A3
28.     AINCR=A4
29.     KPASS=0
30.     30 IPASS=0
31.     INUGC=0
32.     IF (IFLAG.EQ.3) KPASS=2
33.     ATRACI=1.00
34.     VELIQ=0.0
35.     YSCIAL=0.0
36.     TRFACT=0.0
37.     TRANSF=0.0
38.     H2OPRP=0.5*(H-CL-F)
39.     H2USUM=H2OPRP+100.0*A1*H1/29.0
40.     S2=MGAS+100.*A1*H1/29.+79.*A1/29.+21.*(A1-A2)/29.0
41.     H2OPR=H2OPRP*P1/S2
42.     P4=CL*P1/S2
43.     P5=F*P1/S2
44.     SA=HTCAP+(A1-A2)*21.0*7.02/29.0+A1*79.0*6.96/29.0
45.     IF (IFLAG.NE.3) GO TO 40
46.     C---- CORRECTED HEAT RELEASE FOR CLOSED ROOM MEASUREMENT
47.     GASCP=SA*PROCPWT/100.
48.     CONST1=GASCP/(GASCP+ROCMCP)
49.     HTREL=HTREL*CONST1
50.     40 T3=-1000.0*HTREL/SA+T2
51.     IF (T3.GE.C273) P6=EXP(20.9484-5306.7/T3)
52.     IF (T3.LT.C273) P6=EXP(24.047-6153.0/T3)
53.     T4=1.8*T3-459.69
54.     XY=1.0

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----- PROGRAM LISTING OF SG005

```

55.      XP4=PP4
56.      XP5=PP5
57.      XH2OPP=H2OPP
58.      CYX=0.05
59.      XT3=T3
60.      HCCND=H2OSUM*10500.+CL*16000.+F*11400.
61. 50 CALL CALCCY (A1,P1,H2OPP,P2,P4,P5,P6,R2,S2,T3,Y1,Y2,IGC)
62.      IF (IGC.EQ.2) GO TO 140
63.      Y1P6=Y1*P6
64.      TOTWT=AMASS*(1.0+A1)
65.      WTSCL=WTSCL*1.0E6/TOTWT
66.      VOLTCT=S2*(T3/C273)*(760.0/P1)*22.4136
67.      VFSCL=VCLSCL*1000.0/VOLTCT
68.      XSCTAS=VFSCL*1.5/PP
69.      IF (R2.GT.R1.AND.IPASS.NE.1.AND.KPASS.NE.1) GO TO 120
70. C----- FIND AIR DILUTION RATIO AT WHICH ALL GAS TO GAS/LIQUID
71.      IF (KPASS.EQ.2) GO TO 80
72.      IF (KPASS.EQ.1) GO TO 60
73.      ERR=1.0
74.      KPASS=1
75.      AUSAVE=A1
76.      CYX=1.0
77.      NNN=100
78.      YXX=0.
79.      CALL ROOT (NNN,YXX,CXX,PP2R1,ERR,K1)
80. 60 PP2R1=R2-R1
81.      CALL ROOTB (NNN,YXX,CXX,PP2R1,ERR,K1)
82.      A1=AUSAVE-YXX
83.      IF (Y1.FG.0) GO TO 70
84.      IF (Y1.EG.2) GO TO 30
85.      IGC=4
86. 70 KPASS=2
87.      APRINT=A1
88.      A1=AUSAVE-APRINT
89.      IF (IGC.EQ.4) GO TO 140
90.      IGC=3
91.      GO TO 140
92. 80 CONTINUE
93. C----- R2.LT.R1 GAS AND LIQUID ARE PRESENT
94.      IF (IPASS.EQ.1) GO TO 90
95.      IPASS=1
96.      IF (IFLAG.EQ.3) WRITE (6,240) A1,T4,T3,R2,Y1,P4,P5,H2OPP,Y1P6,WTS
97. 10L,VFSCL,XSCTAS,XX,VFLIG,XSCTAL,TRFACT
98. 90 IF (ABS(R2-R1).LE.2.0) GO TO 110
99.      IF (R2.LT.R1) GO TO 100
100.      CYX=-0.001
101.      YNUGC=1
102. 100 IF (INCGC.EQ.1.AND.R2.LT.R1) GO TO 110
103.      YX=XX-CYX
104.      IF (YX.EQ.0.0) YX=0.001
105.      P4=XP4*YX
106.      P5=XP5*YX
107.      H2OPP=XH2OPP*YX
108.      T3=XT3+(1.0-YX)*(HCCND/S4)*CONST1
109.      GO TO 50
110. 110 T4=1.8+T3-459.69
111.      WTLIG=(1.0-YX)*(H2OSUM*19.016+CL*36.465+F*20.016)

```

----- PROGRAM LISTING OF SEQ05

```
55.      RETURN
56.      70 K=1
57.      RETURN
58.      80 K=1
59.      RETURN
60.      C
61.      END
```

TIME: 0.2680 SECONDS.

----- PROGRAM LISTING OF SGR05

```

112.      WFLIG=WTLIG/TOTWT
113.      VOLLIG=NTLIG
114.      VFLIG=VOLLIG*1000.0/VOLTCT
115.      XSCTAL=VFLIG*1.5/CPL
116.      120 TRFACT=1.0-XSCTAS-XSCTAL
117.      IF (TRFACT.GT.0.0) GO TO 130
118.      TRFACT=0.0
119.      TRANSM=0.0
120.      GO TO 140
121.      130 TRANSM=TRFACT**PTHL
122.      C----- PRINT OUTPUT -----
123.      140 IF (IGO.EQ.1) WRITE (6,240) A1,T4,T3,R2,Y1,P4,P5,H2OPP,Y1P6,WTFSC
124.      1,VFSOL,XSCTAS,XX,VFLIG,XSCTAL,TRFACT
125.      IF (IGO.EQ.2) WRITE (6,230) A1,T4,T3,P4,P5,H2OPP
126.      IF (IGO.EQ.3) WRITE (6,250) APRINT,T4,T3,R2,Y1,P4,P5,H2OPP,Y1P6,W
127.      1,VFSOL,VFSOL,XSCTAS,XX,VFLIG,XSCTAL
128.      IF (IGO.EQ.4) WRITE (6,260)
129.      IF (IFLAG.EQ.3) WRITE (6,200) TRANSM
130.      IF (IFLAG.EQ.3) GO TO 180
131.      IF (IFLAG.NE.2) GO TO 150
132.      C----- SAVE VALUES FOR PLUME ROUTINE IFLAG=2
133.      IF (KKK.EQ.100) GO TO 150
134.      KKK=KKK+1
135.      AAA(KKK)=A1
136.      IF (IGO.EQ.3) AAA(KKK)=APRINT
137.      IF (IGO.EQ.4) KKK=KKK-1
138.      C----- STEP AIR DILUTION RATIO      A1
139.      150 IF (A1.GE.1000.0) AINCR=A5
140.      A1=A1+AINCR
141.      IF (A1.LE.A6) GO TO 30
142.      IF (IFLAG.NE.2) GO TO 160
143.      TAIR2=T2
144.      CALL PLUME (IFLAG)
145.      CALL TITLEA (1)
146.      160 IF (IFLAG.NE.0) GO TO 170
147.      IPAGE=IPAGE+1
148.      IF (IPAGE.LT.2) GO TO 170
149.      CALL TITLEA (1)
150.      IPAGE=0
151.      170 T1=T1+T6
152.      IF (T1.LE.T7) GO TO 10
153.      180 RETURN
154.      C
155.      190 FORMAT (1H,' STOICHIOMETRIC AIR RATIO ',G15.6)
156.      200 FORMAT (1H,' TRANSMISSIVITY =',F10.4,' ( FOR PATH LENGTH PTHL )')
157.      210 FORMAT (1H,' AIR TEMPERATURE( DEG F) =',F8.2,3X,' (DEG K) =',F8.2,3X,
158.      1,PRESSURE('MM) =',F9.3)
159.      220 FORMAT (1H,4X,'A1',5X,'T4',5X,'T3',5X,'R2',5X,'Y1',4X,'D4',4X,'H2
160.      1',4X,'H2OPP',',',Y1P6',5X,'WTFSC',VFSOL,XSCTAS,XX,',',VFLIG,XSCT
161.      2L,TRFACT')
162.      230 FORMAT (1H, ,F7.1,2F7.2,15X,2F6.4,F6.3,'*** OUTSIDE DATA RANGE')
163.      240 FORMAT (1H, ,F7.1,2F7.2,F8.1,F7.4,2F6.4,F6.3,F8.3,F8.4,F6.4,F7.4,4F
164.      17.4)
165.      250 FORMAT (1H, ,F7.1,2F7.2,F8.1,F7.4,2F6.4,F6.3,F8.3,F8.4,F6.4,F7.4,4F
166.      17.4)
167.      260 FORMAT (1X,'UNABLE TO FIND ALL GAS TO GAS/LIQUID POINT CONTINUE')
168.      C

```

----- PROGRAM LISTING OF SG005

169. END

TIME: 0.7792 SECONDS.

----- PROGRAM LISTING OF SG005

SA
Y UNIVAC 1100 SERIES ELT PROCESSOR LEVEL WA AT 11:56:39 AM ON TUESDAY, DECEMBER 14,

```

1.      SUBROUTINE TITLEA (ICC)
2.      COMMON /ITITLE/ TITLE(12)
3.      DATA ICASE,IPAGE /0,1/
4.      IF (ICC.EQ.1) GO TO 20
5.      IF (ICC.EQ.2) GO TO 10
6.      10 IPAGE=0
7.      ICASE=ICASE+1
8.      20 IPAGE=IPAGE+1
9.      WRITE (6,30) ICASE,IPAGE
10.     WRITE (6,40) TITLE
11.     RETURN
12.     C
13.     30 FORMAT (1H1,10(1H-), 'A R M Y   M I S S I L E   C O M M A N D   '
14.     1 HUNTSVILLE ALABAMA ',30(1H-),'CASE',I2,1X,'PAGE',I3)
15.     40 FORMAT (1H ,20(1H-),12A6,20(1H-))
16.     C
17.     END

```

TIME: 0.0838 SECONDS.

----- LISTING TEST CASES FOR SG005

----- LISTING TEST CASES FOR SG005

E/ABC
NIVAC 1100 SERIES ELT PROCESSOR LEVEL 12 AT 11:56:40 AM ON TUESDAY, DECEMBER 14, 19

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1.  EXPLAME A IFLAG=0
2.  SINPLTD
3.    IFLAG=0
4.      C=1.6576,H=3.2171,N=2.2809,C=2.8059,DELHF=-7.73,P1=258.4,
5.  A3=100,A4=100,A5=1900,A6=10000,T5=-58,T6=9,T7=-22
6.  SEND
7.  EXPLAME B IFLAG=1
8.  SINPLTD
9.    IFLAG=1
10.  C=0,H=0,N=0,C=0,DELHF=0,P1=0      ,A3=0,A4=0,A5=0,A6=0,T5=0,T6=0,T7=0
11.  WAWPC=0.,DWAAP=2.,NW=10,RT=.5,ALPHA=15,EXPR=9.,EXPC=9.,UJET=2350,TJET=2500
12.  UAIR=0.,TAIR=536.7,WAWGT=.7,.75,.8,.85,.9,.95,1.,
13.  TT=3216.,3456.,3006.,2475.,1926.,1305.,536.7,
14.  CP6=.403,.348,.326,.308,.289,.267,.240,    NT=7,
15.  SEND
16.  EXPLAME C IFLAG=3
17.  SINPLTD
18.    IFLAG=3
19.  WAWPC=0.04WAP=0,NW=0,RT=0,ALPHA=0,EXPR=0,EXPC=0,UJET=0,IJET=0
20.  UAIR=0.,TAIR=0.,WAWGT=0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,CP6=0.0,0.0,0.0,0.0,0.0,NT=0,
21.      C=1.5833,H=3.4597,C=2.9170,N=1.8988,CL=0.1192
22.  DELHF=-21.04
23.  A3=0,A4=0,A5=0,A6=0
24.  T5=-40.,T6=1.0,T7=-40.
25.  PROPLT=62.1,RCOMCP=6020.,PTHL=5.374
26.  P1=760.0,
27.  SEND

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: 0.1332 SECONDS.

----- LISTING TEST CASES FOR SG005

SE/A

INIVAC 1100 SERIES ELY PROCESSOR LEVEL WA AT 11:56:40 AM ON TUESDAY, DECEMBER 14, 1-

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1. 76/00/24 HMX/AP/TMETN-PEG BINDER IFLAG=0
2. SINPLTD
3. IFLAG=0
4. C=1.6576,H=3.2171,N=2.2809,O=2.8059,DELHF=-7.73,P1=258.4,
5. A3=100,A4=100,A5=1900,A6=10000,T5=-58,T6=9,T7=-22
6. SEND
7. 71/05/24 HMX/AP/TMETN-PEG BINDER
8. SINPLTD C=1.5901,CL=.0426,H=3.2522,N=2.1884,O=2.841,DELHF=-11.04 SEND
9. 66/10/24 HMX/AP/TMETN-PEG BINDER
10. SINPLTD C=1.5226,CL=.0851,H=3.2874,N=2.0959,O=2.8762,DELHF=-14.35 SEND
11. 00/76/24 HMX/AP/TMETN-PEG BINDER
12. SINPLTD C=0.6312,CL=.6468,H=3.7516,N=0.2749,O=3.3404,DELHF=58.08 SEND
13. 70/15/15 HMX/AP/TMETN-PEG BINDER
14. SINPLTD
15. C=1.4349,CL=.1277,H=3.1291,N=2.1610,O=2.8721,DELHF=-12.5
16. P1=258.4
17. R1=0
18. A3=100,A4=100,A5=1900,A6=10000
19. T5=-58,T6=9,T7=-22
20. SEND
21. RH SE 253 PROPELLANT
22. SINPLTD C=1.676,H=2.888,N=2.075,O=1.909,CL=0.0,F=.910,DELHF=-15.7
23. T5=-58,T6=12,T7=32.
24. P1=760.
25. SEND
26. PROP RH SE 246 (CONTAINS CL AND F)
27. SINPLTD C=1.406,CL=.170,H=3.028,N=1.705,O=2.049,F=.910
28. DELHF=-28.9,T7=95.
29. SEND
30. PROPELLANT APP
31. SINPLTD C=2.1301,H=2.3502,N=.9432,O=3.5414,PR=.008,CL=0.0,F=0.0
32. DELHF=-56.6
33. SEND

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: 0.1376 SECONDS.

----- LISTING TEST CASES FOR SG005

E/B

NIVAC 1100 SERIES ELT PROCESSOR LEVEL 48 AT 11:56:40 AM ON TUESDAY, DECEMBER 14, 197

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1.  TITLE PLUME TESTCASE  EXAMPLE A
2.  SIMPLTD
3.  WAWPC=0.,DNWAP=2.,NW=10,RT=.5,ALPHA=15,EXPR=9.,EXPC=9.,UJET=8350,TJET=2500.
4.  UAIR=0.,TAIR=536.7,WAWGT=.7,.75,.8,.85,.9,.95,1.,
5.  TT=3816.,3456.,3006.,2475.,1926.,1305.,536.7,
6.  CPG=.403,.342,.326,.308,.289,.267,.240,  NT=7,
7.  IFLAG=1
8.  SEND
9.  TITLE PLUME TESTCASE  EXAMPLE B
10. SIMPLTD
11. WAWPC=1.25,DNAP=1.18920712,NW=40
12. SEND
13. SMOKELESS PRCP B (LWX/AP=4) * SEA-LEVEL * AIR VELOCITY =0
14. SIMPLTD WAWPC=5.,DNWAP=2.,NW=9,RT=0.5,ALPHA=15.,EXPR=10.,EXPC=8.26,PEPA=.769
15. UJET=8359.,TJET=2493.,UAIR=0.,TAIR=536.7,
16. WAWGT=0.70,0.75,0.80,0.85,0.90,0.95,1.00,NT=7,
17. TT=3816.,3456.,3006.,2475.,1926.,1305.,536.7,
18. CPG=.403,.342,.326,.308,.289,.267,.240,
19. SEND
20. SMOKELESS PRCP R * 27000 FT. * THROAT DIA.= 1.5 * AIR VELOCITY=2000
21. SIMPLTD EXPC=18.5,PEPA=2.182,TAIR=419.69,RT=.75,WAWPC=1.2,DNAP=1.2,
22. NW=39,SEND
23. SMOKELESS PRCP R * 27000 FT. * THROAT DIA.= 1.5 * AIR VELOCITY= 500
24. SIMPLTD UAIR= 500., SEND
25. SMOKELESS PRCP R * 27000 FT. * THROAT DIA.= 1.5 * AIR VELOCITY=1000
26. SIMPLTD UAIR=1000., SEND
27. SMOKELESS PRCP R * 27000 FT. * THROAT DIA.= 1.5 * AIR VELOCITY=2000
28. SIMPLTD UAIR=2000., SEND
29. SMOKELESS PRCP R * 27000 FT. * THROAT DIA.= 1.5 * AIR VELOCITY=4000
30. SIMPLTD UAIR=4000., SEND

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: 0.1350 SECONDS.

----- LISTING TEST CASES FOR SG005

E/C

NIVAC 1100 SERIES ELT PROCESSOR LEVEL 48 AT 11:56:41 AM ON TUESDAY, DECEMBER 14, 19

```
1.      AGC #2 GRAIN WT = 62.1          OPTION IFLAG=3
2.      SINPLTD C=1.4833,H=3.4597,C=2.9170,A=1.8988,CL=0.1192
3.      DELHF=-21.04
4.      A3=0,A4=0,A5=0,A6=0
5.      T5=-40.,T6=1.0,T7=-40.
6.      PROPW.T=62.1,POCMCP=6020.,PTHU=5.334
7.      P1=760.
8.      IFLAG=3
9.      SEND
```

: 0.0796 SECONDS.

----- LISTING TEST CASES FOR SG005

E/U

ATVAC 1100 SERIES BLT PROCESSOR LEVEL 48 AT 11:56:42 AM ON TUESDAY, DECEMBER 14, 19

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1.  SMCKELESS PROP.2(15%AP)*AIR VEL.=0*SEA LEVEL*THROAT D=1.0*OPTION 2
2.  SIMPLTD
3.  IFLAG=2
4.  C=1.4550,CL=0.1277, H=3.3226, N=2.0034, O=2.9113
5.  P1=760,R1=0,DP=0,
6.  DELHF=-17.67
7.  A3=100.,A4=100.,A5=1900.,A6=10000.
8.  T5=-52.,T6=9.,T7=49.
9.  RT=0.5,ALPHA=15.,EXPR=10.,EXPC=8.26,PEPA=0.769,UJET=8359.,TJET=2493.
10. UAIR=0.,TAIR=536.7
11. WAHGT=0.7,0.75,0.8,0.85,0.9,0.95,1.0
12. TT=3816.,3456.,3006.,2475.,1926.,1305.,536.7
13. CPG=.403,.348,.326,.308,.289,.267,.240
14. NT=7,TRLF=0.0
15.  SEND
```

: 0.1112 SECONDS.

----- COMPILED LISTING PROGRAM SG005