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HIGH-ALTITUDE COOLING

I - RESUME OF THE COOLING PROBLEM

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NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

ADVANCE RESTRICTED REPORT

HIGH-ALTITUDE COOLING

I - RÉSUMÉ OF THE COOLING PROBLEM

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SUMMARY

This paper is the first of a series of six papers that discusses the cooling of aircraft-engine installations with special reference to the difficulties of cooling at high altitudes. The other papers of the series will present a discussion of air-cooled engines, radiators, intercoolers, ducts, and fans; and it is intended that in each case the approach will be that best suited to the needs of the designer. In the present paper the properties of NACA standard air and Army summer air, with corresponding stagnation conditions for a range of flight speed, are summarized in tables and figures; and the general effects of the density and temperature variations with altitude are discussed with regard to required mass flow and volume flow of cooling air, required cooling pressure, available cooling pressure, and cooling power. The general relations between the necessary heat transfer and the corresponding required flow of cooling air are summarized, together with their effects on the required cooling pressures; and it is shown that the required cooling pressure increases whereas the available cooling pressure decreases at high altitudes. The high pressure drops that result from high velocities and accelerations in the heat-exchanger passages become particularly costly as these pressure drops approach the available pressure. In such cases a fan is an efficient cooling aid whereas large deflection of cowling flaps is inefficient and very detrimental to performance.

INTRODUCTION

Flight at altitudes of 35,000 to 40,000 feet introduces special problems in the cooling of aircraft power-plant installations. The difficulties result principally from the low density of the air at these altitudes, through its effect on the removal of heat and the airplane performance. The characteristics of the heat exchangers establish the values of the pressures required to cool for any altitude, whereas the performance of the airplane at the same altitude determines the pressures available for cooling. Increasing the altitude usually reduces the margin between the pressure available and the pressure required for cooling.

Design for efficient cooling, however, will be restricted by the severe limitation of the space available for installation of the power plant and the final design will evolve through the usual engineering compromises. The six papers of the series (this paper and references 1 to 5) present the results of a study directed toward understanding the cooling variables that must be weighed in the compromises; in particular, the variation of cooling characteristics with altitude and the penalties for the use of inadequate or barely adequate cooling equipment are considered. Specific analyses of the altitude performance of air-cooled engines, radiators, intercoolers, ducts, and fans are given in parts II to VI (references 1 to 5). Because of the differences in the types of problem involved, the treatments of the subject matter in the different papers are not parallel; however, in each paper the approach to the subject has been that believed best suited to the needs of the designer.

The purposes of the present paper are to introduce the series and to review the altitude effects. The NACA, Army summer, and British standard atmospheres are described and the main characteristics of heat exchangers, with particular reference to the altitude effects on heat transfer, cooling pressure drop, and cooling power, are qualitatively discussed. The altitude effects on cooling pressures available and the influence of cooling requirements on airplane performance are also discussed.

SYMBOLS

t temperature, °F

T temperature, °F absolute

density, slugs per cubic foot

p pressure, pounds per square foot

q_c full impact pressure

M mass flow of cooling air per second

t_w wall temperature, °F

t_a stagnation temperature of cooling air at inlet, °F

k constant, exponent in heat-transfer equation

D_e cooling drag

V velocity of air in cooling passages

V_o velocity of air in free stream, or airplane speed, miles per hour

V_{ex} velocity of cooling air, relative to airplane, when static pressure has returned to free-stream static pressure, miles per hour

σ relative density

Subscript:

SL sea level

VARIATION OF PHYSICAL PROPERTIES OF ATMOSPHERE WITH ALTITUDE

In order to provide uniformity in altitude cooling and performance calculations, standard values of the physical properties of the atmosphere are used. Diehl's tables (reference 6), from which data are reproduced in table I and figures 1 and 2, define NACA standard air, which has the following properties at sea level:

Temperature, t_{SL}, °F	59
Density, $_{SL}$, slug per cubic foot	0.002378
Pressure, p_{SL}, pounds per square foot	2116.2

The temperature decreases linearly with increase in height at the rate of 3.566° F per thousand feet up to the lower level of the isothermal layer, at an altitude of 35,332 feet. The air is assumed to be dry and to obey the laws for a perfect gas. Absolute temperatures are obtained by adding 459.4° to the temperatures in degrees Fahrenheit.

Since it is necessary that adequate cooling be provided in locales and under climatic conditions for which air temperatures considerably exceed those of NACA standard air, several altitude-temperature relations more representative of such conditions have been set up for use in making cooling calculations. The relation of pressure to altitude established for NACA standard air is retained in defining these warmer atmospheres. The density of the air is calculated from its temperature and pressure by the gas law.

The Army Air Corps (reference 7) has specified a summer atmosphere having a sea-level temperature of 100° F and a linear decrease in temperature with altitude at the rate of 3.6° F per thousand feet up to the altitude of 46,500 feet. Above this altitude it is assumed that no further decrease in temperature occurs. The properties at different altitudes of Army summer air, which have been used in the calculations of the present series of papers, are given in table II and figures 1 and 2.

The NACA standard and Army summer atmospheres are compared in figure 1 with British standard atmospheres for subarctic, temperate, and tropical conditions. The Army summer atmosphere is similar to the British tropical summer atmosphere, which is based on meteorological observations made in India. The temperatures for the British temperate summer atmosphere, which is based on observations made in England, lie about halfway between those for Army summer and NACA standard atmospheres. As an aid in calculations, the stagnation temperatures, impact pressures, and stagnation densities of NACA standard and Army summer air are given for ranges of altitude and airplane speed in tables III to VIII. Because of entrance and duct losses, full impact pressure q_c is rarely obtained at the face of a heat exchanger; accordingly, values of $0.8q_c$ and $0.9q_c$ are also given, together with corresponding densities. The temperature rise (in °F) due to airplane speed is unaffected by duct losses and remains $1.8\left(\frac{V_o}{100}\right)^2$, where V_o is the airplane speed in miles per hour. The temperature so computed is taken as the temperature at the face of the heat exchanger.

REQUIRED FLOW OF COOLING AIR

The heat removed from the cooling element is roughly proportional to some power of the mass flow M and to the difference between the wall temperature t_w and the stagnation temperature t_a of the cooling air at the inlet; that is,

$$\text{Heat transfer} \propto (t_w - t_a)M^k$$

where k is of the order of 0.85 for radiators and 0.65 for air-cooled engines. The equation is not appreciably affected by compressibility and remains valid even with the high flow velocities and large density variations along the cooling passages that occur at high altitudes.

For constant heat transfer, then,

$$M \propto \frac{1}{(t_w - t_a)^{1/k}}$$

Since the temperature difference $t_w - t_a$ increases with altitude, the mass flow required for constant cooling correspondingly decreases. This reduction of mass flow with increasing altitude is shown in figure 3 for a typical air-cooled engine, ethylene-glycol radiator, and oil cooler. It is important to observe in this figure that the effect of the altitude on the temperature differences is more pronounced for heat exchangers with low values of t_w than for ones with high values of t_w. For the oil cooler ($t_w = 175^\circ$ F), $t_w - t_a$ changes from 56° F at sea level to 175° F at 40,000 feet, so that the required mass flow at 40,000 feet, in the absence of congealing effects, is only 28 percent of that at sea level. For the air-cooled engine ($t_w = 450^\circ$ F), with corresponding altitude change, $t_w - t_a$ changes from 331° F to 450° F, so that the required mass flow at 40,000 feet is 60 percent of that at sea level.

Division of the ordinates (mass flow) of figure 3 by the corresponding densities from table VIII results in a set of curves that show the variation of the required volume of cooling air with altitude (fig. 4). For the air-cooled engine, the necessary volume of cooling air increases rapidly with altitude; whereas, for the radiator, the necessary volume increases less rapidly and, for the oil cooler, decreases at some altitudes. For the lowest wall temperature, for example, the increase with altitude of the temperature difference $t_w - t_a$ is more than enough to compensate for the density decrease, and the cooling capacity per unit volume of air actually increases with altitude.

PRESSURE REQUIRED FOR COOLING

In the absence of compressibility effects - that is, if the density of the air remained constant in passing through the cooling element - the pressure drop for either radiators or air-cooled engines is roughly proportional to $M^{1.8}/$. The pressure drop clearly increases or decreases with increasing altitude, depending on whether $M^{1.8}$ decreases more or less rapidly than . The incompressible pressure drop for the typical cooling elements of figures 3 and 4 has been plotted with dotted lines in figure 5. At 40,000 feet the incompressible pressure drop is 1.45 times that at sea level for the high-temperature air-cooled engine, about 0.3 times that at sea level for the low-temperature oil cooler, and slightly less than that at sea level for the intermediate-temperature ethylene-glycol radiator.

Further losses of pressure exist whenever a large reduction of density occurs along the cooling passages. These losses become important whenever the pressure drop in the cooling passages is an appreciable fraction of the absolute pressure or whenever the temperature rise is an appreciable fraction of the absolute temperature. Since the relative changes in both temperature and pressure increase with altitude, compressibility becomes a dominant factor at high altitudes. The additional pressure losses are of two kinds, both resulting from the increase in velocity V that accompanies the reduction in density. The first is an increase in friction loss; for a uniform passage, in which the product V is constant, this loss may be evaluated by considering the friction at each point to be proportional to V. The second is a loss that accompanies the acceleration; for a uniform passage, this loss is numerically equal to the increase in dynamic pressure $\Delta(\rho V^2/2)$, since it is the difference between a static-pressure drop equal to the momentum increase $(\rho V)\Delta V = \Delta(\rho V^2)$ and the dynamic-pressure increase $\Delta(\rho V^2/2)$.

The true total-pressure loss, as corrected for these compressibility effects, is plotted in figure 5 together with the uncorrected values. The ratio of the two (designated compressibility correction in fig. 5) at 40,000 feet is about 1.57 for the air-cooled engine, 1.67 for the ethylene-glycol radiator, and 1.19 for the oil cooler.

These results show that, with increasing altitude, the hotter the wall temperature of the heat exchanger to be cooled and the higher the speed of the cooling air through the cooling passages, the greater will be the ratio of the pressure drop required at altitude to the pressure drop required at sea level. Cooling difficulties at high altitudes are greatest for air-cooled engine cylinders, less for ethylene-glycol radiators, and least for intercoolers. Intercoolers, unlike the other heat exchangers, must dissipate an increasing quantity of heat with increasing altitude and therefore in the upper altitudes do not experience the reduction in cooling-air mass-flow rate experienced by the other heat exchangers. Intercooler internal-flow velocities, however, are usually quite low and compressibility effects are correspondingly small.

PRESSURE AVAILABLE FOR COOLING

The maximum pressure available for cooling is primarily determined by the flight dynamic pressure and is of about the same order of magnitude. Figures 6 and 7 show how this dynamic pressure varies with altitude for typical pursuit and bomber airplanes, respectively. In high-speed and cruising flight, the variation of dynamic pressure with altitude is pronounced, and in either condition the dynamic pressure at 40,000 feet is only about one-half that at sea level (fig. 6). For climbing flight, however, the change of dynamic pressure with altitude is relatively small.

Large losses of available pressure may result from incorrectly designed cooling-air ducts, so that in high-altitude flight, for which the dynamic pressure is already reduced, such losses may become very important. Correct duct design has been considered in detail in reference 4.

As a means of increasing the cooling pressure, cowling or duct outlet flaps are used to reduce the pressure behind the heat exchanger and to provide thereby an over-all pressure drop that is larger than the free-stream dynamic pressure. Augmentation of cooling by use of outlet flaps has generally been considered necessary only in climbing flight. For many installations, however, deflection of the outlet flaps is required when cruising at altitude.

An effective means of augmenting the available cooling pressure is the use of a cooling fan located, if possible, ahead of the engine or heat exchanger. Design methods and performance curves for cooling fans are given in reference 5. Analysis of fans for air-cooled engine installations designed for high-altitude flight shows that fan speeds of about 1.5 times the engine speed are needed for effective and efficient installations. Fans turning at propeller speed are not particularly useful in high-altitude flight.

COOLING AND PERFORMANCE

The cooling requirements considereably influence any calculations of airplane characteristics in high-altitude flight. In particular, the use of outlet flaps for increasing the cooling pressure greatly increases the drag and seriously affects the performance. In climbing flight, for example, large deflections of the cowling flaps result in marked decreases in the rate of climb. This effect is illustrated in figure 8 for a bomber airplane climbing at an altitude of 25,000 feet. The decreases become more pronounced as the altitude increases. Similarly, the cruising range is greatly reduced if large flap deflection is required for cooling.

The flap and cooling drag, furthermore, enter significantly into any computations of optimum flight conditions. For example, in the determination of the speed of best climb, the power-required curve must, at each speed, correspond to flight with the particular flap angle that provides the necessary cooling at that speed. In the determination of the best cruising speed, the flap and cooling drag will similarly depend, for each altitude and engine operating condition considered, on the flap angle required to cool under that condition. A flap angle much in excess of the optimum, besides reducing the cruising range, may diminish rather than increase the cooling pressure, because the corresponding drag increase may appreciably reduce the speed. A typical chart for a bomber airplane showing the pressure available in cruising flight plotted against cowl-flap deflection is given in figure 9; cowl-flap deflections of over 10° or 12° are not particularly effective in increasing the available pressure drop.

EFFECT OF ALTITUDE ON POWER REQUIRED FOR COOLING

Accompanying the increase in the pressure required and the decrease in the pressure available for cooling at altitude is an increase in the cooling power required. If mixing and other external effects associated with the flow of low-energy air are disregarded, the drag associated with cooling is given by the momentum loss of the cooling air

$$D_c = M(V_o - V_{ox})$$

where

D_c cooling drag

M mass flow of cooling air per second

V_o airplane speed

V_{ex} velocity of cooling air, relative to airplane, when static pressure has returned to free-stream static pressure

The cooling power is then

$$V_o D_c = MV_o(V_o - V_{ex})$$

If the density of the cooling air is assumed constant, this cooling power is readily shown to equal the sum of (1) the internal pump power $\frac{M}{\rho}\Delta p$ required to pump the volume per second M/ρ through the cooling unit against the pressure drop Δp and (2) the kinetic energy $\frac{1}{2}M(V_o - V_{ex})^2$ possessed by the mass of cooling air per second M which, after it leaves the airplane, follows at a velocity $V_o - V_{ex}$. Thus,

$$\frac{M}{\rho}\Delta p + \frac{1}{2}M(V_o - V_{ex})^2 = \frac{M}{\rho}\left(\frac{1}{2}\rho V_o^2 - \frac{1}{2}\rho V_{ex}^2\right) + \frac{1}{2}M(V_o - V_{ex})^2$$

$$= \frac{M}{2}\left(V_o^2 - V_{ox}^2\right) \quad \frac{M}{2}(V_o - V_{ox})^2$$

$$= MV_o(V_o - V_{ox})$$

For low pressure drops, the kinetic-energy term is small in comparison with the pressure term and the drag power simply equals the internal pump power. For large pressure drops, the kinetic-energy term becomes relatively larger and equals the internal pump power when the pressure drop equals the free-stream dynamic pressure $\frac{1}{2}\rho V_o^2$; that is, when V_{ex} is zero. For this case, the drag power is twice the pump power. Actually, pressure drops of this magnitude or higher normally correspond to flight with outlet flaps extended, for which the accompanying energy losses in the external flow may result in a drag power that is several times the pump power.

The addition of heat to the cooling air in its passage through the heat exchanger may be considered to have two opposing effects on the cooling drag. The decreased density at the exit implies, for a given mass flow and internal pressure drop, increased exit velocity V_{ex} and thus less momentum loss. The pressure drop, however, as previously explained, is increased by the addition of heat. If the pressure drop is small relative to the flight dynamic pressure, the decreased exit density usually dominates and addition of heat reduces the drag; if the pressure drop is large relative to the flight dynamic pressure, addition of heat increases the drag. A more complete discussion of the effects of heat addition on the drag power and the exit velocity V_{ex} is given in reference 5.

Because of the higher pressure drop required at altitude, the power required to cool is increased both by the larger $\frac{M}{\rho}\Delta p$ term in the cooling-power equation and by the decrease in the value of V_{ex} in the kinetic-energy term. The large cooling powers required at high altitudes can be greatly reduced by improving or enlarging the heat exchanger. In most cases, the installation of large heat exchangers is simply a design problem but, for air-cooled engines, becomes a matter of engine-cylinder design. The high cost in power of attempting to operate at high altitudes with engines designed for low-altitude operation - as is the case for most air-cooled engines in general use at present - is illustrated in figure 10. It will be observed that the power required at an altitude of 39,000 feet is about 12 times that at sea level. The low cooling power at sea level results from the recovery of a part of the heat energy that has been added to the cooling air. The large cooling power required at 39,000 feet is due to the large volume of cooling air needed, the high pressure drop therefore necessary, and the large wake loss resulting from a pressure drop almost equal to the flight dynamic pressure. The use of a fan to eliminate this wake loss effects a large saving of cooling drag power. The value of the cooling power for the engine installation with the fan includes the power to drive the fan. A quantitative discussion of the effectiveness of fans in decreasing the cooling power required is given in reference 5.

CONCLUSIONS

1. The cooling of aircraft power-plant installations is more difficult in high-altitude flight than at sea level because of the increase in the pressure drop required for cooling and the decrease in the available pressure drop.

2. High pressure drops required for cooling at altitude result from large air-flow velocities and accelerations through the heat-exchanger passages.

3. Cowling-flap deflections of more than 10° to 12° are relatively ineffective in cruising flight. Large cowl-flap deflections cause extreme reduction in cruising range and rate of climb.

4. A cooling fan located ahead of the heat exchanger provides an efficient method for increasing the pressure available for cooling.

5. The power required for cooling increases with altitude and in the absence of a fan may, at 39,000 feet, be as much as 12 times the sea-level cooling power.

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REFERENCES

1. Williams, David T.: High-Altitude Cooling. II - Air-Cooled Engines. NACA ARR No. L4I11a, 1944.

2. Nielsen, Jack N.: High-Altitude Cooling. III - Radiators. NACA ARR No. L4I11b, 1944.

3. Rubert, K. F.: High-Altitude Cooling. IV - Intercoolers. NACA ARR No. L4I11c, 1944.

4. Katzoff, S.: High-Altitude Cooling. V - Cowling and Ducting. NACA ARR No. L4I11d, 1944.

5. Mutterperl, William: High-Altitude Cooling. VI - Axial-Flow Fans and Cooling Power. NACA ARR No. L4I11e, 1944.

6. Diehl, Walter S.: Standard Atmosphere - Tables and Data. NACA Rep. No. 218, 1925.

7 see erratum sheet.

ERRATUM

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Page 13: The following reference (reference 7) was inadvertently omitted in the Wartime Report version:

7. Anon.: Handbook of Instructions for Airplane Designers. Vol. II, Materiel Div., Army Air Corps, 8th ed., July 1, 1936, p. 1110.

TABLE I

PHYSICAL PROPERTIES OF NACA STANDARD ATMOSPHERE[a]

Altitude (ft)	p (lb/sq ft)	T (°F abs.)	ρ (slugs/cu ft)	(ρ/ρ_{SL})
0	2116.2	518.4	0.002378	1.000
1,000	2041.3	514.8	.002309	.971
2,000	1967.7	511.3	.002242	.943
3,000	1896.3	507.7	.002176	.915
4,000	1827.7	504.1	.002112	.888
5,000	1760.5	500.6	.002049	.862
6,000	1696.1	497.0	.001988	.836
7,000	1633.2	493.4	.001928	.811
8,000	1571.6	489.9	.001869	.786
9,000	1512.2	486.3	.001812	.762
10,000	1455.6	482.7	.001756	.738
11,000	1399.7	479.2	.001702	.715
12,000	1346.0	475.6	.001648	.693
13,000	1293.7	472.0	.001596	.671
14,000	1242.7	468.5	.001545	.650
15,000	1193.9	464.9	.001496	.629
16,000	1146.5	461.3	.001448	.609
17,000	1100.6	457.8	.001401	.589
18,000	1056.7	454.2	.001355	.570
19,000	1013.6	450.6	.001311	.551
20,000	972.5	447.1	.001267	.533
21,000	932.2	444.5	.001225	.515
22,000	893.3	439.9	.001183	.497
23,000	855.8	436.4	.001143	.481
24,000	819.8	432.8	.001103	.464
25,000	785.1	429.2	.001065	.448
26,000	751.2	425.7	.001028	.432
27,000	718.6	422.1	.000992	.417
28,000	687.5	418.5	.000957	.402
29,000	657.3	415.0	.000922	.388
30,000	628.1	411.4	.000889	.374
31,000	600.0	407.8	.000857	.360
32,000	573.0	404.3	.000826	.347
33,000	546.9	400.7	.000795	.334
34,000	521.8	397.2	.000765	.322
35,000	497.7	393.6	.000736	.310
36,000	474.5	392.4	.000704	.296
37,000	452.3		.000671	.282
38,000	431.2		.000640	.269
39,000	411.1		.000610	.257
40,000	391.9		.000582	.245
41,000	373.7		.000554	.233
42,000	356.2		.000529	.222
43,000	339.6		.000504	.212
44,000	323.8		.000481	.202
45,000	308.7		.000459	.193
46,000	294.2		.000437	.184
47,000	280.5		.000417	.175
48,000	267.4		.000397	.167
49,000	254.9		.000379	.159
50,000	243.0		.000361	.152
51,000	231.7		.000344	.145
52,000	220.9		.000328	.138
53,000	210.6		.000312	.131
54,000	200.8		.000298	.125
55,000	191.5		.000284	.120
56,000	182.6		.000271	.114
57,000	174.0		.000258	.109
58,000	165.9		.000246	.104
59,000	158.2		.000234	.099
60,000	150.8		.000224	.094
61,000	143.8		.000214	.090
62,000	134.1		.000203	.086
63,000	130.6		.000194	.082
64,000	124.6		.000185	.078
65,000	118.8	392.4	.000176	.074

[a]Data from reference 6.

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TABLE II

PHYSICAL PROPERTIES OF ARMY SUMMER ATMOSPHERE

Altitude (ft)	p (lb/sq ft)	T (°F abs.)	ρ (slugs/cu ft)	(ρ/ρ$_{SL}$)
0	2116.2	559.4	0.002204	0.927
1,000	2041.3	555.8	.002139	.899
2,000	1967.7	552.2	.002076	.873
3,000	1896.3	548.6	.002013	.847
4,000	1827.7	545.0	.001953	.821
5,000	1760.5	541.4	.001894	.796
6,000	1696.1	537.8	.001837	.772
7,000	1633.2	534.2	.001781	.749
8,000	1571.6	530.6	.001725	.725
9,000	1512.2	527.0	.001671	.703
10,000	1455.6	523.4	.001620	.681
11,000	1399.7	519.8	.001569	.659
12,000	1346.0	516.2	.001519	.639
13,000	1293.7	512.6	.001470	.618
14,000	1242.7	509.0	.001422	.598
15,000	1193.9	505.4	.001376	.579
16,000	1146.5	501.8	.001331	.560
17,000	1100.6	498.2	.001287	.541
18,000	1056.7	494.6	.001244	.523
19,000	1013.6	491.0	.001202	.505
20,000	972.5	487.4	.001162	.489
21,000	932.2	483.8	.001122	.472
22,000	893.3	480.2	.001084	.456
23,000	855.8	476.6	.001046	.440
24,000	819.8	473.0	.001010	.424
25,000	785.1	469.4	.000974	.410
26,000	751.2	465.8	.000939	.395
27,000	718.6	462.2	.000906	.381
28,000	687.5	458.6	.000873	.367
29,000	657.3	455.0	.000841	.354
30,000	628.1	451.4	.000810	.341
31,000	600.0	447.8	.000780	.328
32,000	573.0	444.2	.000751	.316
33,000	546.9	440.6	.000723	.304
34,000	521.8	437.0	.000695	.292
35,000	497.7	433.4	.000669	.281
36,000	474.5	429.8	.000643	.270
37,000	452.3	426.2	.000618	.260
38,000	431.2	422.6	.000594	.250
39,000	411.1	419.0	.000571	.240
40,000	391.9	415.4	.000550	.231
41,000	373.7	411.8	.000529	.222
42,000	356.2	408.2	.000508	.214
43,000	339.6	404.6	.000489	.206
44,000	323.8	401.0	.000470	.198
45,000	308.7	397.4	.000452	.190
46,000	294.2	393.8	.000435	.183
47,000	280.5	392.4	.000416	.175
48,000	267.4	↑	.000397	.167
49,000	254.9	│	.000378	.159
50,000	243.0	│	.000361	.152
51,000	231.7	│	.000344	.145
52,000	220.9	│	.000328	.138
53,000	210.6	│	.000313	.132
54,000	200.8	│	.000298	.125
55,000	191.5	│	.000284	.119
56,000	182.6	│	.000271	.114
57,000	174.0	│	.000258	.108
58,000	165.9	│	.000246	.103
59,000	158.2	│	.000235	.099
60,000	150.8	│	.000224	.094
61,000	143.8	│	.000213	.090
62,000	137.1	│	.000203	.085
63,000	130.6	│	.000194	.082
64,000	124.6	↓	.000185	.078
65,000	118.8	392.4	.000176	.074

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TABLE III

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS.

STAGNATION TEMPERATURES, NACA STANDARD ATMOSPHERE

Altitude (ft) \ Airspeed (mph)	Temperature, °F abs.																		
	100	150	200	225	250	275	300	325	350	375	400	425	450	475	500	525	550	575	600
0	520.2	522.5	525.6	527.5	529.7	532.0	534.6	537.4	540.5	543.7	547.2	550.9	554.9	559.0	563.4	568.0	572.9	577.9	583.2
2,000	513.1	515.4	518.5	520.4	522.6	524.9	527.5	530.3	533.4	536.6	540.1	543.8	547.8	551.9	556.3	560.9	565.8	570.8	576.1
4,000	505.9	508.2	511.3	513.2	515.4	517.7	520.3	523.1	526.2	529.4	532.9	536.6	540.6	544.7	549.1	553.7	558.6	563.6	568.9
6,000	498.8	501.1	504.2	506.1	508.3	510.6	513.2	516.0	519.1	522.3	525.8	529.5	533.5	537.6	542.0	546.6	551.5	556.5	561.8
8,000	491.7	494.0	497.1	499.0	501.2	503.5	506.1	508.9	512.0	515.2	518.7	522.4	526.4	530.5	534.9	539.5	544.4	549.4	554.7
10,000	484.5	486.8	489.9	491.8	494.0	496.3	498.9	501.7	504.8	508.0	511.5	515.2	519.2	523.3	527.7	532.3	537.2	542.2	547.5
12,000	477.4	479.7	482.8	484.7	486.9	489.2	491.8	494.6	497.7	500.9	504.4	508.1	512.1	516.2	520.6	525.2	530.1	535.1	540.4
14,000	470.3	472.6	475.7	477.6	479.8	482.1	484.7	487.5	490.6	493.8	497.3	501.0	505.0	509.1	513.5	518.1	523.0	528.0	533.3
16,000	463.1	465.4	468.5	470.4	472.6	474.9	477.5	480.3	483.4	486.6	490.1	493.8	497.8	501.9	506.3	510.9	515.8	520.8	526.1
18,000	456.0	458.3	461.4	463.3	465.5	467.8	470.4	473.2	476.3	479.5	483.0	486.7	490.7	494.8	499.2	503.8	508.7	513.7	519.0
20,000	448.9	451.2	454.3	456.2	458.4	460.7	463.3	466.1	469.2	472.4	475.9	479.6	483.6	487.7	492.1	496.7	501.6	506.6	511.9
22,000	441.7	444.0	447.1	449.0	451.2	453.5	456.1	458.9	462.0	465.2	468.7	472.4	476.4	480.5	484.9	489.5	494.4	499.4	504.7
24,000	434.6	436.9	440.0	441.9	444.1	446.4	449.0	451.8	454.9	458.1	461.6	465.3	469.3	473.4	477.8	482.4	487.3	492.3	497.6
26,000	427.5	429.8	432.9	434.8	437.0	439.3	441.9	444.7	447.8	451.0	454.5	458.2	462.2	466.3	470.7	475.3	480.2	485.2	490.5
28,000	420.3	422.6	425.7	427.6	429.8	432.1	434.7	437.5	440.6	443.8	447.3	451.0	455.0	459.1	463.5	468.1	473.0	478.0	483.3
30,000	413.2	415.5	418.6	420.5	422.7	425.0	427.6	430.4	433.5	436.7	440.2	443.9	447.9	452.0	456.4	461.0	465.9	470.9	476.2
32,000	406.1	408.4	411.5	413.4	415.6	417.9	420.5	423.3	426.4	429.6	433.1	436.8	440.8	444.9	449.3	453.9	458.8	463.8	469.1
34,000	399.0	401.3	404.4	406.3	408.5	410.8	413.4	416.2	419.3	422.5	426.0	429.7	433.7	437.8	442.2	446.8	451.7	456.7	462.0
35,332 and higher altitudes	394.2	396.5	399.6	401.5	403.7	406.0	408.6	411.4	414.5	417.7	421.2	424.9	428.9	433.0	437.4	442.0	446.9	451.9	457.2

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

TABLE IV

STAGNATION TEMPERATURES, ARMY SUMMER ATMOSPHERE

Airspeed (mph) / Altitude (ft)	Temperature, °F abs.																		
	100	150	200	225	250	275	300	325	350	375	400	425	450	475	500	525	550	575	600
0	561.2	563.5	566.6	568.5	570.7	573.0	575.6	578.4	581.5	584.7	588.2	591.9	595.9	600.0	604.4	609.0	613.9	618.9	624.2
2,000	554.0	556.3	559.4	561.3	563.5	565.8	568.4	571.2	574.3	577.5	581.0	584.7	588.7	592.8	597.2	601.8	606.7	611.7	617.0
4,000	546.8	549.1	552.2	554.1	556.3	558.6	561.2	564.0	567.1	570.3	573.8	577.5	581.5	585.6	590.0	594.6	599.5	604.5	609.8
6,000	539.6	541.9	545.0	546.9	549.1	551.4	554.0	556.8	559.9	563.1	566.6	570.3	574.3	578.4	582.8	587.4	592.3	597.3	602.6
8,000	532.4	534.7	537.8	539.7	541.9	544.2	546.8	549.6	552.7	555.9	559.4	563.1	567.1	571.2	575.6	580.2	585.1	590.1	595.4
10,000	525.2	527.5	530.6	532.5	534.7	537.0	539.6	542.4	545.5	548.7	552.2	555.9	559.9	564.0	568.4	573.0	577.9	582.9	588.2
12,000	518.0	520.3	523.4	525.3	527.5	529.8	532.4	535.2	538.3	541.5	545.0	548.7	552.7	556.8	561.2	565.8	570.7	575.7	581.0
14,000	510.8	513.1	516.2	518.1	520.3	522.6	525.2	528.0	531.1	534.3	537.8	541.5	545.5	549.6	554.0	558.6	563.5	568.5	573.8
16,000	503.6	505.9	509.0	510.9	513.1	515.4	518.0	520.8	523.9	527.1	530.6	534.3	538.3	542.4	546.8	551.4	556.3	561.3	566.6
18,000	496.4	498.7	501.8	503.7	505.9	508.2	510.8	513.6	516.7	519.9	523.4	527.1	531.1	535.2	539.6	544.2	549.1	554.1	559.4
20,000	489.2	491.5	494.6	496.5	498.7	501.0	503.6	506.4	509.5	512.7	516.2	519.9	523.9	528.0	532.4	537.0	541.9	546.9	552.2
22,000	482.0	484.3	487.4	489.3	491.5	493.8	496.4	499.2	502.3	505.5	509.0	512.7	516.7	520.8	525.2	529.8	534.7	539.7	545.0
24,000	474.8	477.1	480.2	482.1	484.3	486.6	489.2	492.0	495.1	498.3	501.8	505.5	509.5	513.6	518.0	522.6	527.5	532.5	537.8
26,000	467.6	469.9	473.0	474.9	477.1	479.4	482.0	484.8	487.9	491.1	494.6	498.3	502.3	506.4	510.8	515.4	520.3	525.3	530.6
28,000	460.4	462.7	465.8	467.7	469.9	472.2	474.8	477.6	480.7	483.9	487.4	491.1	495.1	499.2	503.6	508.2	513.1	518.1	523.4
30,000	453.2	455.5	458.6	460.5	462.7	465.0	467.6	470.4	473.5	476.7	480.2	483.9	487.9	492.0	496.4	501.0	505.9	510.9	516.2
32,000	446.0	448.3	451.4	453.3	455.5	457.8	460.4	463.2	466.3	469.5	473.0	476.7	480.7	484.8	489.2	493.8	498.7	503.7	509.0
34,000	438.8	441.1	444.2	446.1	448.3	450.6	453.2	456.0	459.1	462.3	465.8	469.5	473.5	477.6	482.0	486.6	491.5	496.5	501.8
36,000	431.6	433.9	487.0	438.9	441.1	443.4	446.0	448.8	451.9	455.1	458.6	462.3	466.3	470.4	474.8	479.4	484.3	489.3	494.6
38,000	424.4	426.7	429.8	431.7	433.9	436.2	438.8	441.6	444.7	447.9	451.4	455.1	459.1	463.2	467.6	472.2	477.1	482.1	487.4
40,000	417.2	419.5	422.6	424.5	426.7	429.0	431.6	434.4	437.5	440.7	444.2	447.9	451.9	456.0	460.4	465.0	469.9	474.9	480.2
42,000	410.0	412.3	415.4	417.3	419.5	421.8	424.4	427.2	430.3	433.5	437.0	440.7	444.7	448.8	453.2	457.8	462.7	467.7	473.0
44,000	402.8	405.1	408.2	410.1	412.3	414.6	417.2	420.0	423.1	426.3	429.8	433.5	437.5	441.6	446.0	450.6	455.5	460.5	465.8
46,000	395.6	397.9	401.0	402.9	405.1	407.4	410.0	412.8	415.9	419.1	422.6	426.3	430.3	434.4	438.8	443.4	448.3	453.3	458.6
46,500 and higher altitudes	394.2	396.5	399.6	401.5	403.7	406.0	408.6	411.4	414.5	417.7	421.2	424.9	428.9	433.0	437.4	442.0	446.9	451.9	457.2

TABLE V

IMPACT PRESSURES, NACA STANDARD ATMOSPHERE

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS.

Airspeed (mph) / Altitude (ft)	Pressure, lb/sq ft														
	100			150			200			225			250		
	q_c	$0.9q_c$	$0.8q_c$	q_c	$0.9q_c$	$0.8q_c$	q_c	$0.9q_c$	$0.8q_c$	q_c	$0.9q_c$	$0.8q_c$	q_c	$0.9q_c$	$0.8q_c$
0	25.7	23.1	20.6	58.2	52.4	46.6	104.2	93.8	83.4	132.5	119.3	106.0	164.4	148.0	131.5
2,000	24.2	21.8	19.4	54.9	49.4	43.9	98.2	88.4	78.6	124.9	112.4	99.9	155.0	139.5	124.0
4,000	22.8	20.5	18.2	51.7	46.5	41.4	92.6	83.3	74.1	117.7	105.9	94.2	146.0	131.4	116.8
6,000	21.5	19.4	17.2	48.8	43.9	39.0	87.2	78.5	69.8	110.9	99.8	88.7	137.6	123.8	110.1
8,000	20.2	18.2	16.2	45.8	41.2	36.6	82.0	73.8	65.6	104.3	93.9	83.4	129.3	116.4	103.4
10,000	19.0	17.1	15.2	43.1	38.8	34.5	77.1	69.4	61.7	98.0	88.2	78.4	121.6	109.4	97.3
12,000	17.8	16.0	14.2	40.4	36.4	32.4	72.2	65.2	57.9	92.0	82.8	73.6	114.2	102.8	91.4
14,000	16.7	15.0	13.4	37.9	34.1	30.3	67.8	61.0	54.2	86.3	77.7	69.0	107.1	96.4	85.7
16,000	15.7	14.1	12.6	35.5	32.0	28.4	63.5	57.2	50.9	80.9	72.8	64.7	100.4	90.4	80.3
18,000	14.7	13.2	11.8	33.2	29.9	26.6	59.5	53.6	47.6	75.7	68.1	60.6	94.0	84.6	75.2
20,000	13.7	12.3	11.0	31.1	28.0	24.9	55.7	50.1	44.6	70.8	63.7	56.6	87.9	79.1	70.3
22,000	12.8	11.5	10.2	29.0	26.1	23.2	52.0	46.8	41.6	66.2	59.6	53.0	82.1	73.9	65.7
24,000	11.9	10.7	9.5	27.1	24.4	21.7	48.5	43.7	38.8	61.7	55.5	49.4	76.6	68.9	61.3
26,000	11.1	10.0	8.9	25.2	22.7	20.2	45.2	40.7	36.2	57.5	51.8	46.0	71.4	64.3	57.1
28,000	10.3	9.3	8.2	23.5	21.2	18.8	42.1	37.9	33.7	53.6	48.2	42.9	66.5	59.9	53.2
30,000	9.6	8.6	7.7	21.8	19.6	17.4	39.1	35.2	31.3	49.8	44.8	39.8	61.8	55.6	49.4
32,000	8.9	8.0	7.1	20.3	18.3	16.2	36.4	32.8	29.1	46.3	41.7	37.0	57.5	51.8	46.0
34,000	8.3	7.5	6.6	18.8	16.9	15.0	33.7	30.3	27.0	42.9	38.6	34.3	53.2	47.9	42.6
36,000	7.6	6.8	6.1	17.3	15.6	13.8	31.0	27.9	24.8	39.5	35.6	31.6	49.1	44.2	39.3
38,000	6.9	6.2	5.5	15.7	14.1	12.6	28.2	25.4	22.6	35.9	32.2	28.7	44.6	40.1	35.7
40,000	6.3	5.7	5.0	14.3	12.9	11.4	25.7	23.1	20.6	32.6	29.3	26.1	40.6	36.5	32.5
42,000	5.7	5.1	4.6	13.0	11.7	10.4	23.3	21.0	18.6	29.7	26.7	23.8	36.9	33.2	29.5
44,000	5.2	4.7	4.2	11.8	10.6	9.4	21.2	19.1	17.0	27.0	24.3	31.6	33.5	30.2	26.8
46,000	4.7	4.2	3.8	10.7	9.6	8.6	19.3	17.4	15.4	24.5	22.1	19.6	30.4	27.4	24.3
48,000	4.3	3.9	3.4	9.7	8.7	7.8	17.5	15.8	14.0	22.3	20.1	17.8	27.7	24.9	22.2
50,000	3.9	3.5	3.1	8.9	8.0	7.1	15.9	14.3	12.7	20.2	18.2	16.2	25.2	22.7	20.2

Airspeed (mph) / Altitude (ft)	Pressure, lb/sq ft														
	275			300			325			350			375		
	q_c	$0.9q_c$	$0.8q_c$	q_c	$0.9q_c$	$0.8q_c$	q_c	$0.9q_c$	$0.8q_c$	q_c	$0.9q_c$	$0.8q_c$	q_c	$0.9q_c$	$0.8q_c$
0	199.9	179.9	159.9	239.3	215.4	191.4	282.7	254.4	226.2	330.4	297.4	264.3	382.1	343.9	305.7
2,000	188.6	169.7	150.9	225.8	203.2	180.6	266.8	240.1	213.4	311.8	280.6	249.4	360.6	324.5	288.5
4,000	177.7	159.9	142.2	212.7	191.4	170.2	251.3	226.2	201.0	293.7	264.3	235.0	339.7	305.7	271.8
6,000	167.4	150.7	133.9	200.4	180.4	160.3	236.8	213.1	189.4	276.7	249.0	221.4	320.1	288.1	256.1
8,000	157.4	141.7	125.9	188.4	169.6	150.7	222.8	200.5	178.2	260.4	234.4	208.3	301.2	271.1	241.0
10,000	147.9	133.1	118.3	177.2	159.5	141.8	209.6	188.6	167.7	244.9	220.4	195.9	283.3	255.0	226.6
12,000	138.9	125.0	111.1	166.5	149.9	133.2	196.9	177.2	157.5	230.0	207.0	184.0	266.1	239.5	212.9
14,000	130.4	117.4	104.3	156.1	140.5	124.9	184.7	166.2	147.8	215.9	194.3	172.7	249.7	224.7	199.8
16,000	122.2	110.0	97.8	146.4	131.8	117.1	173.1	155.8	138.5	202.5	182.3	162.0	234.2	210.8	187.4
18,000	114.5	103.1	91.6	137.1	123.4	109.7	162.2	146.0	129.8	189.7	170.7	151.8	219.6	197.6	175.7
20,000	107.0	96.3	85.6	128.3	115.5	102.6	151.8	136.6	121.4	177.5	159.8	142.0	205.5	185.0	164.4
22,000	100.0	90.0	80.0	120.0	108.0	96.0	141.9	127.7	113.5	165.8	149.2	132.6	192.1	172.9	153.7
24,000	93.3	84.0	74.6	111.8	100.6	89.4	132.4	119.2	105.9	154.7	139.2	123.8	179.3	161.4	143.4
26,000	87.0	78.3	69.6	104.3	93.9	83.4	123.4	111.1	98.7	144.3	129.9	115.4	167.2	150.4	133.8
28,000	81.1	73.0	64.9	97.2	87.5	77.8	115.0	103.5	92.0	134.5	121.1	107.6	156.0	140.4	124.8
30,000	75.4	67.9	60.3	90.4	81.4	72.3	106.9	96.2	85.5	125.2	112.7	100.2	145.0	130.5	116.0
32,000	70.0	63.0	56.0	84.1	75.7	67.3	99.4	89.5	79.5	116.4	104.8	93.1	135.0	121.5	108.0
34,000	64.9	58.4	51.9	77.9	70.1	62.3	92.2	83.0	73.8	107.9	97.1	86.3	125.3	112.8	100.2
36,000	59.8	53.8	47.8	71.7	64.5	57.4	84.9	76.4	67.9	99.4	89.5	79.5	115.4	103.9	92.3
38,000	54.4	49.0	43.5	65.2	58.7	52.2	77.2	69.5	61.8	90.4	81.4	72.3	104.9	94.4	83.9
40,000	49.4	44.5	39.5	59.3	53.4	47.4	70.2	63.2	56.2	82.2	74.0	65.8	95.4	85.9	76.3
42,000	44.9	40.5	35.9	53.9	48.5	43.1	63.8	57.4	51.0	74.7	67.2	59.8	86.7	78.0	69.4
44,000	40.9	36.8	32.7	49.0	44.1	39.2	58.0	52.2	46.4	67.9	61.1	54.3	78.8	70.9	63.0
46,000	37.1	33.4	29.7	44.5	40.1	35.6	52.7	47.4	42.2	61.7	55.5	49.4	71.6	64.4	57.3
48,000	33.7	30.3	27.0	40.4	36.4	32.3	47.9	43.1	38.3	56.0	50.4	44.8	65.1	58.6	52.1
50,000	30.7	27.6	24.6	36.8	33.1	29.4	43.5	39.2	34.8	51.0	45.9	40.8	59.2	53.3	47.4

TABLE V - Concluded

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS.

IMPACT PRESSURES, NACA STANDARD ATMOSPHERE - Concluded

Altitude (ft) \ Airspeed (mph)	Pressure, lb/sq ft														
	400			425			450			475			500		
	q_c	$0.9q_c$	$0.8q_c$	q_c	$0.9q_c$	$0.8q_c$	q_c	$0.9q_c$	$0.8q_c$	q_c	$0.9q_c$	$0.8q_c$	q_c	$0.9q_c$	$0.8q_c$
0	438.1	394.3	350.5	499.2	449.3	399.4	564.8	508.3	451.8	636.2	572.6	509.0	712.0	640.8	569.6
2,000	413.4	372.1	330.7	471.1	424.0	376.9	533.5	480.2	426.8	600.4	540.4	480.3	672.5	605.3	538.0
4,000	389.8	350.8	311.8	444.6	400.1	355.7	503.5	453.2	402.8	566.6	509.9	453.3	634.1	570.7	507.3
6,000	367.2	330.6	293.8	418.8	376.9	335.0	474.3	426.9	379.4	533.8	480.4	427.0	597.9	538.1	478.3
8,000	345.9	311.3	276.7	394.1	354.7	315.3	446.3	401.7	357.0	502.8	452.5	402.2	563.1	506.8	450.5
10,000	325.3	292.8	260.2	371.0	333.9	296.8	420.1	378.1	336.1	473.2	425.9	378.6	530.0	477.0	424.0
12,000	305.6	275.0	244.5	348.8	313.9	279.0	395.0	355.5	316.0	444.9	400.4	355.9	498.3	448.5	398.6
14,000	286.7	258.0	229.4	327.3	294.6	261.8	371.0	333.9	296.8	417.9	376.1	334.3	468.0	421.2	374.4
16,000	269.2	242.3	215.4	307.3	276.6	245.8	348.0	313.2	278.4	392.0	352.8	313.6	439.4	395.5	351.5
18,000	252.2	227.0	201.8	287.9	259.1	230.3	326.3	293.7	261.0	367.5	330.8	294.0	411.9	370.7	329.5
20,000	236.2	212.6	189.0	269.4	242.5	215.5	305.3	274.8	244.2	344.2	309.8	275.4	385.8	347.2	308.6
22,000	220.8	198.7	176.6	252.0	226.8	201.6	285.6	257.0	228.5	322.0	289.8	257.6	360.9	324.8	288.7
24,000	206.2	185.6	165.0	235.2	211.7	188.2	266.8	240.1	213.4	300.7	270.6	240.6	337.1	303.4	269.7
26,000	192.4	173.2	153.9	219.6	197.6	175.7	248.9	224.0	199.1	280.5	252.5	224.4	314.7	283.2	251.8
28,000	179.4	161.5	143.5	204.8	184.3	163.8	232.1	208.9	185.7	261.6	235.4	209.3	293.7	264.3	235.0
30,000	166.8	150.1	133.4	190.6	171.5	152.5	216.2	194.6	173.0	243.7	219.3	195.0	273.6	246.2	218.9
32,000	155.3	139.8	124.2	177.4	159.7	141.9	201.2	181.1	161.0	226.8	204.1	181.4	254.9	229.4	203.9
34,000	144.1	129.7	115.3	164.6	148.1	131.7	186.7	168.0	149.4	210.6	189.5	168.5	236.5	212.9	189.2
36,000	132.7	119.4	106.2	151.6	136.4	121.3	172.0	154.8	137.6	194.2	174.8	155.4	218.2	196.4	174.6
38,000	120.7	108.6	96.6	137.8	124.0	110.2	156.3	140.7	125.0	176.5	158.9	141.2	198.3	178.5	158.6
40,000	109.7	98.7	87.8	125.3	112.8	100.2	142.2	128.0	113.8	160.5	144.5	128.4	180.4	162.4	144.3
42,000	99.7	89.7	79.7	113.9	102.5	91.1	129.2	116.3	103.4	145.9	131.3	116.7	163.9	147.5	131.1
44,000	90.7	81.6	72.6	103.6	93.2	82.9	117.5	105.8	94.0	132.7	119.4	106.2	149.1	134.2	119.3
46,000	82.4	74.2	65.9	94.1	84.7	75.3	106.7	96.0	85.4	120.5	108.5	96.4	135.4	121.9	108.3
48,000	74.8	67.3	59.8	85.5	77.0	68.4	97.0	87.3	77.6	109.5	98.6	87.6	123.0	110.7	98.4
50,000	68.1	61.3	54.5	77.7	69.9	62.2	88.2	79.4	70.6	99.6	89.6	79.7	111.9	100.7	89.5

Altitude (ft) \ Airspeed (mph)	Pressure, lb/sq ft											
	525			550			575			600		
	q_c	$0.9q_c$	$0.8q_c$	q_c	$0.9q_c$	$0.8q_c$	q_c	$0.9q_c$	$0.8q_c$	q_c	$0.9q_c$	$0.8q_c$
0	792.7	713.4	634.2	880.1	792.1	704.1	973.8	876.4	779.0	1073.2	965.9	858.6
2,000	749.4	674.5	599.5	831.9	748.7	665.5	920.5	828.5	736.4	1015.3	913.8	812.2
4,000	707.2	636.5	565.8	785.1	706.6	628.1	868.6	781.7	694.9	958.0	862.2	766.4
6,000	666.8	600.1	533.4	740.3	666.3	592.2	819.7	737.7	655.8	903.3	813.0	722.6
8,000	628.0	565.2	502.4	697.2	627.5	557.8	772.0	694.8	617.6	851.4	766.3	681.1
10,000	591.1	532.0	472.9	656.7	591.0	525.4	727.2	654.5	581.8	801.3	721.2	641.0
12,000	555.7	500.1	444.6	618.0	556.2	494.4	684.2	615.8	547.4	754.6	679.1	603.7
14,000	521.9	469.7	417.5	580.3	522.3	464.2	643.1	578.8	514.5	708.6	637.7	566.9
16,000	490.4	441.4	392.3	545.3	490.8	436.2	603.8	543.4	483.0	665.8	599.2	532.6
18,000	459.7	413.7	367.8	511.6	460.4	409.3	566.4	509.8	453.1	624.6	562.1	499.7
20,000	431.0	387.9	344.8	479.2	431.3	383.4	530.5	477.5	424.4	585.0	526.5	468.0
22,000	403.1	362.8	322.5	448.6	403.7	358.9	496.6	446.9	397.3	548.1	493.3	438.5
24,000	376.5	338.9	301.2	419.0	377.1	335.2	464.2	417.8	371.4	511.9	460.7	409.5
26,000	351.8	316.6	281.4	391.5	352.4	313.2	433.4	390.1	346.7	478.3	430.5	382.6
28,000	328.4	295.6	262.7	365.1	328.6	292.1	404.5	364.1	323.6	446.7	402.0	357.4
30,000	305.9	275.3	244.7	340.3	306.3	272.2	377.0	339.3	301.6	416.4	374.8	333.1
32,000	284.9	256.4	227.9	316.7	285.0	253.4	351.2	316.1	281.0	387.8	349.0	310.2
34,000	264.6	238.1	211.7	294.3	264.9	235.4	326.0	293.4	260.8	360.4	324.4	288.3
36,000	244.1	219.7	195.3	271.3	244.2	217.0	300.8	270.7	240.6	332.4	299.2	265.9
38,000	221.9	199.7	177.5	246.7	222.0	197.4	273.5	246.2	218.8	302.2	272.0	241.8
40,000	201.8	181.6	161.4	224.3	201.9	179.4	248.7	223.8	199.0	274.8	247.3	219.8
42,000	183.4	165.1	146.7	203.9	183.5	163.1	226.0	203.4	180.8	249.8	224.8	199.8
44,000	166.8	150.1	133.4	185.4	166.9	148.3	205.5	185.0	164.4	227.1	204.4	181.7
46,000	151.5	136.4	121.2	168.4	151.6	134.7	186.7	168.0	149.4	206.4	185.8	165.1
48,000	137.6	123.8	110.1	153.0	137.7	122.4	169.6	152.6	135.7	187.5	168.8	150.0
50,000	125.2	112.7	100.2	139.1	125.2	111.3	154.2	138.8	123.4	170.6	153.5	136.4

NATIONAL ADVISORY
COMMITTEE FOR AERONAUTICS

TABLE VI

IMPACT PRESSURES, ARMY SUMMER ATMOSPHERE

Altitude (ft) \ Airspeed (mph)	Pressure, lb/sq ft														
	100			150			200			225			250		
	q_c	$0.9q_c$	$0.8q_c$	q_c	$0.9q_c$	$0.8q_c$	q_c	$0.9q_c$	$0.8q_c$	q_c	$0.9q_c$	$0.8q_c$	q_c	$0.9q_c$	$0.8q_c$
0	23.8	21.4	19.0	53.8	48.4	43.0	96.5	86.9	77.2	122.6	110.3	98.1	152.1	136.9	121.7
2,000	22.4	20.2	17.9	50.7	45.6	40.6	90.9	81.8	72.7	115.5	104.0	92.4	143.2	128.9	114.6
4,000	21.1	19.0	16.9	47.7	42.9	38.2	85.6	77.0	68.5	108.7	97.8	87.0	134.8	121.3	107.8
6,000	19.8	17.8	15.8	44.9	40.4	35.9	80.6	72.5	64.5	102.3	92.1	81.8	126.9	114.2	101.5
8,000	18.6	16.7	14.9	42.2	38.0	33.8	75.6	68.0	60.5	96.0	86.4	76.8	119.1	107.2	95.3
10,000	17.5	15.8	14.0	39.6	35.6	31.7	71.0	63.9	56.8	90.2	81.2	72.2	111.9	100.7	89.5
12,000	16.4	14.8	13.1	37.1	33.4	29.7	66.6	59.9	53.3	84.7	76.2	67.8	105.0	94.5	84.0
14,000	15.4	13.9	12.3	34.8	31.3	27.8	62.4	56.2	49.9	79.2	71.3	63.4	98.3	88.5	78.6
16,000	14.4	13.0	11.5	32.6	29.3	26.1	58.4	52.6	46.7	74.2	66.8	59.4	92.0	82.8	73.6
18,000	13.4	12.1	10.7	30.5	27.5	24.4	54.6	49.1	43.7	69.4	62.5	55.5	86.1	77.5	68.9
20,000	12.6	11.3	10.1	28.5	25.7	22.8	51.0	45.9	40.8	64.8	58.3	51.8	80.4	72.4	64.3
22,000	11.7	10.5	9.4	26.6	23.9	21.3	47.6	42.8	38.1	60.5	54.5	48.4	75.1	67.6	60.1
24,000	10.9	9.8	8.7	24.8	22.3	19.8	44.3	39.9	35.4	56.4	50.8	45.1	70.0	63.0	56.0
26,000	10.2	9.2	8.2	23.0	20.7	18.4	41.2	37.1	33.0	52.4	47.2	41.9	65.1	58.6	52.1
28,000	9.4	8.5	7.5	21.4	19.3	17.1	38.3	34.5	30.6	48.7	43.8	39.0	60.5	54.5	48.4
30,000	8.8	7.9	7.0	19.9	17.9	15.9	35.6	32.0	28.5	45.3	40.8	36.2	56.2	50.6	45.0
32,000	8.1	7.3	6.5	18.4	16.6	14.7	33.0	29.7	26.4	42.0	37.8	33.6	52.1	46.9	41.7
34,000	7.5	6.8	6.0	17.0	15.3	13.6	30.6	27.5	24.5	38.9	35.0	31.1	48.3	43.5	38.6
36,000	7.0	6.3	5.6	15.8	14.2	12.6	28.3	25.5	22.6	36.0	32.4	28.8	44.7	40.2	35.8
38,000	6.4	5.8	5.1	14.6	13.1	11.7	26.1	23.5	20.9	33.3	30.0	26.6	41.3	37.2	33.0
40,000	5.9	5.3	4.7	13.5	12.2	10.8	24.2	21.8	19.4	30.8	27.7	24.6	38.2	34.4	30.6
42,000	5.5	5.0	4.4	12.5	11.3	10.0	22.4	20.2	17.9	28.4	25.6	22.7	35.4	31.9	28.3
44,000	5.1	4.6	4.1	11.5	10.4	9.2	20.7	18.6	16.6	26.3	23.7	21.0	32.7	29.4	26.2
46,000	4.7	4.2	3.8	10.7	9.6	8.6	19.2	17.3	15.4	24.4	22.0	19.5	30.3	27.3	24.2
48,000	4.3	3.9	3.4	9.7	8.7	7.8	17.5	15.8	14.0	22.3	20.1	17.8	27.7	24.9	22.2
50,000	3.9	3.5	3.1	8.9	8.0	7.1	15.9	14.3	12.7	20.3	18.3	16.2	25.2	22.7	20.2

Altitude (ft) \ Airspeed (mph)	Pressure, lb/sq ft														
	275			300			325			350			375		
	q_c	$0.9q_c$	0.8_c	q_c	$0.9q_c$	$0.8q_c$	q_c	$0.9q_c$	$0.8q_c$	q_c	$0.9q_c$	$0.8q_c$	q_c	$0.9q_c$	$0.8q_c$
0	184.9	166.4	147.9	221.3	199.2	177.0	261.0	234.9	208.8	305.0	274.5	244.0	352.5	317.3	282.0
2,000	174.2	156.8	139.4	208.5	187.7	166.8	246.1	221.5	196.9	287.6	258.8	230.1	332.4	299.2	265.9
4,000	164.0	147.6	131.2	196.1	176.5	156.9	231.7	208.5	185.4	270.6	243.5	216.5	312.7	281.4	250.2
6,000	154.3	138.9	123.4	184.7	166.2	147.8	218.0	196.2	174.4	254.7	229.2	203.8	294.4	265.0	235.5
8,000	145.0	130.5	116.0	173.4	156.1	138.7	204.9	184.4	163.9	239.4	215.5	191.5	276.7	249.0	221.4
10,000	136.2	122.6	109.0	163.0	146.7	130.4	192.6	173.3	154.1	224.9	202.4	179.9	260.1	234.1	208.1
12,000	127.7	114.9	102.2	152.8	137.5	122.2	180.6	162.5	144.5	211.0	189.9	168.8	244.1	219.7	195.3
14,000	119.7	107.7	95.8	143.2	128.9	114.6	169.2	152.3	135.4	197.8	178.0	158.2	228.5	205.7	182.8
16,000	112.0	100.8	89.6	134.1	120.7	107.3	158.5	142.7	126.8	185.1	166.6	148.1	214.1	192.7	171.3
18,000	104.8	94.3	83.8	125.4	112.9	100.3	148.2	133.4	118.6	173.2	155.9	138.6	200.3	180.3	160.2
20,000	97.9	88.1	78.3	117.3	105.6	93.8	138.5	124.7	110.8	161.9	145.7	129.5	187.3	168.6	149.8
22,000	91.4	82.3	73.1	109.4	98.5	87.5	129.4	116.5	103.5	151.2	136.1	121.0	175.0	157.5	140.0
24,000	85.1	76.6	68.1	102.0	91.8	81.6	120.6	108.5	96.5	141.0	126.9	112.8	163.2	146.9	130.6
26,000	79.2	71.3	63.4	94.9	85.4	75.9	112.3	101.1	89.8	131.2	118.1	105.0	151.9	136.7	121.5
28,000	73.7	66.3	59.0	88.3	79.5	70.6	104.4	94.0	83.5	122.1	109.9	97.7	141.3	127.2	113.0
30,000	68.4	61.6	54.7	82.0	73.8	65.6	96.9	87.2	77.5	113.4	102.1	90.7	131.3	118.2	105.0
32,000	63.4	57.1	50.7	76.1	68.5	60.9	90.0	81.0	72.0	105.2	94.7	84.2	121.8	109.6	97.4
34,000	58.8	52.9	47.0	70.5	63.5	56.4	83.3	75.0	66.6	97.5	87.8	78.0	112.8	101.5	90.2
36,000	54.4	49.0	43.5	65.2	58.7	52.2	77.2	69.5	61.8	90.3	81.3	72.2	104.6	94.1	83.7
38,000	50.3	45.3	40.2	60.3	54.3	48.2	71.4	64.3	57.1	83.5	75.2	66.8	96.7	87.0	77.4
40,000	46.6	41.9	37.3	55.9	50.3	44.7	66.1	59.5	52.9	77.4	69.7	61.9	89.7	80.7	71.8
42,000	43.1	38.8	34.5	51.7	46.5	41.4	61.1	55.0	48.9	71.5	64.4	57.2	82.9	74.6	66.3
44,000	39.9	35.9	31.9	47.8	43.0	38.2	56.6	50.9	45.3	66.2	59.6	53.0	76.8	69.1	61.4
46,000	36.9	33.2	29.5	44.3	39.9	35.4	52.5	47.3	42.0	61.4	55.3	49.1	71.2	64.1	57.0
48,000	33.7	30.3	27.0	40.4	36.4	32.3	47.9	43.1	38.3	56.0	50.4	44.8	65.0	58.5	52.0
50,000	30.7	27.6	24.6	36.8	33.1	29.4	43.5	39.2	34.8	51.0	45.9	40.8	59.1	53.2	47.3

TABLE VI - Concluded

NATIONAL ADVISORY
COMMITTEE FOR AERONAUTICS

IMPACT PRESSURES, ARMY SUMMER ATMOSPHERE - Concluded

Altitude (ft) \ Airspeed (mph)	Pressure, lb/sq ft														
	400			425			450			475			500		
	q_c	$0.9q_c$	$0.8q_c$	q_c	$0.9q_c$	$0.8q_c$	q_c	$0.9q_c$	$0.8q_c$	q_c	$0.9q_c$	$0.8q_c$	q_c	$0.9q_c$	$0.8q_c$
0	404.1	363.7	323.3	460.1	414.1	368.1	520.6	468.5	416.5	585.4	526.9	468.3	655.2	589.7	524.2
2,000	381.0	342.9	304.8	433.8	390.4	347.0	490.8	441.7	392.6	552.4	497.2	441.9	617.7	555.9	494.2
4,000	358.8	322.9	287.0	408.4	367.6	326.7	462.2	416.0	369.8	520.1	468.1	416.1	582.1	523.9	465.7
6,000	337.8	304.0	270.2	384.5	346.1	307.6	435.1	391.6	348.1	489.7	440.7	391.8	548.0	493.2	438.4
8,000	317.5	285.8	254.0	361.4	325.3	289.1	409.0	368.1	327.2	460.7	414.6	368.6	515.6	464.0	412.5
10,000	298.2	268.4	238.6	339.7	305.7	271.8	384.8	346.3	307.8	433.0	389.7	346.4	484.6	436.1	387.7
12,000	279.8	251.8	223.8	318.9	287.0	255.1	361.1	325.0	288.9	406.4	365.8	325.1	455.2	409.7	364.2
14,000	262.2	236.0	209.8	298.8	268.9	239.0	338.4	304.6	270.7	380.8	342.7	304.6	426.5	383.9	341.2
16,000	245.7	221.1	196.6	280.2	252.2	224.2	317.3	285.6	253.8	357.1	321.4	285.7	399.9	359.9	319.9
18,000	230.0	207.0	184.0	262.1	235.9	209.7	297.1	267.4	237.7	334.3	300.9	267.4	374.5	337.1	299.6
20,000	215.1	193.6	172.1	245.3	220.8	196.2	277.8	250.0	222.2	312.9	281.6	250.3	350.1	315.1	280.1
22,000	200.8	180.7	160.6	229.0	206.1	183.2	259.4	233.5	207.5	292.1	262.9	233.7	327.2	294.5	261.8
24,000	187.5	168.8	150.0	213.8	192.4	171.0	242.1	217.9	193.7	272.7	245.4	218.2	305.4	274.9	244.3
26,000	174.4	157.0	139.5	199.1	179.2	159.3	225.5	203.0	180.4	254.0	228.6	203.2	284.4	256.0	227.5
28,000	162.3	146.1	129.8	185.3	166.8	148.2	210.0	189.0	168.0	236.5	212.9	189.2	265.1	238.6	212.1
30,000	150.9	135.8	120.7	172.1	154.9	137.7	195.0	175.5	156.0	219.7	197.7	175.8	246.2	221.6	197.0
32,000	140.0	126.0	112.0	159.8	143.8	127.8	181.2	163.1	145.0	204.0	183.6	163.2	228.7	205.8	183.0
34,000	129.8	116.8	103.8	148.0	133.2	118.4	167.9	151.1	134.3	189.2	170.3	151.4	212.2	191.0	169.8
36,000	120.2	108.2	96.2	137.2	123.5	109.8	155.7	140.1	124.6	175.3	157.8	140.2	196.7	177.0	157.4
38,000	111.3	100.2	89.0	127.0	114.3	101.6	144.1	129.7	115.3	162.4	146.2	129.9	182.2	164.0	145.8
40,000	103.2	92.9	82.6	117.8	106.0	94.2	133.6	120.2	106.9	150.6	135.5	120.5	169.1	152.2	135.3
42,000	95.4	85.9	76.3	108.9	98.0	87.1	123.5	111.2	98.8	139.4	125.5	111.5	156.5	140.9	125.2
44,000	88.4	79.6	70.7	100.9	90.8	80.7	114.5	103.1	91.6	129.2	116.3	103.4	145.0	130.5	116.0
46,000	82.0	73.8	65.6	93.7	84.3	75.0	106.3	95.7	85.0	119.9	107.9	95.9	134.7	121.2	107.8
48,000	74.8	67.3	59.8	85.5	77.0	68.4	97.0	87.3	77.6	109.5	98.6	87.6	123.0	110.7	98.4
50,000	68.1	61.3	54.5	77.7	69.9	62.3	88.2	79.4	70.6	99.6	89.6	79.7	111.9	100.7	89.5

Altitude (ft) \ Airspeed (mph)	Pressure, lb/sq ft											
	525			550			575			600		
	q_c	$0.9q_c$	$0.8q_c$	q_c	$0.9q_c$	$0.8q_c$	q_c	$0.9q_c$	$0.8q_c$	q_c	$0.9q_c$	$0.8q_c$
0	729.5	656.6	583.6	808.5	727.7	646.8	893.8	804.4	715.0	984.4	886.0	787.5
2,000	687.7	618.9	550.2	762.9	686.6	610.3	843.5	759.2	674.8	928.8	835.9	743.0
4,000	648.2	583.4	518.6	719.0	647.1	575.2	794.9	715.4	635.9	876.1	788.5	700.9
6,000	610.2	549.2	488.2	677.5	609.8	542.0	749.0	674.1	599.2	825.5	743.0	660.4
8,000	574.0	516.6	459.2	637.3	573.6	509.8	704.5	634.1	563.6	776.5	698.9	621.2
10,000	540.0	486.0	432.0	599.0	539.1	479.2	662.8	596.5	530.2	731.1	658.0	584.9
12,000	506.8	456.1	405.4	562.7	506.6	450.3	622.6	560.3	498.1	686.7	618.0	549.4
14,000	475.3	427.8	380.2	527.7	474.9	422.2	583.8	525.4	467.0	643.9	579.5	515.1
16,000	445.7	401.1	356.6	494.8	445.3	395.8	547.9	493.1	438.3	603.8	543.4	483.0
18,000	417.3	375.6	333.8	463.6	417.2	370.9	513.4	462.1	410.7	565.7	509.1	452.6
20,000	390.5	351.5	312.4	433.8	390.4	347.0	480.3	432.3	384.2	529.4	476.5	423.5
22,000	365.2	328.7	292.2	405.8	365.2	324.6	448.9	404.0	359.1	495.1	445.6	396.1
24,000	340.9	306.8	272.7	379.1	341.2	303.3	419.7	377.7	335.8	462.5	416.3	370.0
26,000	317.8	286.0	254.2	353.0	317.7	282.4	390.9	351.8	312.7	431.0	387.9	344.8
28,000	295.9	266.3	236.7	329.1	296.2	263.3	364.3	327.9	291.4	401.8	361.6	321.4
30,000	274.8	247.3	219.8	305.8	275.2	244.6	338.6	304.7	270.9	373.4	336.1	298.7
32,000	255.5	230.0	204.4	284.3	255.9	227.4	314.7	283.2	251.8	347.1	312.4	277.7
34,000	237.0	213.3	189.6	263.8	237.4	211.0	292.0	262.8	233.6	322.3	290.1	257.8
36,000	219.9	197.9	175.9	244.7	220.2	195.8	270.8	243.7	216.6	298.9	269.0	239.1
38,000	203.7	183.3	163.0	226.6	203.9	181.3	250.8	225.7	200.6	277.0	249.3	221.6
40,000	188.9	170.0	151.1	210.2	189.2	168.2	232.8	209.5	186.2	257.2	231.5	205.8
42,000	174.9	157.4	139.9	194.6	175.1	155.7	215.6	194.0	172.5	238.1	214.3	190.5
44,000	162.3	146.1	129.8	180.4	162.4	144.3	200.0	180.0	160.0	220.8	198.7	176.6
46,000	150.7	135.6	120.6	167.6	150.8	134.1	173.3	156.0	138.6	205.2	184.7	164.2
48,000	137.5	123.8	110.0	153.0	137.7	122.4	158.3	142.5	126.6	187.5	168.8	150.0
50,000	125.1	112.6	100.1	139.1	125.2	111.3	144.0	129.6	115.2	170.5	153.5	136.4

NATIONAL ADVISORY
COMMITTEE FOR AERONAUTICS.

TABLE VII

STAGNATION DENSITY, NACA STANDARD ATMOSPHERE

[Impact pressure = $1.0q_c$]

Altitude (ft) \ Airspeed (mph)	Density, slugs/cu ft																		
	100	150	200	225	250	275	300	325	350	375	400	425	450	475	500	525	550	575	600
0	0.002399	0.002425	0.002461	0.002484	0.002509	0.002537	0.002567	0.002601	0.002637	0.002677	0.002720	0.002766	0.002816	0.002869	0.002925	0.002984	0.003047	0.003115	0.003186
2,000	.002262	.002287	.002322	.002343	.002367	.002394	.002423	.002455	.002490	.002528	.002569	.002613	.002660	.002711	.002765	.002823	.002883	.002948	.003017
4,000	.002131	.002155	.002188	.002209	.002231	.002257	.002285	.002316	.002349	.002385	.002425	.002467	.002513	.002561	.002612	.002667	.002725	.002787	.002853
6,000	.002006	.002029	.002061	.002080	.002102	.002127	.002153	.002183	.002214	.002249	.002286	.002327	.002370	.002417	.002466	.002519	.002574	.002634	.002696
8,000	.001886	.001908	.001938	.001957	.001977	.002001	.002026	.002054	.002085	.002118	.002154	.002192	.002234	.002278	.002325	.002376	.002428	.002485	.002545
10,000	.001773	.001794	.001823	.001841	.001860	.001883	.001907	.001934	.001962	.001994	.002029	.002066	.002105	.002148	.002192	.002240	.002291	.002346	.0024[illegible]
12,000	.001665	.001684	.001712	.001729	.001747	.001769	.001792	.001818	.001845	.001875	.001908	.001944	.001981	.002021	.002064	.002110	.002159	.002211	.002265
14,000	.001560	.001579	.001605	.001621	.001639	.001660	.001682	.001706	.001732	.001761	.001792	.001826	.001862	.001901	.001941	.001984	.002031	.002081	.002131
16,000	.001462	.001480	.001505	.001520	.001537	.001557	.001578	.001601	.001626	.001653	.001683	.001715	.001749	.001786	.001825	.001867	.001911	.001958	.002007
18,000	.001369	.001386	.001410	.001424	.001440	.001459	.001479	.001501	.001525	.001551	.001579	.001610	.001642	.001677	.001714	.001754	.001796	.001841	.001888
20,000	.001280	.001296	.001319	.001333	.001348	.001365	.001384	.001405	.001428	.001453	.001480	.001509	.001540	.001573	.001608	.001646	.001686	.001729	.001775
22,000	.001195	.001210	.001232	.001245	.001260	.001276	.001294	.001314	.001336	.001359	.001375	.001413	.001442	.001474	.001507	.001543	.001581	.001622	.001664
24,000	.001115	.001129	.001150	.001162	.001176	.001192	.001209	.001228	.001248	.001271	.001295	.001321	.001349	.001379	.001411	.001445	.001481	.001520	.001559
26,000	.001039	.001053	.001072	.001084	.001097	.001112	.001128	.001146	.001165	.001187	.001210	.001235	.001261	.001289	.001319	.001352	.001387	.001425	.001461
28,000	.000967	.000980	.000999	.001010	.001022	.001036	.001052	.001069	.001087	.001107	.001129	.001153	.001178	.001205	.001233	.001265	.001297	.001331	.001367
30,000	.000899	.000911	.000929	.000939	.000951	.000964	.000979	.000995	.001013	.001032	.001052	.001075	.001098	.001124	.001151	.001180	.001211	.001244	.001278
32,000	.000835	.000846	.000863	.000873	.000884	.000897	.000911	.000926	.000942	.000960	.000980	.001001	.001023	.001047	.001074	.001101	.001130	.001161	.001193
34,000	.000774	.000785	.000800	.000810	.000820	.000832	.000845	.000860	.000875	.000892	.000911	.000931	.000952	.000975	.000999	.001026	.001053	.001082	.001113
36,000	.000713	.000723	.000737	.000746	.000756	.000767	.000779	.000792	.000807	.000823	.000840	.000859	.000878	.000900	.000923	.000947	.000972	.001000	.001028
38,000	.000648	.000657	.000670	.000678	.000687	.000697	.000708	.000720	.000733	.000748	.000763	.000780	.000798	.000818	.000839	.000860	.000884	.000909	.000935
40,000	.000589	.000597	.000609	.000616	.000624	.000633	.000643	.000654	.000666	.000680	.000694	.000709	.000726	.000743	.000762	.000783	.000803	.000826	.000850
42,000	.000535	.000543	.000553	.000560	.000567	.000576	.000585	.000595	.000606	.000618	.000631	.000645	.000659	.000676	.000693	.000711	.000730	.000751	.000772
44,000	.000486	.000493	.000503	.000509	.000510	.000523	.000532	.000541	.000551	.000562	.000573	.000586	.000600	.000614	.000630	.000647	.000664	.000682	.000702
46,000	.000442	.000448	.000457	.000463	.000468	.000475	.000483	.000491	.000500	.000510	.000521	.000532	.000545	.000558	.000572	.000588	.000603	.000620	.000638
48,000	.000402	.000407	.000415	.000420	.000426	.000432	.000439	.000447	.000455	.000464	.000473	.000484	.000495	.000507	.000520	.000534	.000548	.000563	.000580
50,000	.000365	.000370	.000378	.000382	.000387	.000393	.000399	.000406	.000413	.000422	.000430	.000440	.000450	.000461	.000473	.000485	.000498	.000512	.000527

NATIONAL ADVISORY
COMMITTEE FOR AERONAUTICS

TABLE VII - Continued

STAGNATION DENSITY, NACA STANDARD ATMOSPHERE - Continued

[Impact pressure = $0.9q_c$]

	Density, slugs/cu ft																		
Airspeed (mph) / Altitude (ft)	100	150	200	225	250	275	300	325	350	375	400	425	450	475	500	525	550	575	600
0	0.002396	0.002418	0.002449	0.002469	0.002490	0.002514	0.002541	0.002570	0.002601	0.002636	0.002673	0.002713	0.002755	0.002802	0.002851	0.002902	0.002957	0.003017	0.003079
2,000	.002259	.002280	.002310	.002328	.002349	.002372	.002397	.002425	.002455	.002488	.002524	.002562	.002603	.002647	.002694	.002744	.002797	.002854	.002914
4,000	.002128	.002148	.002177	.002195	.002214	.002237	.002261	.002287	.002316	.002348	.002381	.002418	.002458	.002500	.002544	.002593	.002643	.002697	.002754
6,000	.002003	.002023	.002050	.002067	.002086	.002107	.002130	.002155	.002183	.002213	.002245	.002281	.002318	.002358	.002401	.002447	.002495	.002548	.002602
8,000	.001883	.001902	.001928	.001944	.001962	.001982	.002004	.002028	.002055	.002084	.002115	.002148	.002184	.002223	.002263	.002307	.002353	.002403	.002455
10,000	.001771	.001788	.001813	.001829	.001845	.001865	.001886	.001907	.001934	.001962	.001991	.002023	.002057	.002094	.002133	.002175	.002219	.002267	.002316
12,000	.001662	.001679	.001703	.001717	.001733	.001752	.001772	.001794	.001818	.001844	.001872	.001903	.001936	.001971	.002008	.002048	.002090	.002136	.002183
14,000	.001558	.001574	.001596	.001610	.001626	.001643	.001662	.001684	.001706	.001731	.001758	.001787	.001819	.001852	.001888	.001925	.001966	.002010	.002054
16,000	.001460	.001475	.001497	.001510	.001525	.001541	.001559	.001579	.001601	.001625	.001651	.001679	.001708	.001740	.001774	.001809	.001849	.001890	.001933
18,000	.001367	.001381	.001402	.001414	.001428	.001444	.001461	.001481	.001501	.001524	.001548	.001575	.001603	.001634	.001666	.001700	.001737	.001776	.001817
20,000	.001278	.001292	.001311	.001323	.001336	.001351	.001368	.001386	.001406	.001427	.001451	.001476	.001502	.001532	.001562	.001595	.001630	.001667	.001706
22,000	.001193	.001206	.001225	.001236	.001249	.001263	.001279	.001296	.001314	.001335	.001357	.001381	.001407	.001434	.001463	.001495	.001528	.001563	.001600
24,000	.001113	.001126	.001143	.001154	.001166	.001179	.001194	.001211	.001228	.001248	.001269	.001291	.001316	.001342	.001369	.001399	.001431	.001464	.001499
26,000	.001037	.001049	.001066	.001076	.001087	.001100	.001114	.001130	.001146	.001165	.001185	.001206	.001229	.001254	.001280	.001309	.001339	.001370	.001403
28,000	.000966	.000977	.000993	.001002	.001013	.001025	.001039	.001053	.001069	.001087	.001106	.001126	.001148	.001171	.001196	.001223	.001251	.001282	.001313
30,000	.000898	.000908	.000923	.000932	.000942	.000954	.000967	.000980	.000995	.001012	.001030	.001049	.001070	.001092	.001116	.001142	.001168	.001197	.001227
32,000	.000833	.000843	.000858	.000866	.000876	.000887	.000899	.000912	.000926	.000942	.000959	.000977	.000997	.001017	.001040	.001064	.001089	.001118	.001145
34,000	.000773	.000782	.000795	.000803	.000812	.000823	.000834	.000846	.000860	.000875	.000891	.000908	.000927	.000946	.000968	.000991	.001015	.001040	.001067
36,000	.000711	.000720	.000732	.000740	.000748	.000758	.000768	.000780	.000793	.000807	.000821	.000838	.000855	.000874	.000894	.000915	.000937	.000961	.000986
38,000	.000646	.000654	.000666	.000672	.000680	.000689	.000698	.000709	.000720	.000733	.000747	.000761	.000777	.000794	.000812	.000831	.000851	.000873	.000896
40,000	.000588	.000595	.000605	.000611	.000618	.000626	.000635	.000644	.000655	.000666	.000679	.000692	.000706	.000722	.000738	.000756	.000774	.000794	.000814
42,000	.000534	.000541	.000550	.000556	.000562	.000569	.000577	.000586	.000595	.000606	.000617	.000629	.000642	.000656	.000671	.000687	.000703	.000721	.000740
44,000	.000485	.000491	.000500	.000505	.000511	.000517	.000525	.000532	.000541	.000550	.000561	.000572	.000583	.000596	.000610	.000625	.000640	.000656	.000673
46,000	.000441	.000446	.000454	.000459	.000464	.000470	.000477	.000484	.000491	.000500	.000510	.000519	.000530	.000542	.000554	.000568	.000581	.000596	.000612
48,000	.000401	.000406	.000413	.000417	.000422	.000427	.000433	.000440	.000447	.000455	.000463	.000472	.000482	.000492	.000504	.000516	.000528	.000541	.000556
50,000	.000364	.000369	.000375	.000379	.000383	.000388	.000394	.000400	.000406	.000413	.000421	.000429	.000438	.000447	.000458	.000469	.000480	.000492	.000505

NATIONAL ADVISORY
COMMITTEE FOR AERONAUTICS.

NACA ARR No. L4I11

TABLE VII - Concluded

STAGNATION DENSITY, NACA STANDARD ATMOSPHERE - Concluded

[Impact pressure = $0.8q_c$]

Airspeed (mph) / Altitude (ft)	Density, slugs/cu ft																		
	100	150	200	225	250	275	300	325	350	375	400	425	450	475	500	525	550	575	600
0	0.002393	0.002412	0.002438	0.002455	0.002472	0.002493	0.002515	0.002540	0.002566	0.002595	0.002627	0.002661	0.002696	0.002736	0.002772	0.002821	0.002868	0.002919	0.002978
2,000	.002256	.002274	.002300	.002315	.002332	.002352	.002373	.002396	.002422	.002450	.002480	.002512	.002547	.002584	.002624	.002667	.002712	.002760	.002812
4,000	.002126	.002143	.002167	.002182	.002198	.002217	.002237	.002260	.002284	.002311	.002339	.002371	.002404	.002440	.002478	.002519	.002562	.002606	.002657
6,000	.002001	.002018	.002041	.002055	.002070	.002088	.002108	.002129	.002152	.002178	.002205	.002235	.002267	.002301	.002336	.002377	.002418	.002462	.002509
8,000	.001882	.001897	.001919	.001932	.001947	.001964	.001983	.002003	.002026	.002050	.002076	.002105	.002135	.002168	.002205	.002240	.002279	.002322	.002366
10,000	.001769	.001784	.001805	.001817	.001832	.001848	.001866	.001885	.001906	.001929	.001955	.001982	.002011	.002042	.002075	.002111	.002149	.002189	.002232
12,000	.001660	.001674	.001694	.001707	.001720	.001735	.001752	.001771	.001791	.001813	.001837	.001863	.001891	.001921	.001953	.001987	.002023	.002062	.002108
14,000	.001556	.001569	.001588	.001600	.001613	.001628	.001644	.001662	.001681	.001702	.001725	.001750	.001776	.001805	.001835	.001867	.001902	.001939	.001977
16,000	.001458	.001471	.001489	.001500	.001513	.001527	.001542	.001559	.001577	.001597	.001619	.001643	.001668	.001696	.001724	.001755	.001788	.001822	.001860
18,000	.001365	.001377	.001395	.001405	.001417	.001430	.001445	.001461	.001478	.001498	.001518	.001541	.001565	.001591	.001618	.001647	.001679	.001712	.001747
20,000	.001277	.001288	.001304	.001314	.001325	.001338	.001352	.001367	.001384	.001402	.001422	.001443	.001466	.001491	.001517	.001545	.001575	.001607	.001640
22,000	.001192	.001203	.001218	.001228	.001238	.001251	.001264	.001278	.001294	.001311	.001330	.001350	.001372	.001396	.001420	.001447	.001476	.001506	.001538
24,000	.001112	.001122	.001137	.001146	.001156	.001167	.001180	.001194	.001209	.001225	.001243	.001262	.001283	.001306	.001329	.001354	.001381	.001410	.001439
26,000	.001036	.001046	.001060	.001068	.001078	.001089	.001100	.001114	.001128	.001143	.001160	.001179	.001198	.001219	.001242	.001266	.001292	.001318	.001347
28,000	.000965	.000974	.000987	.000995	.001004	.001015	.001026	.001038	.001051	.001066	.001082	.001100	.001118	.001138	.001160	.001183	.001207	.001232	.001260
30,000	.000897	.000905	.000918	.000925	.000934	.000944	.000954	.000966	.000979	.000993	.001008	.001025	.001042	.001061	.001081	.001103	.001126	.001150	.001176
32,000	.000832	.000841	.000853	.000860	.000868	.000877	.000887	.000898	.000910	.000924	.000938	.000954	.000970	.000988	.001008	.001028	.001050	.001072	.001097
34,000	.000772	.000779	.000791	.000797	.000805	.000814	.000823	.000834	.000845	.000858	.000871	.000886	.000902	.000919	.000937	.000957	.000977	.000998	.001022
36,000	.000710	.000718	.000728	.000734	.000742	.000750	.000758	.000768	.000779	.000791	.000803	.000817	.000832	.000848	.000865	.000883	.000903	.000922	.000944
38,000	.000645	.000652	.000662	.000667	.000674	.000681	.000689	.000698	.000708	.000719	.000730	.000742	.000756	.000770	.000784	.000802	.000820	.000838	.000858
40,000	.000587	.000593	.000601	.000607	.000613	.000619	.000626	.000635	.000643	.000653	.000664	.000675	.000687	.000700	.000714	.000729	.000745	.000762	.000780
			[illegible]	[illegible]	[illegible]	.000563	.000569	.000577	.000585	.000594	.000603	.000613	.000624	.000636	.000649	.000663	.000677	.000692	.000709

NATIONAL ADVISORY
COMMITTEE FOR AERONAUTICS

TABLE VII - Concluded

STAGNATION DENSITY, NACA STANDARD ATMOSPHERE - Concluded

[Impact pressure = $0.8q_c$]

Altitude (ft) \ Airspeed (mph)	Density, slugs/cu ft										
	100	150	200	225	250	275	300	325	350	375	400
0	0.002393	0.002412	0.002438	0.002455	0.002472	0.002493	0.002515	0.002540	0.002566	0.002595	0.002627
2,000	.002256	.002274	.002300	.002315	.002332	.002352	.002373	.002396	.002422	.002450	.002480
4,000	.002126	.002143	.002167	.002182	.002198	.002217	.002237	.002260	.002284	.002311	.002339
6,000	.002001	.002018	.002041	.002055	.002070	.002088	.002108	.002129	.002152	.002178	.002205
8,000	.001882	.001897	.001919	.001932	.001947	.001964	.001983	.002003	.002026	.002050	.002076
10,000	.001769	.001784	.001805	.001817	.001832	.001848	.001866	.001885	.001906	.001929	.001955
12,000	.001660	.001674	.001694	.001707	.001720	.001735	.001752	.001771	.001791	.001813	.001837
14,000	.001556	.001569	.001588	.001600	.001613	.001628	.001644	.001662	.001681	.001702	.001725
16,000	.001458	.001471	.001489	.001500	.001513	.001527	.001542	.001559	.001577	.001597	.001619
18,000	.001365	.001377	.001395	.001405	.001417	.001430	.001445	.001461	.001478	.001498	.001518
20,000	.001277	.001288	.001304	.001314	.001325	.001338	.001352	.001367	.001384	.001402	.001422
22,000	.001192	.001203	.001218	.001228	.001238	.001251	.001264	.001278	.001294	.001311	.001330
24,000	.001112	.001122	.001137	.001146	.001156	.001167	.001180	.001194	.001209	.001225	.001243
26,000	.001036	.001046	.001060	.001068	.001078	.001089	.001100	.001114	.001128	.001143	.001160
28,000	.000965	.000974	.000987	.000995	.001004	.001015	.001026	.001038	.001051	.001066	.001082
30,000	.000897	.000905	.000918	.000925	.000934	.000944	.000954	.000966	.000979	.000993	.001008
32,000	.000832	.000841	.000853	.000860	.000868	.000877	.000887	.000898	.000910	.000924	.000938
34,000	.000772	.000779	.000791	.000797	.000805	.000814	.000823	.000834	.000845	.000858	.000871
36,000	.000710	.000718	.000728	.000734	.000742	.000750	.000758	.000768	.000779	.000791	.000803
38,000	.000645	.000652	.000662	.000667	.000674	.000681	.000689	.000698	.000708	.000719	.000730
40,000	.000587	.000593	.000601	.000607	.000613	.000619	.000626	.000635	.000643	.000653	.000664
42,000	.000533	.000539	.000547	.000551	.000557	.000563	.000569	.000577	.000585	.000594	.000603
44,000	.000485	.000490	.000497	.000501	.000506	.000512	.000518	.000524	.000531	.000540	.000548
46,000	.000440	.000445	.000451	.000455	.000460	.000465	.000470	.000476	.000483	.000490	.000498
48,000	.000400	.000404	.000410	.000414	.000418	.000423	.000427	.000432	.000439	.000446	.000453
50,000	.000364	.000368	.000373	.000376	.000380	.000384	.000388	.000393	.000399	.000405	.000412

Altitude (ft) \ Airspeed (mph)	Density, slugs/cu ft							
	425	450	475	500	525	550	575	600
0	0.002661	0.002696	0.002736	0.002778	0.002821	0.002868	0.002919	0.002978
2,000	.002512	.002547	.002584	.002624	.002667	.002712	.002760	.002812
4,000	.002371	.002404	.002440	.002478	.002519	.002562	.002608	.002657
6,000	.002235	.002267	.002301	.002338	.002377	.002418	.002462	.002509
8,000	.002105	.002135	.002168	.002205	.002240	.002279	.002322	.002366
10,000	.001982	.002011	.002042	.002075	.002111	.002149	.002189	.002232
12,000	.001863	.001891	.001921	.001953	.001987	.002025	.002062	.002108
14,000	.001750	.001776	.001805	.001835	.001867	.001902	.001939	.001977
16,000	.001643	.001668	.001695	.001724	.001755	.001788	.001822	.001860
18,000	.001541	.001565	.001591	.001618	.001647	.001679	.001712	.001747
20,000	.001443	.001466	.001491	.001517	.001545	.001575	.001607	.001640
22,000	.001350	.001372	.001396	.001420	.001447	.001476	.001506	.001538
24,000	.001262	.001283	.001306	.001329	.001354	.001381	.001410	.001439
26,000	.001179	.001198	.001219	.001242	.001266	.001292	.001318	.001347
28,000	.001100	.001118	.001138	.001160	.001183	.001207	.001232	.001260
30,000	.001025	.001042	.001061	.001081	.001103	.001126	.001150	.001176
32,000	.000954	.000870	.000988	.001008	.001028	.001050	.001072	.001097
34,000	.000886	.000902	.000919	.000937	.000957	.000977	.000998	.001022
36,000	.000817	.000832	.000848	.000865	.000883	.000902	.000922	.000944
38,000	.000742	.000756	.000770	.000786	.000802	.000820	.000838	.000858
40,000	.000675	.000687	.000700	.000714	.000729	.000745	.000762	.000780
42,000	.000613	.000624	.000636	.000649	.000663	.000677	.000692	.000709
44,000	.000558	.000568	.000579	.000590	.000603	.000616	.000629	.000644
46,000	.000507	.000516	.000525	.000536	.000548	.000559	.000572	.000585
48,000	.000460	.000469	.000478	.000487	.000498	.000508	.000520	.000532
50,000	.000419	.000426	.000434	.000443	.000452	.000462	.000472	.000484

NATIONAL ADVISORY
COMMITTEE FOR AERONAUTICS.

TABLE VIII

STAGNATION DENSITY - ARMY SUMMER ATMOSPHERE

[Impact pressure = 1.0q_c]

Airspeed (mph) / Altitude (ft)	Density, slugs/cu ft																		
	100	150	200	225	250	275	300	325	350	375	400	425	450	475	500	525	550	575	600
0	0.002222	0.002244	0.002275	0.002295	0.002316	0.002340	0.002366	0.002395	0.002426	0.002460	0.002497	0.002536	0.002578	0.002624	0.002672	0.002723	0.002776	0.002834	0.002894
2,000	.002093	.002114	.002144	.002162	.002183	.002206	.002231	.002258	.002288	.002321	.002355	.002393	.002433	.002477	.002522	.002571	.002622	.002678	.002736
4,000	.001970	.001990	.002019	.002036	.002056	.002077	.002101	.002128	.002156	.002187	.00220	.002256	.002294	.002336	.002380	.002426	.002475	.002528	.002583
6,000	.001853	.001872	.001899	.001916	.001934	.001955	.001978	.002003	.002030	.002060	.002092	.002126	.002162	.002202	.002244	.002288	.002335	.002385	.002438
8,000	.001740	.001759	.001785	.001800	.001818	.001838	.001859	.001883	.001909	.001937	.001968	.002000	.002035	.002075	.002113	.002155	.002200	.002247	.002298
10,000	.001634	.001652	.001676	.001691	.001708	.001727	.001748	.001771	.001795	.001822	.001851	.001882	.001915	.001951	.001989	.002029	.002072	.002118	.002166
12,000	.001532	.001549	.001573	.001587	.001603	.001621	.001640	.001662	.001685	.001711	.001738	.001768	.001800	.001834	.001870	.001908	.001949	.001992	.002039
14,000	.001435	.001451	.001473	.001487	.001502	.001520	.001538	.001558	.001580	.001604	.001630	.001659	.001689	.001721	.001756	.001792	.001831	.001872	.001916
16,000	.001343	.001358	.001379	.001392	.001406	.001423	.001440	.001460	.001481	.001604	.001529	.001556	.001584	.001615	.001648	.001682	.001719	.001759	.001800
18,000	.001256	.001270	.001290	.001303	.001316	.001332	.001348	.001367	.001387	.001409	.001432	.001458	.001485	.001514	.001545	.001578	.001613	.001651	.001690
20,000	.001173	.001187	.001206	.001217	.001230	.001245	.001261	.001278	.001297	.001318	.001341	.001365	.001391	.001418	.001447	.001479	.001512	.001548	.001585
22,000	.001094	.001107	.001125	.001136	.001148	.001162	.001177	.001194	.001212	.001231	.001253	.001275	.001300	.001326	.001354	.001384	.001416	.001449	.001484
24,000	.001019	.001031	.001048	.001059	.001071	.001084	.001098	.001114	.001131	.001149	.001170	.001191	.001214	.001239	.001266	.001294	.001324	.001356	.001389
26,000	.000949	.000960	.000976	.000986	.000997	.001009	.001023	.001038	.001054	.001071	.001090	.001111	.001133	.001157	.001181	.001209	.001237	.001267	.001298
28,000	.000882	.000893	.000908	.000917	.000929	.000939	.000952	.000966	.000981	.000998	.001016	.001036	.001056	.001078	.001102	.001127	.001154	.001183	.001213
30,000	.000819	.000829	.000843	.000852	.000862	.000873	.000885	.000898	.000912	.000928	.000945	.000964	.000983	.001004	.001026	.001050	.001076	.001102	.001130
32,000	.000759	.000769	.000782	.000790	.000800	.000810	.000821	.000834	.000847	.000862	.000878	.000896	.000914	.000934	.000955	.000978	.001002	.001027	.001054
34,000	.000703	.000711	.000725	.000732	.000741	.000751	.000761	.000773	.000786	.000800	.000815	.000831	.000849	.000867	.000887	.000909	.000931	.000955	.000980
36,000	.000650	.000658	.000670	.000678	.000686	.000695	.000705	.000716	.000728	.000741	.000756	.000771	.000787	.000805	.000824	.000844	.000865	.000888	.000911
38,000	.000601	.000609	.000620	.000627	.000634	.000643	.000653	.000663	.000674	.000687	.000700	.000715	.000730	.000747	.000764	.000783	.000803	.000824	.000847
40,000	.000556	.000563	.000574	.000580	.000587	.000596	.000605	.000614	.000625	.000637	.000649	.000663	.000678	.000693	.000710	.000728	.000747	.000766	.000788
42,000	.000514	.000531	.000531	.000537	.000544	.000552	.000560	.000569	.000579	.000590	.000602	.000615	.000629	.000643	.000659	.000676	.000694	.000712	.000732
44,000	.000476	.000482	.000492	.000497	.000504	.000511	.000519	.000528	.000537	.000548	.000559	.000571	.000584	.000598	.000612	.000629	.000645	.000663	.000681
46,000	.000440	.000446	.000455	.000461	.000467	.000474	.000481	.000489	.000498	.000508	.000519	.000530	.000542	.000555	.000570	.000585	.000600	.000617	.000634
48,000	.000402	.000407	.000415	.000420	.000426	.000432	.000439	.000447	.000455	.000464	.000473	.000484	.000495	.000507	.000520	.000534	.000548	.000563	.000580
50,000	.000365	.000370	.000378	.000382	.000387	.000393	.000399	.000406	.000413	.000421	.000430	.000440	.000450	.000461	.000473	.000485	.000498	.000512	.000527

NATIONAL ADVISORY
COMMITTEE FOR AERONAUTICS

TABLE VIII - Continued

STAGNATION DENSITY - ARMY SUMMER ATMOSPHERE - Continued

[Impact pressure = $0.9q_0$]

Altitude (ft) \ Airspeed (mph)	Density, slugs/cu ft																		
	100	150	200	225	250	275	300	325	350	375	400	425	450	475	500	525	550	575	600
0	0.002219	0.002238	0.002265	0.002281	0.002300	0.002321	0.002343	0.002368	0.002395	0.002424	0.002456	0.002490	0.002527	0.002566	0.002608	0.002652	0.002699	0.002749	0.002802
2,000	.002090	.002108	.002134	.002150	.002167	.002187	.002209	.002233	.002258	.002287	.002317	.002349	.002384	.002422	.002462	.002504	.002549	.002597	.002647
4,000	.001967	.001984	.002009	.002024	.002041	.002060	.002080	.002103	.002128	.002154	.002183	.002214	.002248	.002284	.002322	.002362	.002405	.002451	.002499
6,000	.001850	.001867	.001890	.001905	.001921	.001939	.001958	.001980	.002003	.002029	.002056	.002086	.002118	.002152	.002188	.002227	.002268	.002312	.002358
8,000	.001738	.001754	.001776	.001790	.001805	.001822	.001841	.001861	.001884	.001908	.001934	.001962	.001992	.002026	.002060	.002097	.002136	.002177	.002221
10,000	.001632	.001647	.001668	.001681	.001696	.001712	.001730	.001749	.001771	.001794	.001819	.001846	.001875	.001906	.001939	.001974	.002011	.002051	.002093
12,000	.001530	.001544	.001565	.001577	.001591	.001606	.001623	.001642	.001662	.001684	.001708	.001734	.001761	.001791	.001822	.001855	.001891	.001929	.001969
14,000	.001435	.001446	.001466	.001477	.001490	.001505	.001521	.001539	.001558	.001579	.001602	.001626	.001652	.001680	.001710	.001742	.001776	.001812	.001850
16,000	.001341	.001354	.001372	.001383	.001396	.001410	.001425	.001442	.001460	.001480	.001501	.001525	.001550	.001577	.001605	.001635	.001667	.001702	.001737
18,000	.001254	.001266	.001284	.001294	.001306	.001319	.001334	.001350	.001367	.001386	.001406	.001429	.001452	.001478	.001505	.001533	.001564	.001597	.001631
20,000	.001171	.001183	.001199	.001209	.001221	.001233	.001247	.001262	.001278	.001297	.001316	.001337	.001359	.001384	.001409	.001436	.001465	.001496	.001529
22,000	.001092	.001103	.001119	.001128	.001139	.001151	.001164	.001178	.001194	.001211	.001229	.001249	.001270	.001293	.001317	.001344	.001371	.001400	.001431
24,000	.001018	.001028	.001043	.001052	.001062	.001073	.001086	.001099	.001114	.001130	.001148	.001166	.001186	.001208	.001231	.001256	.001282	.001310	.001339
26,000	.000947	.000957	.000971	.000979	.000989	.000999	.001011	.001024	.001038	.001053	.001070	.001088	.001107	.001127	.001149	.001172	.001197	.001223	.001251
28,000	.000881	.000890	.000903	.000911	.000920	.000930	.000941	.000953	.000966	.000981	.000996	.001013	.001031	.001051	.001071	.001093	.001117	.001142	.001168
30,000	.000817	.000826	.000838	.000846	.000854	.000864	.000874	.000886	.000898	.000912	.000927	.000943	.000959	.000978	.000997	.001018	.001040	.001064	.001088
32,000	.000758	.000766	.000778	.000785	000793	.000802	.000812	.000822	.000834	.000847	.000861	.000876	.000892	.000909	.000927	.000947	.000968	.000990	.001013
34,000	.000702	.000709	.000720	.000727	.000735	.000743	.000752	.000762	.000773	.000785	.000799	.000813	.000828	.000844	.000861	.000880	.000900	.000921	.000943
36,000	.000649	.000656	.000667	.000673	.000680	.000688	.000696	.000706	.000716	.000728	.000740	.000754	.000768	.000783	.000799	.000817	.000836	.000855	.000876
38,000	.000600	.000607	.000616	.000622	.000629	.000636	.000645	.000654	.000663	.000674	.000686	.000698	.000712	.000726	.000741	.000758	.000775	.000794	.000813
40,000	.000555	.000561	.000570	.000576	.000582	.000589	.000597	.000605	.000615	.000625	.000636	.000648	.000660	.000674	.000688	.000704	.000720	.000738	.000756
42,000	.000513	.000519	.000528	.000533	.000539	.000546	.000553	.000561	.000569	.000579	.000589	.000600	.000612	.000625	.000639	.000654	.000669	.000685	.000703
44,000	.000475	.000481	.000489	.000494	.000499	.000505	.000512	.000520	.000528	.000537	.000547	.000557	.000568	.000581	.000593	.000607	.000622	.000637	.000653
46,000	.000439	.000445	.000453	.000457	.000462	.000468	.000485	.000475	.000490	.000498	.000507	.000517	.000528	.000539	.000551	.000565	.000578	.000579	.000608
48,000	.000401	.000406	.000413	.000417	.000422	.000427	.000433	.000440	.000447	.000455	.000463	.000472	.000482	.000492	.000504	.000516	.000528	.000528	.000556
50,000	.000364	.000369	.000375	.000379	.000383	.000388	.000394	.000400	.000406	.000413	.000421	.000429	.000438	.000447	.000458	.000469	.000480	.000480	.000505

NATIONAL ADVISORY
COMMITTEE FOR AERONAUTICS

TABLE VIII - Concluded

STAGNATION DENSITY - ARMY SUMMER ATMOSPHERE - Concluded

[Impact pressure = $0.8q_c$]

Altitude (ft) \ Airspeed (mph)	Density, slugs/cu ft																		
	100	150	200	225	250	275	300	325	350	375	400	425	450	475	500	525	550	575	600
0	0.002217	0.002233	0.002256	0.002269	0.002285	0.002302	0.002321	0.002342	0.002365	0.002390	0.002417	0.002446	0.002476	0.002510	0.002546	0.002583	0.002622	0.002665	0.002410
2,000	.002088	.002103	.002125	.002139	.002153	.002170	.002188	.002208	.002230	.002254	.002279	.002307	.002336	.002368	.002402	.002438	.002476	.002517	.002560
4,000	.001966	.001980	.002001	.002013	.002027	.002043	.002060	.002080	.002100	.002123	.002147	.002174	.002202	.002233	.002266	.002299	.002335	.002375	.002416
6,000	.001849	.001862	.001882	.001894	.001907	.001923	.001939	.001957	.001977	.001999	.002022	.002047	.002074	.002103	.002134	.002167	.002202	.002239	.002278
8,000	.001736	.001749	.001768	.001780	.001792	.001807	.001822	.001840	.001859	.001879	.001902	.001925	.001951	.001979	.002008	.002039	.002073	.002108	.002146
10,000	.001630	.001643	.001661	.001672	.001684	.001698	.001713	.001729	.001747	.001767	.001788	.001811	.001835	.001862	.001890	.001919	.001951	.001985	.002021
12,000	.001529	.001541	.001558	.001568	.001580	.001593	.001607	.001623	.001640	.001658	.001678	.001700	.001724	.001749	.001776	.001804	.001834	.001866	.001901
14,000	.001432	.001443	.001459	.001469	.001480	.001492	.001506	.001521	.001537	.001555	.001574	.001594	.001617	.001640	.001666	.001693	.001722	.001752	.001785
16,000	.001340	.001351	.001366	.001375	.001386	.001397	.001410	.001425	.001440	.001457	.001475	.001495	.001516	.001539	.001563	.001588	.001615	.001645	.001676
18,000	.001253	.001263	.001276	.001287	.001296	.001308	.001320	.001333	.001348	.001364	.001381	.001400	.001420	.001442	.001465	.001489	.001515	.001543	.001572
20,000	.001170	.001180	.001194	.001202	.001211	.001222	.001234	.001246	.001260	.001275	.001292	.001310	.001329	.001349	.001371	.001394	.001419	.001445	.001473
22,000	.001091	.001100	.001113	.001121	.001130	.001140	.001151	.001163	.001177	.001191	.001206	.001223	.001241	.001261	.001281	.001304	.001327	.001352	.001379
24,000	.001018	.001025	.001038	.001045	.001054	.001063	.001074	.001085	.001098	.001111	.001126	.001142	.001159	.001178	.001197	.001218	.001241	.001264	.001289
26,000	.000946	.000954	.000966	.000973	.000981	.000990	.001000	.001011	.001022	.001035	.001049	.001065	.001081	.001098	.001116	.001137	.001157	.001180	.001204
28,000	.000880	.000887	.000898	.000905	.000912	.000921	.000930	.000941	.000952	.000964	.000977	.000992	.001007	.001023	.001041	.001060	.001080	.001101	.001123
30,000	.000817	.000824	.000834	.000841	.000848	.000856	.000864	.000874	.000885	.000896	.000909	.000922	.000936	.000952	.000968	.000986	.001006	.001026	.001046
32,000	.000757	.000764	.000774	.000780	.000786	.000794	.000802	.000811	.000821	.000832	.000844	.000857	.000870	.000885	.000900	.000917	.000935	.000954	.000974
34,000	.000701	.000707	.000717	.000722	.000728	.000736	.000743	.000752	.000761	.000771	.000783	.000795	.000807	.000821	.000836	.000852	.000869	.000886	.000905
36,000	.000648	.000654	.000662	.000668	.000674	.000681	.000688	.000696	.000705	.000715	.000725	.000736	.000749	.000761	.000775	.000790	.000806	.000823	.000841
38,000	.000599	.000605	.000613	.000618	.000623	.000630	.000637	.000644	.000652	.000662	.000671	.000682	.000694	.000706	.000719	.000733	.000748	.000764	.000780
40,000	.000554	.000559	.000567	.000572	.000577	.000583	.000589	.000597	.000604	.000613	.000622	.000632	.000643	.000655	.000667	.000680	.000695	.000709	.000725
42,000	.000512	.000516	.000525	.000529	.000534	.000540	.000546	.000553	.000560	.000568	.000577	.000586	.000596	.000607	.000619	.000631	.000645	.000659	.000673
44,000	.000475	.000479	.000486	.000490	.000495	.000500	.000506	.000512	.000519	.000526	.000535	.000544	.000553	.000564	.000575	.000587	.000599	.000612	.000626
46,000	.000439	.000443	.000450	.000454	.000458	.000463	.000468	.000475	.000481	.000488	.000496	.000505	.000513	.000523	.000534	.000545	.000557	.000569	.000582
48,000	.000400	.000404	.000410	.000414	.000418	.000423	.000427	.000433	.000439	.000446	.000453	.000460	.000468	.000478	.000487	.000498	.000508	.000519	.000532
50,000	.000364	.000368	.000373	.000376	.000380	.000384	.000388	.000393	.000399	.000405	.000412	.000419	.000426	.000434	.000446	.000452	.000462	.000472	.000484

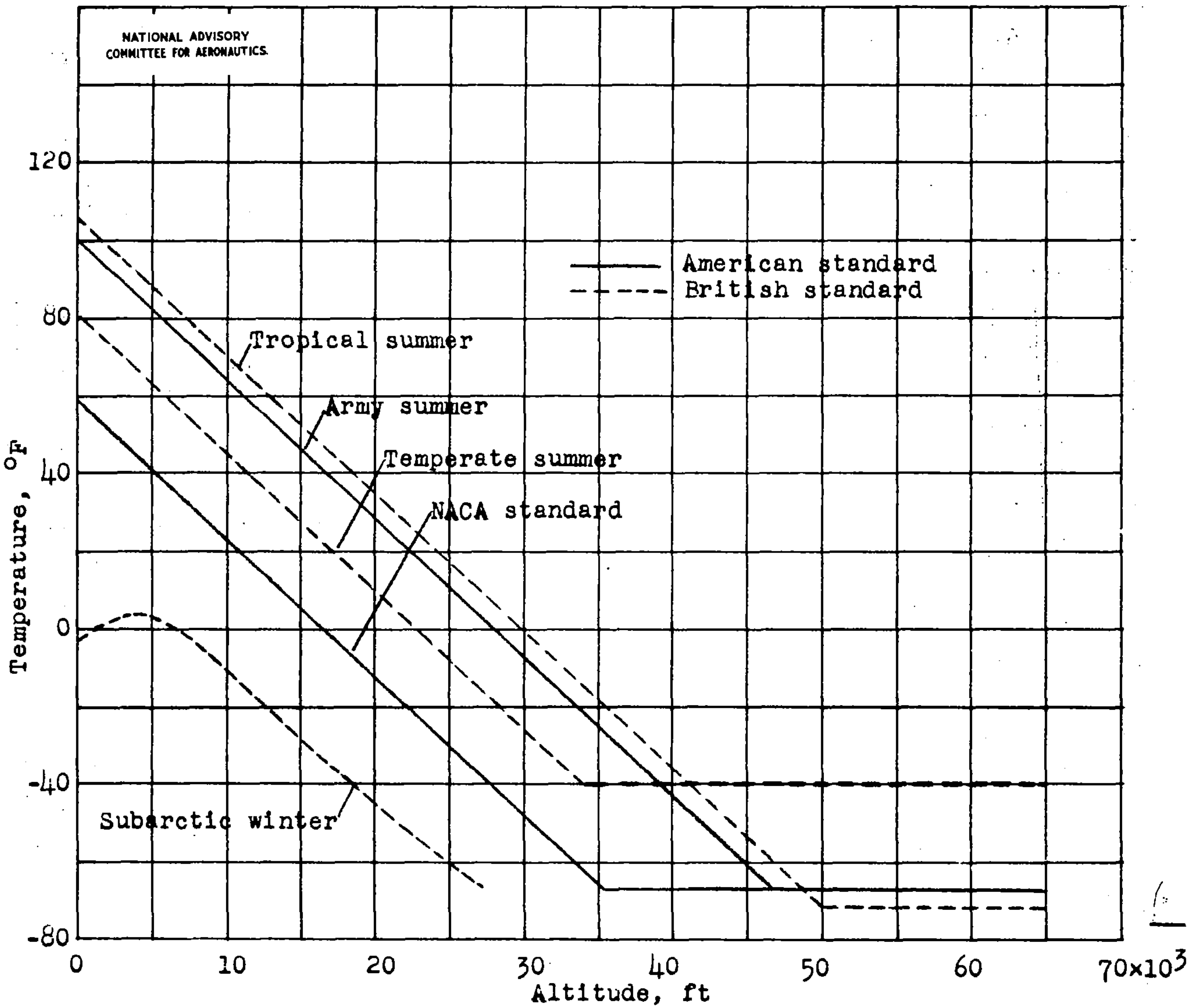

Figure 1. - Variation with altitude of the temperatures of NACA standard, Army summer, and British standard atmospheres.

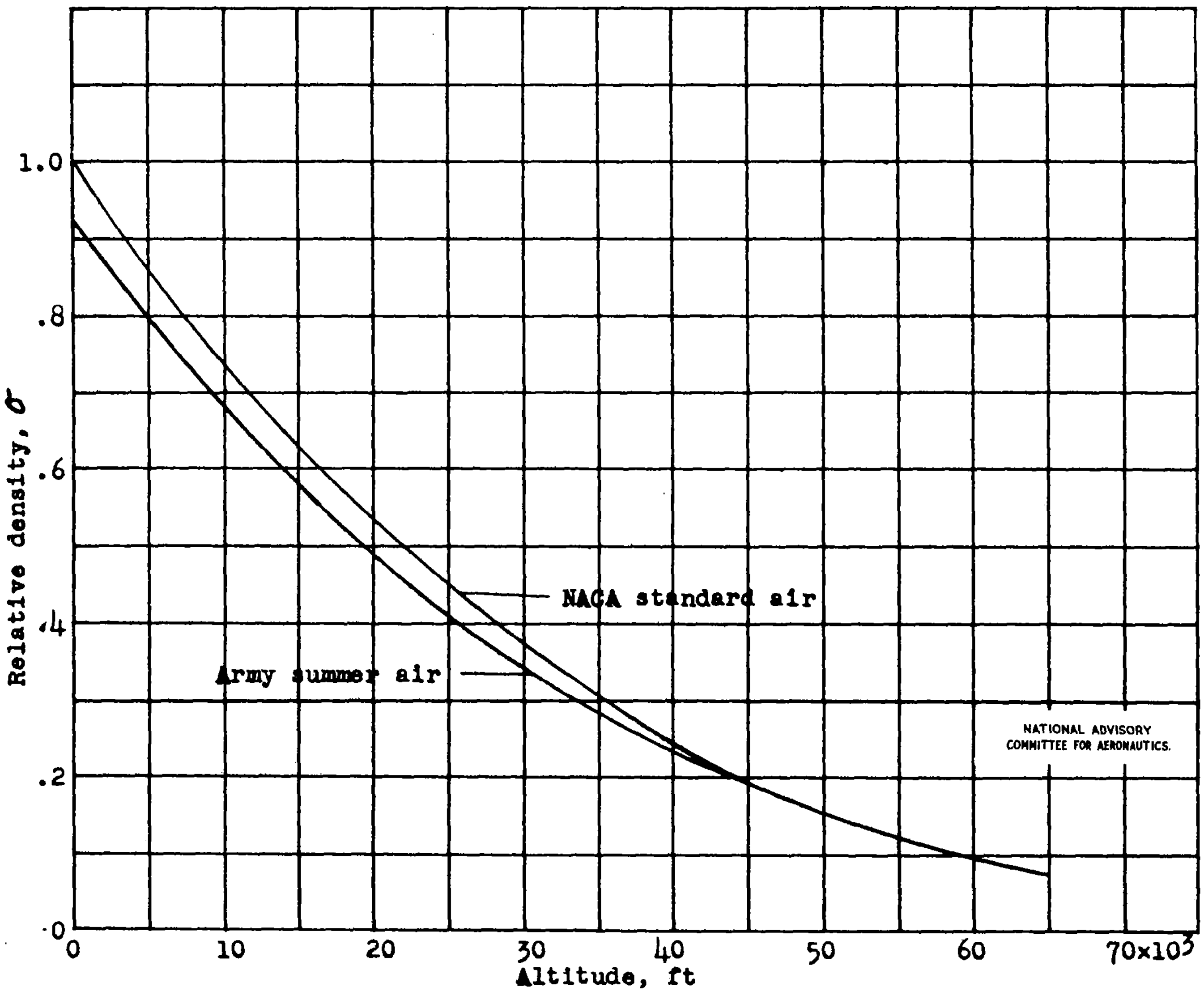

Figure 2. - Variation with altitude of the relative densities of NACA standard and Army summer air.

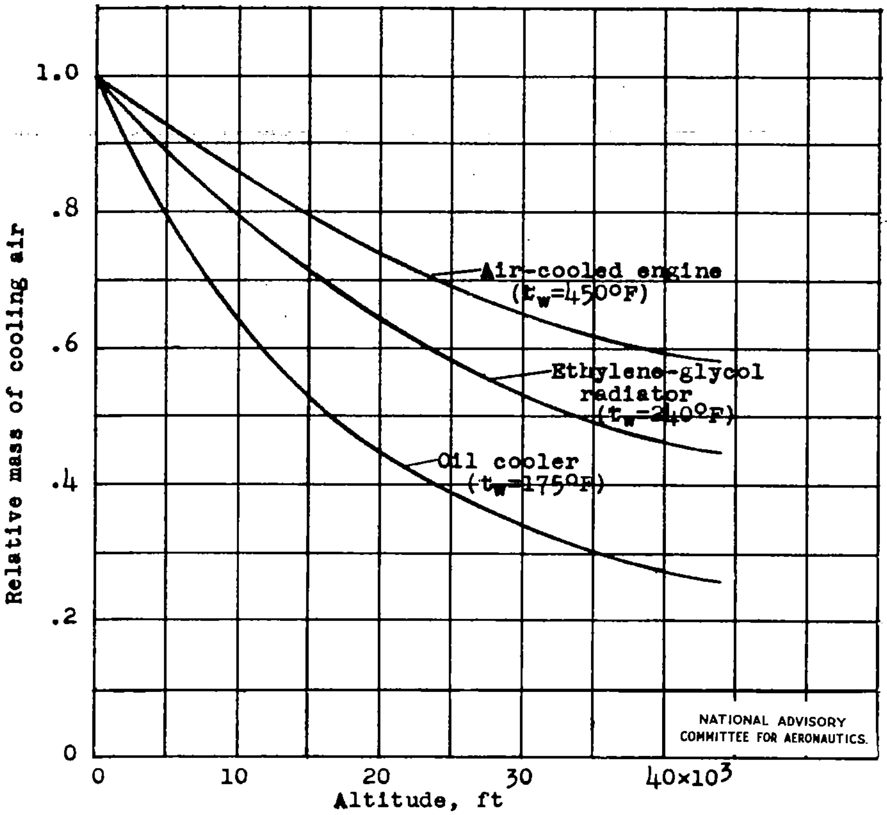

Figure 3. - Altitude effect on the mass of cooling air required by typical cooling elements. Army air; pursuit airplane in high-speed flight.

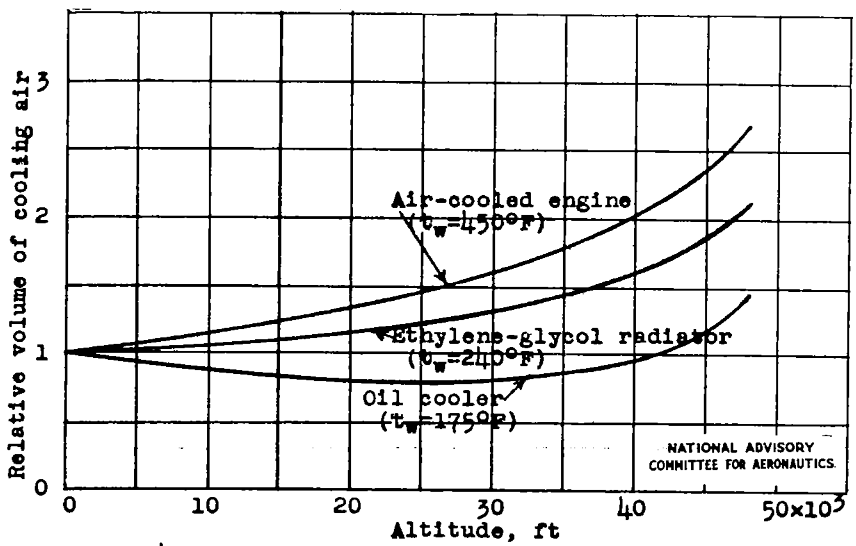

Figure 4. - Altitude effect on the volume of cooling air required by typical cooling elements. Army air; pursuit airplane in high-speed flight.

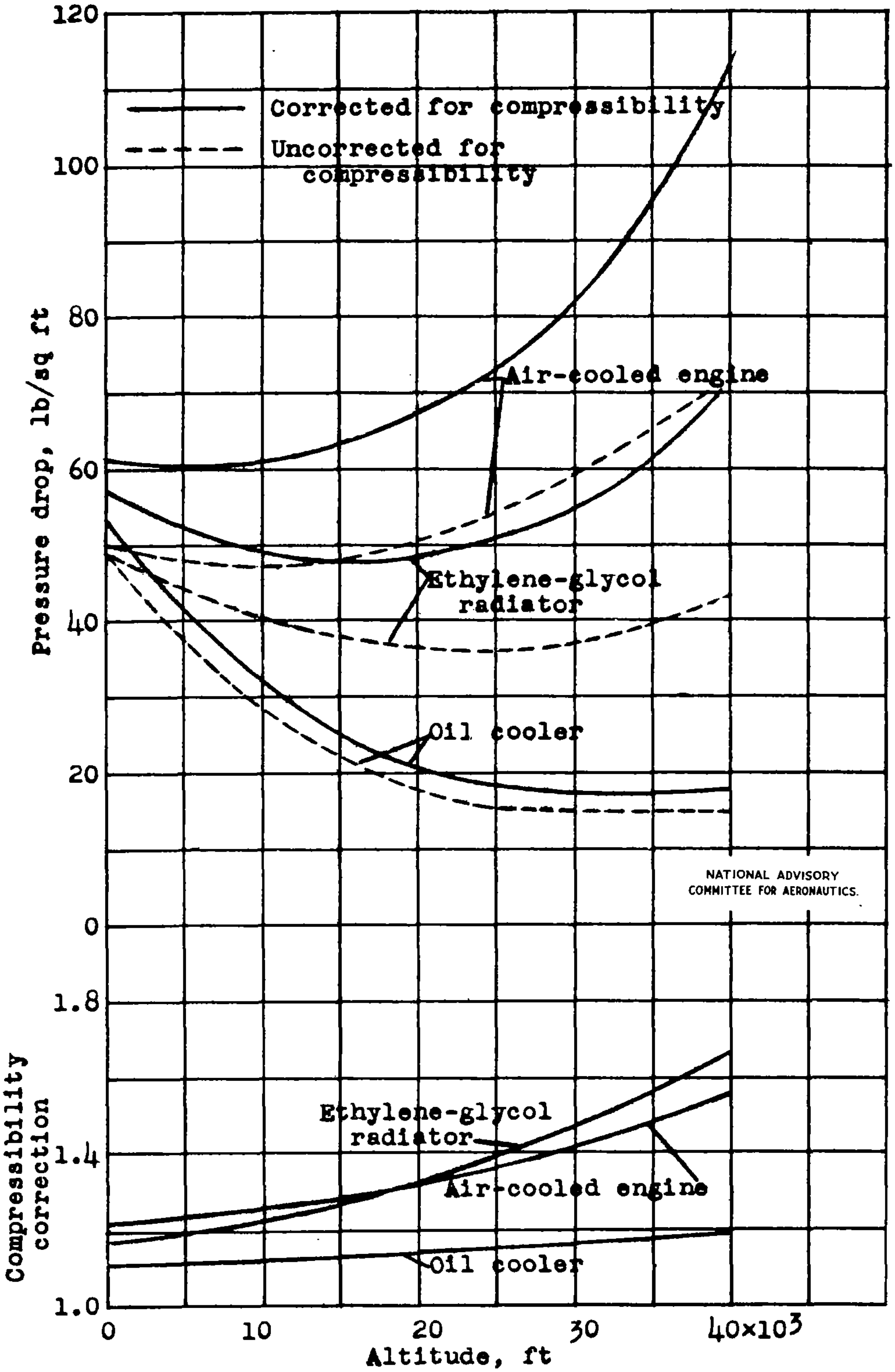

Figure 5. - Altitude and compressibility effects on the required pressure drops for typical cooling elements.

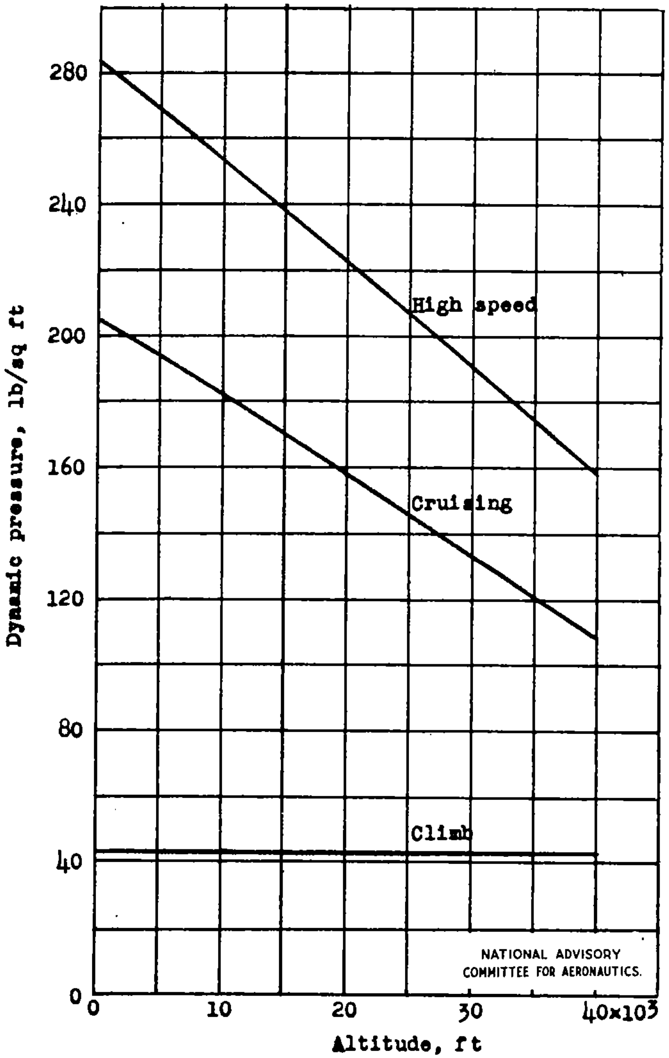

Figure 6. - Variation with altitude of the dynamic pressure of flight for a typical pursuit airplane.

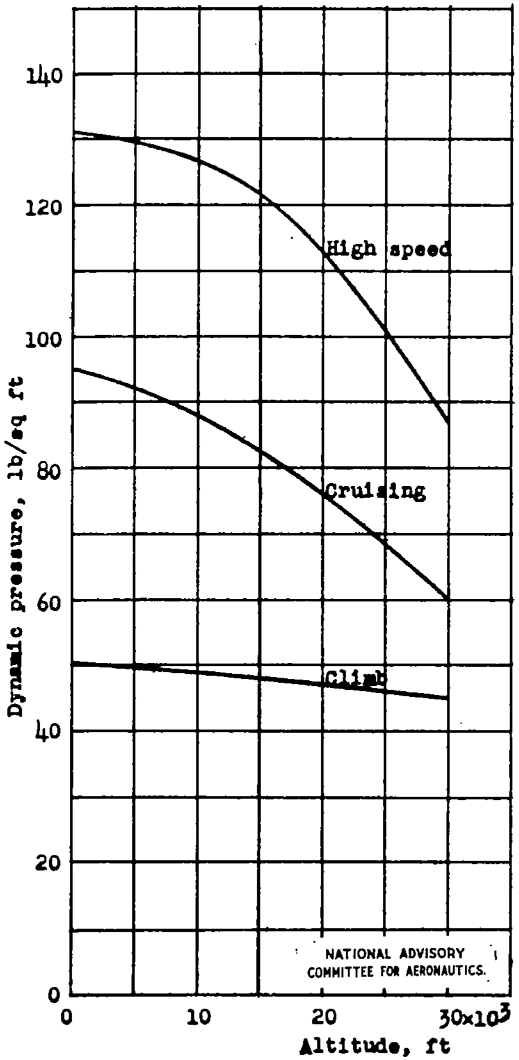

Figure 7. - Variation with altitude of the dynamic pressure of flight for a typical bomber airplane.

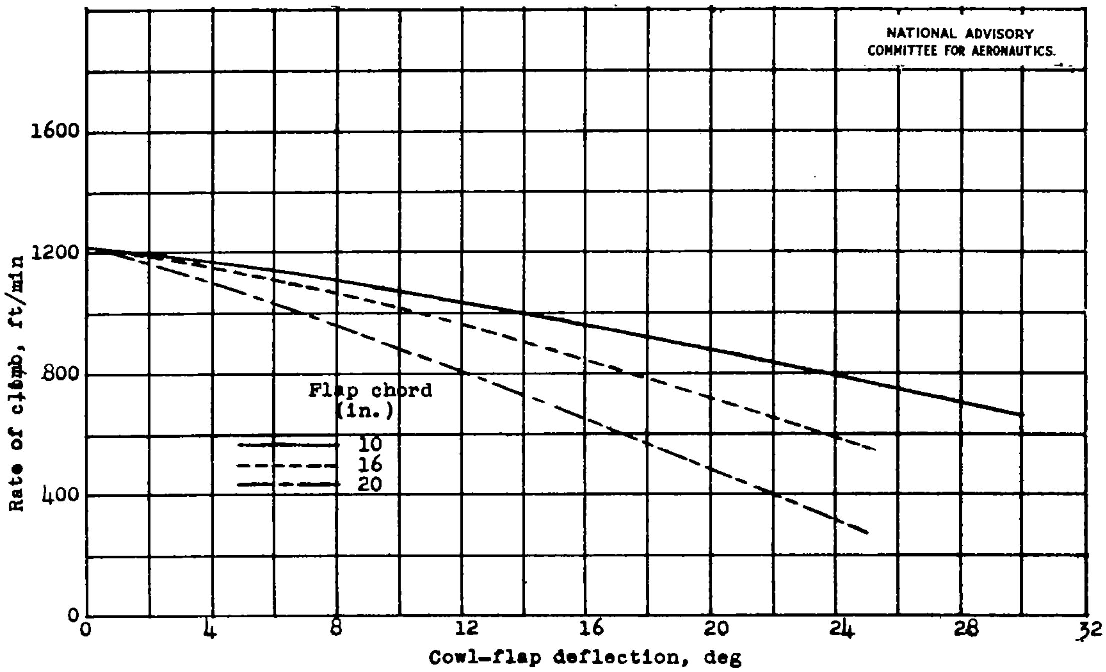

Figure 8. - Effect of drag due to cowl-flap deflection on the rate of climb of typical bomber airplane; altitude, 25,000 feet.

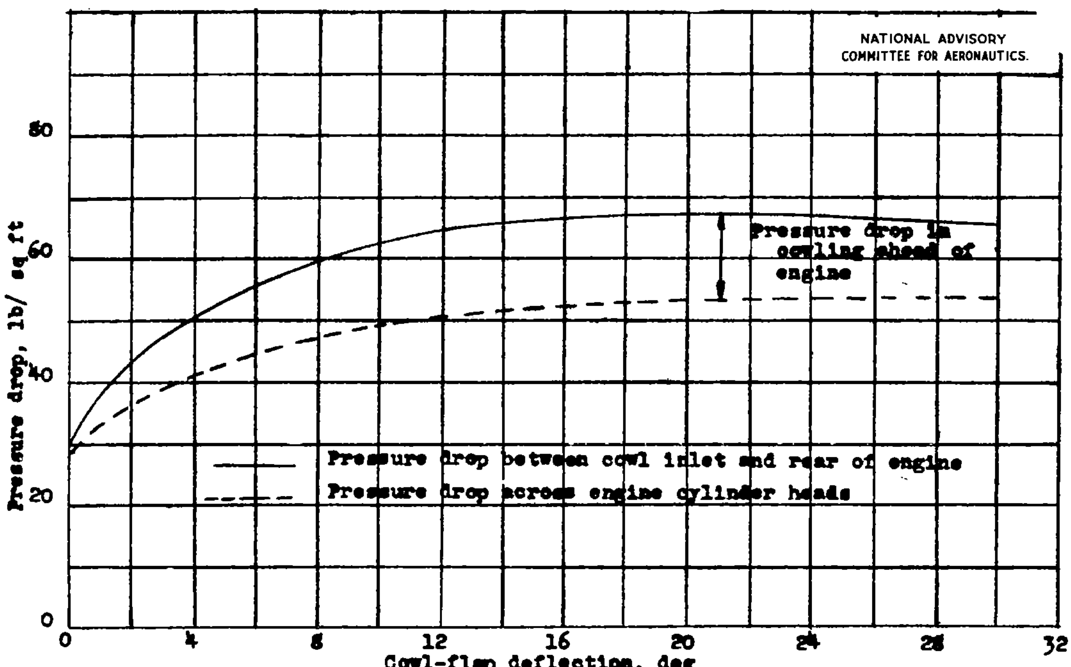

Figure 9. - Effectiveness of cowl flaps in increasing the pressure drop across the cylinder heads of an air-cooled engine installation in a typical bomber airplane. Cruising flight; altitude, 25,000 feet.

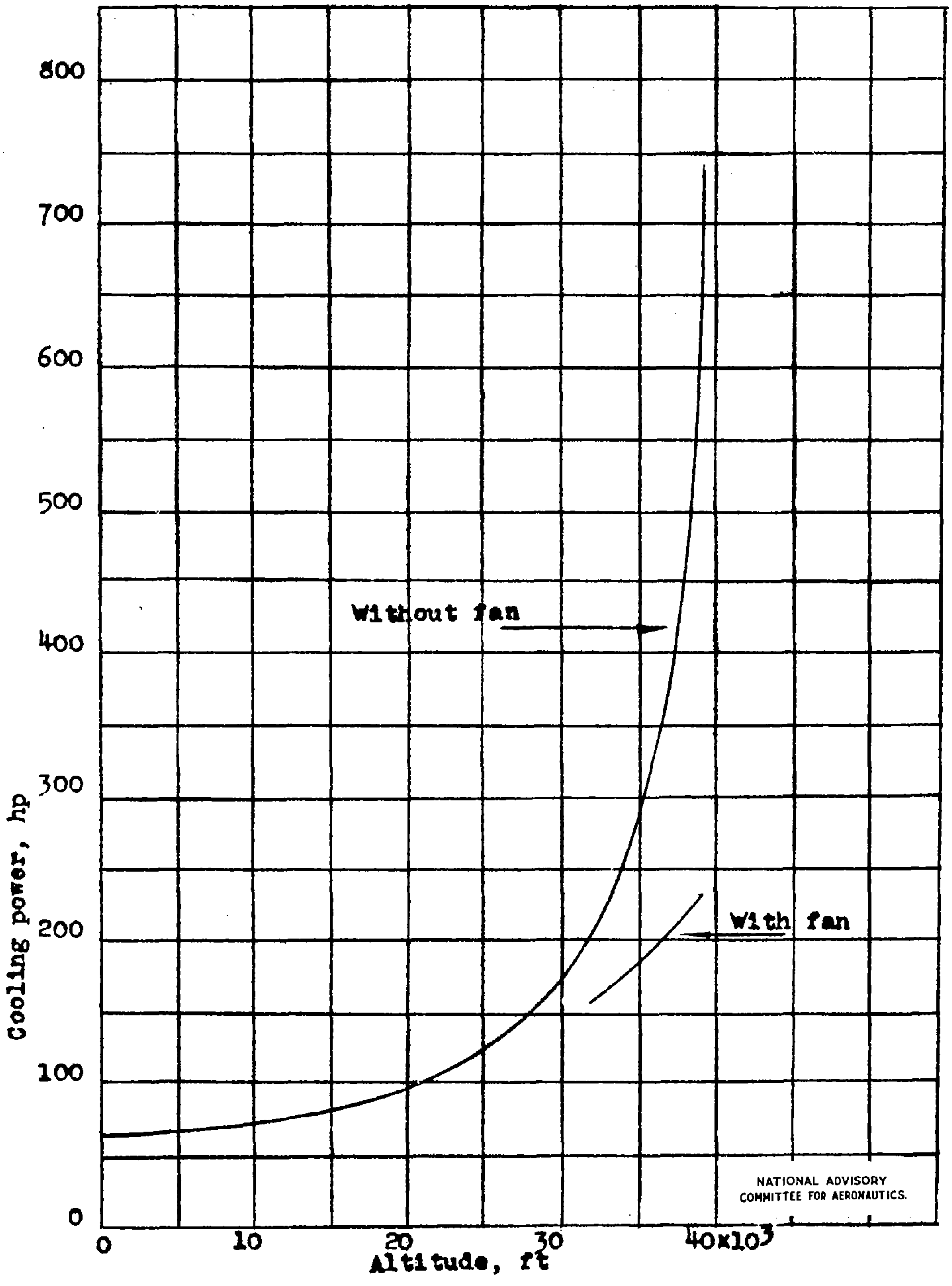

Figure 10. - Altitude effect on the cooling power of an air-cooled engine installation with and without a cooling fan.