TECHNICAL NOTE R-8

THE CALCULATION OF THE FLOW PROPERTIES AND STANDOFF DISTANCE OF A VEHICLE BASED ON AN IDEAL GAS WITH VARIABLE SPECIFIC HEATS AND REDUCED PRESSURES

Prepared By

V. L. Reed

August 8, 1962

BROWN ENGINEERING COMPANY INC.
HUNTSVILLE, ALABAMA

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August 8, 1962

Prepared Under the Direction Of:

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ARMY MISSILE COMMAND
REDSTONE ARSENAL, ALABAMA
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ABSTRACT

The program calculates temperature, pressure, density ratio, reduced pressure, collision frequency, and standoff distance based on an ideal gas solution of the adiabatic steady flow compressible relations.

Approved By:

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DISCUSSION

The program was established to provide a quick solution to flow fields of relatively low velocity vehicles, i.e., those velocities where perfect gas relations are valid, in the region of the nose of the vehicles.

The three points which were considered as being indicative of properties at the nose were the free stream stagnation properties, the local properties directly behind a normal shock, and the stagnation properties behind a normal shock. In addition the standoff distance of the shock wave was calculated as a function of the nose radius of the vehicle.

The input required to the program consists of the following:

1. altitude - H
2. velocity - V
3. ambient temperature - T
4. ambient pressure - P
5. density ratios defined as that ratio produced when the ambient density is divided by the sealevel density at standard conditions - ρ/ρ_0
6. ratio of the specific heats - γ

The output generated by the program will be the following:

1. altitude - H
2. velocity - V
3. Mach Number - M
4. temperature - T
5. pressure - P
6. density ratio - ρ/ρ_0

7. reduced pressure defined as the pressure divided by the temperature and multiplied by standard temperature, (PT_o/T).

8. Nu, the collision frequency - ν

9. logarithm to the base ten of the density ratio

The units used in the program are as follows:

1. altitude - feet

2. velocity - feet per second

3. Mach Number - dimensionless

4. temperature - degrees Kelvin

5. pressure - atmospheres

6. reduced pressure - millimeters of mercury

7. density ratio - dimensionless

8. collision frequency - radians per second

9. ratio of specific heats - dimensionless

The entire program was calculated in double precision, i.e., sixteen significant digits, so as to provide eight significant figures of accuracy for the results of the calculations. Therefore, the output of this program should be accurate to as many decimal places as are shown on the print out sheets.

DATA FORMATS

The data should be presented in columnar form listing the properties for each altitude as follows:

H, V, T, P, ρ/ρ_o, γ

A sample of the input and print out are included as Table I, input, and Appendix A, output. Note the use of an altitude of -1. to stop the program. This -1. data point will cause the program to stop and will be included as the last data point for the program.

TABLE I

H	V	T	P	ρ/ρ_o	γ
10000.	8500	268.36	.68784	.737875	1.0
-1.					

APPENDIX A

Appendix A appears with the program files and consists of the symbolic program and the test cases utilized.