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RESEARCH MEMORANDUM

for the

Bureau of Aeronautics, Navy Department

PRELIMINARY RESULTS OF ALTITUDE-WIND-TUNNEL INVESTIGATION OF X24C-4B TURBOJET ENGINE

III - COMPRESSOR PERFORMANCE

By David T. Dupree, and H. Carl Thorman

Flight Propulsion Research Laboratory
Cleveland, Ohio

[redacted]

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PRELIMINARY RESULTS OF ALTITUDE-WIND-TUNNEL INVESTIGATION OF X24C-4B TURBOJET ENGINE

III - COMPRESSOR PERFORMANCE

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SUMMARY

The performance of the 11-stage axial-flow compressor in the X24C-4B turbojet engine was analyzed on the basis of results obtained from an investigation of the complete engine in the NACA Cleveland altitude wind tunnel. The engine was operated with four exhaust nozzles of different outlet area over a range of engine speeds from 6000 to 12,500 rpm, corrected engine speeds from approximately 6100 to 13,600 rpm, and compressor Mach numbers from 0.45 to 1.00. Data are presented for engine operation over a range of simulated altitudes from 15,000 to 45,000 feet and simulated flight Mach numbers from 0.24 to 1.08.

Compressor operating lines fell on the high-air-flow side of the region of maximum efficiency. The highest compressor efficiency obtained was 85.7 percent. An increase in altitude reduced the corrected air flow at a given compressor pressure ratio and corrected engine speed and at a given compressor pressure ratio and corrected air flow, the compressor efficiency decreased. At any given corrected engine speed or corrected air flow, the compressor pressure ratio increased when the altitude was increased. When the flight Mach number increased, the compressor efficiency decreased at low air flows and increased at high air flows. An increase in flight Mach number from 0.24 to 0.73 at a constant corrected engine speed decreased the compressor pressure ratio and increased the corrected air flow. Raising the flight Mach number above 0.73 had a negligible effect on compressor pressure ratio and corrected air flow. Enlarging the exhaust-nozzle-outlet area at a constant corrected engine speed diminished the compressor pressure ratio and the compressor efficiency and slightly increased the corrected air flow.

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INTRODUCTION

An investigation to determine the performance and operational characteristics of the X24C-4B turbojet engine and its components has been conducted in the NACA Cleveland altitude wind tunnel at the request of the Bureau of Aeronautics, Navy Department. The effects of variations in flight conditions on pressure and temperature distribution in the engine are presented in reference 1. A preliminary presentation of engine performance is given in reference 2. The performance of the compressor operating as an integral part of the engine was investigated and is described herein.

For a compressor operating as part of a turbojet engine, the range of performance characteristics is restricted by the requirements of the other components and the geometry of the engine. In order to extend the range of compressor performance characteristics, four exhaust nozzles having different outlet areas were used for this part of the investigation. A complete set of data was obtained with each exhaust nozzle over a range of altitudes and flight Mach numbers.

Effects on the compressor operating line and on the compressor efficiency of changes in altitude, flight Mach number, and exhaust-nozzle-outlet area are graphically presented. Compressor performance characteristics at each altitude are shown. Compressor performance data are also presented in tabular form.

ENGINE AND INSTALLATION

The X24C-4B turbojet engine includes an 11-stage axial-flow compressor, a double-ring fuel manifold, a combustion chamber consisting of two concentric annuli, and a two-stage turbine. At sea-level static conditions, the rated thrust is 3000 pounds at an engine speed of 12,500 rpm. At this condition the air flow is approximately 58.5 pounds per second, the fuel consumption is 3200 pounds per hour, and the compressor pressure ratio is approximately 3.8.

The engine was mounted in a wing section in the altitude wind tunnel (fig. 1). For this part of the investigation, refrigerated air was supplied from the tunnel make-up air system through a duct to the engine cowl inlet. Outlet areas of the four exhaust nozzles used were 183.1, 231.5, 280.4, and 330.4 square inches. In the standard configuration with an exhaust-nozzle-outlet area of 183.1 square inches, the engine produced rated thrust at maximum engine speed and the turbine-outlet temperature reached the recommended limit of 1250° F at the hottest thermocouple location. The

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exhaust nozzle having an outlet area of 330.4 square inches was a straight section with a diameter slightly smaller than the turbine diameter. The location of stations at which instrumentation was installed is shown in figure 2. A complete description of the engine, the installation, and the instrumentation is given in reference 1.

COMPRESSOR

The axial-flow compressor used in the X24C-4B turbojet engine (figs. 3 and 4) was designed for wheel-rotation flow. Air enters the compressor through a single row of inlet guide vanes and is discharged through two rows of straightening vanes into the combustion-chamber inlet annulus. The rotor consists of 11 stages having an outside diameter of 18.9 inches and extending over an axial distance of 29.7 inches. The hub diameter of the rotor blades increases from 9.4 inches at the first and second stages to 14 inches at the tenth and eleventh stages.

PROCEDURE

Data were obtained at altitudes from 15,000 to 45,000 feet with a simulated flight Mach number of 0.53 and at an altitude of 25,000 feet with simulated flight Mach numbers from 0.24 to 1.08, which correspond to ram-pressure ratios from 1.04 to 2.07. Ram-pressure ratios were simulated by regulating the total pressure at the compressor inlet while the static pressure in the tunnel test section corresponding to the desired altitude was maintained. Flight Mach numbers were calculated on the basis of 100-percent free-stream total-pressure recovery at the compressor inlet.

Complete compressor performance data were obtained at each altitude and flight Mach number by operating the engine over the operable range of speeds with each of the four exhaust nozzles. The data cover a range of engine speeds from 6000 to 12,500 rpm, corrected engine speeds from approximately 6100 to 13,600 rpm, and compressor Mach numbers from 0.45 to 1.00.

RESULTS AND DISCUSSION

Method of Presentation

The correction factors used to generalize the compressor performance data account only for variations in total temperature and

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total pressure at the compressor inlet for a constant flight Mach number. In the development of correction factors (reference 3), component efficiencies were assumed constant. Variations in compressor efficiency therefore cause variations in the generalized results.

For each combination of altitude, flight Mach number, and exhaust-nozzle-outlet area, a compressor operating line was obtained. Compressor operating lines are presented in two forms: (1) the relation of compressor pressure ratio to corrected air flow, and (2) the relation of compressor pressure ratio to compressor Mach number and corrected engine speed. Characteristics of the compressor are shown by the relation of compressor pressure ratio to corrected air flow along lines of constant corrected engine speed and along contours of constant efficiency. The characteristic curves were constructed by use of the operating lines and the relation of compressor efficiency to corrected air flow for the four exhaust nozzles at given flight conditions.

The data used in this analysis are presented in table I. Symbols and methods of calculation are presented in the appendix.

Compressor Operating Lines

Effect of altitude. - An increase in altitude so shifted the operating line based on corrected air flow that at any given air flow the compressor pressure ratio increased when the altitude increased (fig. 5(a)). A similar shift occurred in the operating line based on compressor Mach number or corrected engine speed (fig. 5(b)) but the shift was greatest at high compressor Mach numbers and was negligible at compressor Mach numbers below 0.6. Reasons for this shift are discussed in a later section of this report.

Effect of flight Mach number. - The compressor pressure ratio decreased when the flight Mach number was increased at any given corrected air flow (fig. 6(a)). For any given compressor Mach number or corrected engine speed, the compressor pressure ratio decreased as the flight Mach number was increased (fig. 6(b)). The shift in the operating line was greatest at low values of corrected air flow and compressor Mach number. Increases in flight Mach number above 0.73 had very little effect on the position of the operating line based on corrected air flow (fig. 6(a)) and no effect on the compressor operating line based on compressor Mach number or corrected engine speed (fig. 6(b)). Examination of figures 6(a) and 6(b) shows that at a constant corrected engine

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speed, an increase in flight Mach number caused the corrected air flow to increase.

Effect of exhaust-nozzle-outlet area. - An increase in the exhaust-nozzle-outlet area caused the compressor operating line to shift downward and to the right with respect to the coordinates (fig. 7). The compressor pressure ratio was decreased when the exhaust-nozzle-outlet area was increased at any given corrected air flow, compressor Mach number, or corrected engine speed. Examination of figures 7(a) and 7(b) shows that at a constant corrected engine speed, an increase in exhaust-nozzle-outlet area caused the corrected air flow to increase slightly.

Compressor Efficiency

The effects of altitude, flight Mach number, and exhaust-nozzle-outlet area on the relation between compressor efficiency and corrected air flow are presented in figure 8. For a given corrected air flow, an increase in altitude caused a decrease in compressor efficiency (fig. 8(a)). At an altitude of 25,000 feet and at values of corrected air flow below about 50 pounds per second, an increase in flight Mach number up to a value of 0.73 resulted in a decrease in compressor efficiency (fig. 8(b)). At air flows greater than 50 pounds per second, an increase in flight Mach number caused an increase in compressor efficiency. An increase in exhaust-nozzle-outlet area caused a decrease in compressor efficiency, except at high values of air flow when the efficiency was not appreciably influenced by the exhaust-nozzle-outlet area (fig. 8(c)).

At any given condition of altitude, flight Mach number, and exhaust-nozzle-outlet area, the compressor efficiency reached a maximum at corrected air flows between 50 and 55 pounds per second, which correspond to corrected engine speeds between 11,000 and 12,000 rpm. A maximum compressor efficiency of 85.7 percent was obtained with an exhaust-nozzle-outlet area of 183.1 square inches at an altitude of 15,000 feet, a flight Mach number of 0.54, and a corrected engine speed of 11,209 rpm. With the same exhaust nozzle and flight conditions, the compressor efficiency was 82.2 percent at a corrected engine speed of 12,500 rpm.

Characteristic Curves

Compressor performance characteristics for several altitudes at a flight Mach number of 0.53 are presented in figures 9 and 10 for the four exhaust-nozzle-outlet areas used. An increase in

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altitude caused the lines of constant corrected engine speed to shift to the left with respect to the coordinates (fig. 9). At a given compressor pressure ratio and a given corrected engine speed, the corrected air flow decreased when the altitude was raised. Changes in compressor characteristics caused by increases in altitude were such that at a given corrected air flow and compressor pressure ratio the compressor efficiency was lower at high altitudes than at low altitudes (fig. 10). The decrease in compressor efficiency and the shift of the lines of constant corrected engine speed with an increase in altitude are attributed to the decrease in Reynolds number.

All operating lines obtained in this investigation fell on the high air-flow side of the maximum-efficiency regions shown in figure 10. An increase in exhaust-nozzle-outlet area at a constant corrected air flow therefore resulted in a lower compressor efficiency, as shown in figure 8(c).

Analysis of Altitude Effect on Operating Line

The reduction in compressor efficiency as the altitude increased (fig. 10) required that more energy per pound of gas be extracted by the turbine. In order to obtain more energy from the gas, the turbine-inlet temperature was increased. This increase in temperature caused a slight reduction in volume flow at the compressor outlet, which resulted in a higher compressor pressure ratio corresponding to the performance characteristics of the compressor. The shift in the operating line with increased altitude shown in figure 5 is the effect of the decrease in compressor efficiency shown in figure 8(a) and the required rise in turbine-inlet temperature. The shift may be modified by variation of turbine efficiency.

Performance with Standard Engine Configuration

Compressor performance at various corrected engine speeds with an exhaust-nozzle-outlet area of 183.1 square inches is shown in the following table, for which values were taken from figures 5, 6, and 8:

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Corrected engine speed $N/\sqrt{\theta}$ (rpm)	Altitude (ft)	Flight Mach number M_0	Compressor pressure ratio P_4/P_2	Corrected air flow $(W\sqrt{\theta})/\delta$ (lb/sec)	Compressor efficiency η_c (percent)
13,500	25,000	0.53	4.28	61.5	78.0
13,000	25,000	0.24	4.08	60.1	80.7
		.53	4.00	60.1	81.0
		.86	3.95	60.8	81.8
		1.08	3.95	60.8	82.9
12,500	15,000	0.53	3.68	59.0	82.2
	25,000	.24	3.82	58.0	83.0
	25,000	.53	3.76	58.8	82.2
	25,000	.73-1.08	3.70	59.3	82.0
	35,000	.53	3.84	58.2	81.0
	45,000	.53	3.98	57.0	77.5
11,500	15,000	0.53	3.22	54.8	85.0
	25,000	.24	3.30	53.6	83.0
	25,000	.53	3.27	54.8	83.9
	25,000	.73	3.16	55.0	83.5
	25,000	.86	3.16	55.0	83.8
	25,000	.98	3.16	55.0	84.2
	25,000	1.08	3.16	55.0	85.0
	35,000	.53	3.28	53.8	82.0
	45,000	.53	3.41	53.0	79.5
10,000	15,000	0.53	2.44	45.3	82.7
	25,000	.24	2.52	42.5	81.2
	25,000	.53	2.44	44.7	81.4
	25,000	.86	2.21	44.0	79.2
	25,000	1.08	2.21	45.0	79.7
	35,000	.53	2.48	43.6	80.4
	45,000	.53	2.53	43.3	78.8
8,000	15,000	0.53	1.68	32.0	----------
	25,000	.24	1.78	29.0	74.2
	25,000	.53	1.68	31.1	74.3

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Compressor Stator-Stage Static Pressures

The rise in static pressure through the compressor stator stages at altitudes of 15,000 and 45,000 feet is shown in figure 11 as the ratio of the static pressure at each stator stage to the static pressure at the compressor inlet. At a corrected engine speed of 12,500 rpm, the static pressure in the first stage, and in some cases in the second stage, was lower than the compressor-inlet static pressure. The static-pressure ratio in the first three or four stages was lower at high corrected engine speeds than at low corrected engine speeds, but increased beyond the fourth stage when the corrected engine speed was raised.

Comparison of figures 11(a) and 11(b) shows that for corrected engine speeds of 11,000 and 12,500 rpm the static-pressure ratio across the compressor was greater at 45,000 feet than at 15,000 feet. At a corrected engine speed of 9000 rpm, the pressure ratio was approximately the same at both altitudes.

Velocity Profile at Compressor Outlet

Typical velocity profiles at the compressor outlet for four engine speeds at altitudes of 15,000 and 45,000 feet are plotted in figure 12. The position of the peak velocity moved from approximately the center of the annulus at low engine speed toward the outer wall at high engine speed. Increasing the engine speed also increased the difference between the maximum and minimum velocities. At the highest engine speed obtainable at each altitude, the velocity near the inner wall was zero.

SUMMARY OF RESULTS

The results of an investigation in the Cleveland altitude wind tunnel of the performance of the 11-stage axial-flow compressor in the X24C-4B turbojet engine are summarized as follows:

1. Compressor operating lines fell on the high air-flow side of the region of maximum efficiency.

2. The maximum compressor efficiency at each altitude was reached at corrected engine speeds between 11,000 and 12,000 rpm. A maximum compressor efficiency of 85.7 percent was obtained with an exhaust-nozzle-outlet area of 183.1 square inches at a corrected engine speed of 11,209 rpm, an altitude of 15,000 feet, and a flight Mach number of 0.53.

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3. An increase in altitude so changed the compressor characteristics that at a given compressor pressure ratio and a given corrected engine speed the corrected air flow decreased and at a given compressor pressure ratio and corrected air flow, the compressor efficiency decreased. An increase in altitude so shifted the compressor operating line that at any given corrected air flow, corrected engine speed, or compressor Mach number, the compressor pressure ratio was increased. These effects are attributed to the reduction in Reynolds number with an increase in altitude.

4. An increase in flight Mach number at an altitude of 25,000 feet resulted in a decrease in compressor efficiency at values of corrected air flow below 50 pounds per second. At corrected air flows greater than 50 pounds per second, an increase in flight Mach number resulted in an increase in compressor efficiency. The shift in operating line with an increase in flight Mach number from 0.24 to 0.73 was such that for a given corrected engine speed the compressor pressure ratio decreased and the corrected air flow increased. At values of flight Mach number above 0.73, the shift in the operating line due to flight Mach number was negligible.

5. Increasing the exhaust-nozzle-outlet area so shifted the compressor operating line that for any given corrected engine speed the compressor pressure ratio and the compressor efficiency diminished and the corrected air flow increased slightly.

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National Advisory Committee for Aeronautics,
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David T. Dupree
David T. Dupree,
Mechanical Engineer.

H. Carl Thorman
H. Carl Thorman,
Aeronautical Engineer.

Approved:

Alfred W. Young,
Mechanical Engineer.

Abe Silverstein,
Aeronautical Engineer.

jgm

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APPENDIX - CALCULATIONS

Symbols

The following symbols are used in this analysis:

A	area, sq ft
a	stagnation speed of sound in air, ft/sec
c_p	specific heat at constant pressure, Btu/(lb)(°F)
c_v	specific heat at constant volume, Btu/(lb)(°F)
D	diameter of rotor, ft
g	acceleration due to gravity, 32.2 ft/sec^2
J	mechanical equivalent of heat, 778 ft-lb/Btu
M_c	compressor Mach number
M_0	flight Mach number
N	engine speed, rpm
P	total pressure, lb/sq ft absolute
P_2/p_0	ram-pressure ratio
P_4/P_2	compressor pressure ratio
p	static pressure, lb/sq ft absolute
p_3/p_2	compressor stator-stage static-pressure ratio
R	gas constant for air, 53.4 ft-lb/(lb)(°F)
T	total temperature, °R
T_i	indicated temperature, °R
t	static temperature, °R
U	rotor tip speed, ft/sec
V	velocity, ft/sec

W_a air flow, lb/sec

γ ratio of specific heat at constant pressure to specific heat at constant volume, (c_p/c_v)

δ ratio of compressor-inlet absolute total pressure to NACA standard sea-level absolute pressure

η_c compressor efficiency, percent

θ ratio of compressor-inlet absolute total temperature to NACA standard sea-level absolute temperature

Subscripts:

0 free-stream conditions

1 cowl inlet

2 compressor inlet

3 compressor stator stages

4 compressor outlet

c compressor

Stations to which the numerical subscripts refer are shown in figure 2.

The following parameters are used to generalize the results to NACA standard atmospheric conditions at sea level:

$(W_a\sqrt{\theta})/\delta$ corrected air flow, lb/sec

$N/\sqrt{\theta}$ corrected engine speed, rpm

Methods of Calculation

Flight Mach number. - Flight Mach number was calculated from the ram-pressure ratio by the following relation, in which complete ram-pressure recovery at the compressor inlet was assumed:

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$$M_0 = \sqrt{\frac{2}{\gamma-1}\left[\left(\frac{P_2}{p_0}\right)^{\frac{\gamma-1}{\gamma}} - 1\right]} \tag{1}$$

Temperatures. - Static temperatures were calculated from the indicated temperature by use of the empirical equation

$$t = \frac{T_i}{1 + 0.85\left[\left(\frac{P}{p}\right)^{\frac{\gamma-1}{\gamma}} - 1\right]} \tag{2}$$

where 0.85 is the thermocouple recovery factor.

Total temperatures at the compressor inlet and at the compressor outlet were assumed to be equal to the corresponding indicated temperatures because the average velocities were relatively low at these stations. This assumption introduced an error of less than 2° F.

Air flow. - Air flow was calculated from cowl-inlet measurements of temperature and pressure by the relation

$$W_a = \frac{p_1 A_1}{R}\sqrt{\frac{2Jgc_p}{t_1}\left[\left(\frac{P_1}{p_1}\right)^{\frac{\gamma-1}{\gamma}} - 1\right]} \tag{3}$$

Compressor Mach number. - Compressor Mach number is defined as the dimensionless ratio

$$M_c = \frac{U}{a_2} = \frac{\pi\ DN}{60\sqrt{\gamma_2 gRT_2}} \tag{4}$$

Compressor efficiency. - Compressor efficiency, defined as the adiabatic temperature-rise efficiency across the compressor, was calculated as

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$$\eta_c = \frac{\left(\frac{P_4}{P_2}\right)^{\frac{\gamma_c - 1}{\gamma_c}} - 1}{\frac{T_{i,4}}{T_{i,2}} - 1} \tag{5}$$

where γ_c was determined from a temperature equal to

$$\frac{T_{i,2} + T_{i,4}}{2}$$

Compressor-Outlet Velocity

The velocities at the compressor outlet were calculated by means of the following relation:

$$V_4 = \sqrt{2Jgc_p\, T_{i,4} \left[1 - \left(\frac{p_4}{P_4}\right)^{\frac{\gamma_4 - 1}{\gamma_4}}\right]} \tag{6}$$

where P_4 was the total pressure measured by each individual total-pressure tube. Uniform distribution of indicated temperature and static pressure permitted the use of average values.

REFERENCES

1. Prince, William R., and Hawkins, W. Kent: Preliminary Results of Altitude-Wind-Tunnel Investigation of X24C-4B Turbojet Engine. I - Pressure and Temperature Distributions. NACA RM No. SE7L22, Bur. Aero., 1947.

2. Meyer, Carl L., and Bloomer, Harry E.: Preliminary Results of Altitude-Wind-Tunnel Investigation of X24C-4B Turbojet Engine. II - Engine Performance. NACA RM No. SE7L26, Bur. Aero., 1947.

3. Sanders, Newell D.: Performance Parameters for Jet-Propulsion Engines. NACA TN No. 1106, 1946.

TABLE I. - COMPRESSOR PERFORMANCE

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Run	Altitude (ft)	Exhaust-nozzle-outlet area (sq in.)	Flight Mach number, M_0	Ram-pressure ratio, P_2/p_0	Engine speed, N (rpm)	Tunnel-static pressure, p_0 (lb/sq ft abs.)	Compressor-inlet indicated temperature, $T_{1,2}$ (°R)	Compressor-inlet total pressure, P_2 (lb/sq ft abs.)	Compressor-inlet total pressure, P_2 (lb/sq ft abs.)[a]	Compressor-inlet static pressure, P_2 (lb/sq ft abs.)	Compressor-stator-stage static pressure, p_3 (lb/sq ft abs.)				
											1	2	3	4	5
1	15,000	183.1	0.53	1.210	6,000	1190	507	1440	1439	1424	1450	1514	1570	1619	1669
2	15,000	183.1	.53	1.209	8,000	1197	506	1447	1446	1413	1457	1556	1655	1767	1880
3	15,000	183.1	.53	1.208	9,000	1197	509	1446	1447	1398	1465	1570	1704	1852	2014
4	15,000	183.1	.53	1.210	10,000	1204	507	1457	1458	1386	1436	1556	1542	1929	2133
5	15,000	183.1	.54	1.217	11,000	1190	500	1448	1452	1351	1338	1443	1669	1936	2183
6	15,000	183.1	.54	1.222	11,500	1197	493	1463	1468	1352	1303	1394	1641	1922	2211
7	15,000	183.1	.54	1.221	12,000	1197	497	1461	1467	1341	1260	1331	1577	1873	2176
8	15,000	183.1	.53	1.212	12,500	1190	494	1442	1455	1319	(c)	(c)	(c)	(c)	(c)
9	15,000	231.5	.52	1.206	8,000	1190	483	1435	1434	1398	1450	1549	1655	1760	1894
10	15,000	231.5	.53	1.208	9,000	1190	507	1437	1438	1386	1458	1549	1655	1831	2000
11	15,000	231.5	.53	1.208	10,000	1190	499	1438	1440	1365	1415	1528	1704	1901	2112
12	15,000	231.5	.53	1.208	11,000	1190	489	1438	1442	1339	1331	1422	1655	1894	2157
13	15,000	231.5	.53	1.208	11,500	1197	488	1446	1452	1336	1274	1359	1563	1866	2133
14	15,000	231.5	.53	1.211	12,000	1190	486	1441	1448	1320	1211	1274	1514	1788	2077
15	15,000	231.5	.53	1.211	12,500	1190	489	1441	1456	1312	1148	1197	1422	1711	2007
16	15,000	280.4	.53	1.215	9,000	1190	499	1446	1447	1396	1465	1563	1697	1859	2021
17	15,000	280.4	.52	1.204	10,000	1190	487	1433	1437	1360	1401	1507	1697	1894	2105
18	15,000	280.4	.52	1.205	10,500	1190	496	1434	1439	1351	1373	1486	1690	1908	2133
19	15,000	280.4	.52	1.204	11,000	1190	495	1433	1439	1338	1324	1422	1641	1894	2140
20	15,000	280.4	.53	1.208	11,500	1190	496	1438	1446	1332	1281	1366	1598	1859	2126
21	15,000	280.4	.53	1.208	12,000	1190	497	1437	1446	1320	1225	1296	1528	1802	2091
22	15,000	280.4	.53	1.208	12,500	1190	497	1437	1447	1314	1148	1204	1429	1718	2007
23	15,000	330.4	.52	1.204	9,200	1197	472	1441	1443	1381	1443	1556	1774	1880	2056
24	15,000	330.4	.53	1.207	10,000	1190	485	1436	1442	1365	1408	1514	1697	1908	2112
25	15,000	330.4	.53	1.208	10,500	1190	484	1438	1444	1353	1373	1472	1690	1922	2154
26	15,000	330.4	.53	1.208	11,000	1190	489	1437	1443	1339	1317	1415	1641	1894	2147
27	15,000	330.4	.52	1.206	11,500	1190	486	1435	1444	1327	1267	1345	1584	1845	2119
28	15,000	330.4	.53	1.208	12,000	1190	490	1438	1448	1321	1218	1282	1514	1795	2077
29	15,000	330.4	.53	1.210	12,500	1190	485	1440	1450	1315	1141	1183	1415	1697	1993
30	25,000	183.1	.22	1.037	6,000	774	443	803	803	795	809	844	880	915	943
31	25,000	183.1	.22	1.037	8,000	788	445	817	818	796	823	887	950	1013	1077
32	25,000	183.1	.23	1.041	9,000	781	440	813	814	778	816	880	964	1063	1168
33	25,000	183.1	.25	1.046	10,000	781	439	817	819	769	795	858	978	1098	1239
34	25,000	183.1	.25	1.046	11,000	781	441	817	820	754	725	781	922	1077	1239
35	25,000	183.1	.25	1.049	11,500	781	439	819	824	750	682	732	873	1034	1210
36	25,000	183.1	[d].11	1.009	11,800	774	439	781	785	710	661	704	844	1013	1196
37	25,000	183.1	.24	1.045	12,000	781	439	816	823	745	647	689	760	1006	1196
38	25,000	183.1	.24	1.045	12,350	781	441	816	823	744	619	661	795	985	1182
39	25,000	183.1	.53	1.210	7,000	781	455	945	944	913	943	999	1063	1119	1182
40	25,000	183.1	.52	1.202	8,000	788	455	947	947	922	957	1027	1098	1175	1260
41	25,000	183.1	.53	1.211	9,000	774	446	937	937	898	936	1013	1112	1225	1344
42	25,000	183.1	.52	1.203	10,000	788	451	948	949	894	922	999	1126	1274	1422
43	25,000	183.1	.53	1.208	11,000	774	452	935	938	865	837	907	1056	1232	1422
44	25,000	183.1	.53	1.209	11,500	781	454	944	948	866	(c)	(c)	(c)	(c)	1408
45	25,000	183.1	.53	1.213	12,000	781	454	947	950	863	760	816	964	1168	1373
46	25,000	183.1	.53	1.207	12,450	781	451	943	953	861	711	753	908	1119	1351
47	25,000	183.1	.73	1.428	8,950	781	467	1115	1113	1072	1119	1196	1309	1436	1569
48	25,000	183.1	.72	1.417	10,000	781	470	1107	1109	1047	1077	1168	1316	1478	1640
49	25,000	183.1	.73	1.428	10,500	781	464	1115	1117	1042	1049	1126	1295	1478	1675
50	25,000	183.1	.73	1.420	11,000	781	469	1109	1120	1029	1013	1091	1267	1471	1682
51	25,000	183.1	.72	1.402	11,500	788	470	1105	1108	1016	971	1041	1224	1443	1668
52	25,000	183.1	.73	1.428	12,000	781	470	1115	1120	1020	922	978	1161	1386	1633
53	25,000	183.1	.73	1.424	12,400	781	460	1112	1121	1015	858	901	1091	1323	1584
54	25,000	183.1	.73	1.424	12,500	781	461	1112	1122	1015	851	894	1077	1316	1577
55	25,000	183.1	.87	1.634	9,500	774	503	1265	1265	1210	1267	1358	1499	1647	1816
56	25,000	183.1	.86	1.624	10,000	788	495	1280	1281	1215	1253	1358	1513	1696	1879
57	25,000	183.1	.86	1.629	10,500	774	495	1261	1264	1185	1203	1295	1478	1682	1886
58	25,000	183.1	.86	1.626	11,000	781	496	1270	1272	1186	1182	1274	1471	1696	1914
59	25,000	183.1	.86	1.625	11,500	781	497	1269	1272	1173	1133	1210	1422	1661	1907
60	25,000	183.1	.87	1.633	12,000	781	500	1275	1279	1171	1084	1154	1140	1626	1886
61	25,000	183.1	.87	1.634	12,500	781	490	1276	1286	1167	1027	1077	1288	1555	1830
62	25,000	183.1	.98	1.850	8,000	781	503	1445	1447	1410	1471	1562	1661	1774	1893
63	25,000	183.1	.98	1.841	9,000	788	507	1451	1455	1399	1464	1576	1703	1865	2020
64	25,000	183.1	.98	1.837	10,000	78[illegible]	502	1435	1441	1365	1415	1527	1710	1907	2112
65	25,000	183.1	.98	1.846	11,000	781	500	1442	1451	1349	1344	1443	1337	1921	2168

[a]Manufacturer's instrumentation.

[b]No data obtained at stator stage 9.

[c]Data not available.

[d]Test conditions set at improper flight Mach number.

DATA FOR X24C-4B TURBOJET ENGINE

16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
Compressor-stator-stage static pressure, p_3 (lb/sq ft abs.)					Compressor-outlet indicated temperature, $T_{1,4}$ (°R)	Compressor-outlet indicated temperature, $T_{1,4}$ (°R)[a]	Compressor-outlet total pressure, P_4 (lb/sq ft abs.)	Compressor-outlet total pressure, P_4 (lb/sq ft abs.)[a]	Compressor-outlet static pressure, P_4 (lb/sq ft abs.)	Compressor-pressure ratio, P_4/P_2	Corrected engine speed, $N/\sqrt{\theta}$ (rpm)	Compressor Mach number, M_c	Air flow, W_a (lb/sec)	Corrected air flow, $(W_a\sqrt{\theta})/\delta$ (lb/sec)	Compressor efficiency, η_c (percent)	
6	7	8	[b]10	11												Run
1732	1774	1824	1817	1641	562	564	1820	1817	1769	1.264	6,072	0.449	15.69	22.78	63.69	1
1993	2105	2211	2373	2169	621	625	2493	2499	2415	1.723	8,104	.599	22.12	31.92	73.87	2
2169	2330	2485	2753	2605	656	660	2989	3006	2898	2.067	9,090	.672	26.79	38.81	79.50	3
2344	2549	2774	3246	3196	690	695	3648	3675	3547	2.504	10,120	.748	31.90	45.77	82.77	4
2443	2711	3027	3788	3929	721	729	4475	4485	4336	3.090	11,209	.828	36.86	52.85	85.70	5
2485	2802	3168	4154	4464	737	746	4995	4985	4836	3.414	11,799	.872	40.18	56.63	84.38	6
2471	2809	3217	4358	4766	765	771	5263	5273	5080	3.602	12,264	.906	41.15	58.30	81.49	7
(c)	(c)	(c)	(c)	(c)	781	785	(c)	(c)	(c)	(c)	12,813	.947	42.29	60.53	(c)	8
2007	2126	2225	2366	2098	591	598	2460	2464	2367	1.714	8,296	.613	23.45	33.35	74.51	9
2154	2309	2450	2682	2401	648	657	2856	2851	2748	1.987	9,108	.673	28.20	41.05	78.03	10
2309	2514	2711	3119	2921	675	684	3462	3478	3339	2.408	10,200	.754	32.81	47.32	81.00	11
2401	2654	2929	3577	3555	699	708	4159	4189	4026	2.892	11,330	.839	37.94	54.18	82.67	12
2345	2675	2985	3795	3886	716	726	4534	4548	4380	3.136	11,868	.877	40.20	56.99	82.75	13
2345	2654	2992	3957	4210	728	738	4838	4837	4658	3.357	12,396	.916	41.73	59.30	83.15	14
2288	2605	2978	4112	4499	751	760	5085	5083	4891	3.529	12,875	.952	42.59	60.70	81.06	15
2176	2330	2471	2690	2352	635	643	2829	2830	2713	1.956	9,180	.678	27.58	39.56	77.61	16
2302	2506	2704	3105	2873	657	665	3424	3443	3300	2.389	10,320	.762	33.33	47.70	81.01	17
2352	2377	2810	3288	3105	688	696	3689	3710	3563	2.573	10,742	.794	35.17	50.74	80.16	18
2373	2619	2880	3478	3415	702	710	4008	4034	3875	2.797	11,264	.832	37.42	53.97	81.78	19
2380	2654	2936	3661	3684	720	730	4324	4351	4179	3.007	11,765	.870	39.16	56.31	81.95	20
2351	2640	2964	3851	4013	738	750	4669	4689	4498	3.249	12,264	.906	40.93	58.99	82.64	21
2288	2591	2964	3999	4330	757	766	4948	4928	4755	3.443	12,775	.944	42.00	60.53	80.75	22
2232	2394	2563	2837	2471	618	625	3019	3020	2896	2.095	9,651	.713	30.75	43.03	76.14	23
2309	2506	2711	3091	2774	656	664	3385	3394	3251	2.357	10,340	.764	33.39	47.60	78.81	24
2373	2598	2830	3323	3112	672	680	3733	3760	3602	2.596	10,868	.803	35.94	51.08	80.77	25
2373	2626	2887	3492	3379	696	703	4014	4041	3883	2.793	11,330	.835	38.08	54.46	80.68	26
2373	2640	2943	3703	3724	708	718	4396	4421	4247	3.063	11,880	.878	40.13	57.30	82.60	27
2345	2633	2957	3879	4027	729	739	4712	4724	4540	3.277	12,348	.913	41.52	59.35	82.86	28
2274	2577	2950	4055	4407	742	752	5026	5020	4832	3.490	12,925	.955	42.99	61.08	81.07	29
971	1013	1063	1119	1091	514	515	1170	1175	1152	1.457	6,498	.480	9.06	22.04	70.80	30
1147	1224	1316	1471	1464	571	576	1615	1626	1580	1.977	8,640	.638	13.57	32.54	75.80	31
1281	1386	1513	1760	1774	598	606	1986	1999	1936	2.443	9,774	.722	17.18	41.18	80.79	32
1372	1520	1689	2076	2154	631	642	2426	2435	2357	2.969	10,870	.803	20.65	49.20	83.20	33
1408	1591	1809	2421	2625	673	680	2891	2893	2795	3.539	11,935	.882	23.49	56.07	82.49	34
1393	1598	1872	2597	2851	693	698	3136	3118	3003	3.829	12,501	.924	24.59	58.45	80.63	35
1379	1605	1900	2689	2942	704	707	3235	3210	3082	4.142	12,827	.948	24.31	60.58	82.62	36
1393	1640	1971	2830	3013	714	716	3382	3358	3204	4.145	13,044	.964	25.47	60.76	80.11	37
1393	1661	2027	2942	3118	732	736	3500	3463	3297	4.289	13,400	.991	25.60	61.18	78.27	38
1239	1302	1365	1422	1316	541	547	1484	1485	1441	1.570	7,476	.552	13.70	28.72	72.75	39
1344	1429	1520	1647	1541	571	576	1760	1767	1709	1.859	8,544	.632	16.14	33.76	75.87	40
1465	1591	1717	1964	1907	596	603	2180	2203	2121	2.327	9,711	.717	20.44	42.77	81.00	41
1576	1731	1907	2302	2344	637	647	2665	2682	2588	2.811	10,730	.793	23.81	49.53	83.12	42
1598	1802	2041	2654	2857	677	686	3184	3182	3080	3.405	11,781	.871	26.46	55.91	84.03	43
1612	1837	2126	2900	3189	704	712	3513	3520	3378	3.721	12,294	.908	28.10	58.93	82.39	44
1591	1844	2168	3069	3372	726	730	3720	3689	3550	3.928	12,828	.947	28.59	59.75	79.50	45
1591	1886	2295	3351	3561	745	748	4002	3956	3768	4.244	13,359	.988	29.35	61.38	78.54	46
1689	1823	1943	2161	1978	608	615	2330	2337	2248	2.090	9,433	.697	22.91	41.26	77.51	47
1802	1978	2154	2541	2499	651	659	2879	2900	2796	2.601	10,510	.777	26.55	48.28	81.38	48
1858	2062	2281	2816	2879	671	679	3302	3316	3204	2.961	11,109	.821	29.31	52.58	81.35	49
1879	2105	2351	2999	3153	691	701	3574	3583	3459	3.223	11,572	.855	30.35	55.05	83.54	50
1893	2147	2442	3273	3541	719	727	3934	3935	3800	3.560	12,087	.894	31.83	58.00	82.20	51
1858	2140	2485	3463	3815	740	745	4207	4202	4037	3.773	12,612	.932	32.96	59.52	79.97	52
1844	2161	2590	3766	4033	745	747	4534	4498	4277	4.077	13,169	.974	34.09	61.09	79.84	53
1844	2168	2618	3822	4083	752	754	4584	4547	4333	4.122	13,263	.981	34.14	61.23	79.12	54
1971	2126	2274	2541	2302	660	666	2746	2752	2642	2.171	9,652	.713	26.23	(c)	79.11	55
2062	2238	2428	2816	2696	673	681	3149	3160	3039	2.460	10,240	.757	29.27	47.25	81.23	56
2083	2295	2520	3034	3034	696	703	3488	3513	3384	2.766	10,752	.795	31.07	50.91	82.74	57
2126	2358	2618	3245	3301	714	724	3809	3829	3692	2.999	11,253	.832	32.65	53.17	83.53	58
2147	2407	2710	3520	3752	740	749	4232	4224	4089	3.335	11,753	.869	34.56	56.37	83.49	59
2147	2435	2780	3787	3928	763	769	4575	4583	4412	3.588	12,228	.904	35.85	58.40	83.23	60
2105	2435	2865	4083	4400	774	778	4991	4949	4764	3.911	12,863	.951	37.71	60.76	81.61	61
1999	2105	2189	2231	1647	603	609	2156	2161	2044	1.492	8,128	.601	23.16	33.37	60.97	62
2182	2330	2471	2661	2161	640	653	2767	2759	2635	1.907	9,108	.673	27.95	40.27	77.32	63
2309	2506	2710	3104	2816	677	684	3424	3449	3311	2.386	10,170	.752	32.41	47.01	81.01	64
2421	2675	2970	3674	3646	721	730	4309	4336	4177	2.988	11,209	.829	37.05	53.34	83.17	65

NACA

TABLE I. - CONTINUED. COMPRESSOR PERFORMANCE

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Run	Altitude (ft)	Exhaust-nozzle-outlet area (sq in.)	Flight Mach number, M_0	Ram-pressure ratio, P_2/p_0	Engine speed, N (rpm)	Tunnel-static pressure, p_0 (lb/sq ft abs.)	Compressor-inlet indicated temperature, $T_{1,2}$ (°R)	Compressor-inlet total pressure, P_2 (lb/sq ft abs.)	Compressor-inlet total pressure, P_2 (lb/sq ft abs.)[a]	Compressor-inlet static pressure, p_2 (lb/sq ft abs.)	Compressor-stator-stage static pressure, p_3 (lb/sq ft abs.)				
											1	2	3	4	5
66	25,000	183.1	0.98	1.846	11,500	781	503	1442	1452	1338	1302	1393	1344	1900	2175
67	25,000	183.1	.98	1.843	12,000	788	504	1452	1463	1338	1253	1330	1576	1858	2154
68	25,000	183.1	.98	1.836	12,500	788	505	1447	1458	1325	1189	1246	1365	1788	2104
69	25,000	183.1	1.07	2.063	9,500	788	509	1626	1628	1557	1626	1738	1921	2119	2330
70	25,000	183.1	1.08	2.078	10,000	781	506	1623	1625	1543	1591	1710	1921	2140	2365
71	25,000	183.1	1.08	2.074	10,500	781	504	1620	1622	1526	1555	1675	1900	2154	2407
72	25,000	183.1	1.08	2.076	11,000	788	505	1636	1638	1528	1527	1647	1900	2175	2464
73	25,000	183.1	1.08	2.073	11,500	781	506	1619	1623	1499	1457	1555	1816	2189	2435
74	25,000	183.1	1.08	2.073	12,000	781	505	1619	1623	1489	1401	1478	1753	2069	2400
75	25,000	183.1	1.07	2.054	12,500	781	504	1604	1627	1478	1330	1393	1675	1999	2351
76	25,000	231.5	.25	1.049	6,000	788	467	827	826	818	823	858	901	922	950
77	25,000	231.5	.26	1.052	8,000	788	464	829	830	808	837	901	964	1027	1091
78	25,000	231.5	.27	1.055	9,000	781	465	824	825	792	816	887	964	1056	1154
79	25,000	231.5	.27	1.055	10,000	781	466	824	826	780	802	865	978	1091	1217
80	25,000	231.5	.28	1.058	11,000	781	467	826	830	766	753	809	943	1091	1239
81	25,000	231.5	.30	1.064	11,500	781	467	831	835	763	711	760	894	1049	1210
82	25,000	231.5	.30	1.064	12,000	781	466	831	834	758	675	711	851	1006	1175
83	25,000	231.5	.29	1.062	12,500	788	465	837	842	762	633	661	795	957	1126
84	25,000	231.5	.52	1.202	8,000	781	467	939	939	913	950	1013	1091	1161	1246
85	25,000	231.5	.52	1.205	9,000	781	465	941	942	905	943	1013	1112	1217	1337
86	25,000	231.5	.52	1.206	10,000	781	460	942	944	888	901	978	1112	1246	1386
87	25,000	231.5	.53	1.207	11,000	781	457	943	946	873	837	901	1056	1217	1393
88	25,000	231.5	.52	1.206	11,500	781	460	942	945	864	795	844	999	1175	1365
89	25,000	231.5	.53	1.213	12,000	781	460	947	951	863	760	795	943	1133	1323
90	25,000	231.5	.53	1.213	12,500	781	456	947	951	861	711	739	880	1070	1267
91	25,000	231.5	.72	1.412	9,000	788	466	1113	1113	1067	1112	1189	1288	1436	1576
92	25,000	231.5	.72	1.416	10,000	781	466	1106	1107	1046	1070	1147	1281	1464	1626
93	25,000	231.5	.72	1.414	10,500	788	462	1114	1116	1039	1034	1112	1281	1471	1654
94	25,000	231.5	.72	1.412	11,000	788	473	1113	1115	1031	1006	1077	1253	1450	1654
95	25,000	231.5	.73	1.425	11,500	788	472	1123	1125	1034	971	1027	1210	1415	1633
96	25,000	231.5	.73	1.420	12,000	781	472	1109	1113	1014	915	957	1133	1351	1576
97	25,000	231.5	.74	1.429	12,500	781	469	1116	1120	1015	844	887	1056	1274	1506
98	25,000	231.5	.87	1.635	9,500	781	500	1277	1165	1220	1260	1358	1506	1654	1816
99	25,000	231.5	.87	1.634	10,000	774	498	1265	1057	1197	1218	1323	1492	1654	1837
100	25,000	231.5	.87	1.634	10,500	781	496	1276	1082	1198	1205	1309	1478	1661	1893
101	25,000	231.5	.86	1.627	11,000	788	495	1282	1244	1195	1182	1267	1232	1675	1907
102	25,000	231.5	.86	1.626	11,500	788	490	1281	1206	1182	1126	1196	1154	1640	1879
103	25,000	231.5	.86	1.626	12,000	781	495	1270	1145	1165	1056	1140	1154	1584	1830
104	25,000	231.5	.87	1.631	12,500	781	496	1274	1103	1161	1020	1070	1274	1527	1985
105	25,000	231.5	.98	1.850	10,000	781	504	1445	1443	1375	1422	1569	1710	1900	2097
106	25,000	231.5	.98	1.843	10,500	781	507	1439	1436	1354	1372	1478	1682	1957	2133
107	25,000	231.5	.97	1.832	11,000	788	502	1444	1400	1350	1309	1464	1661	1914	2154
108	25,000	231.5	.98	1.843	11,500	781	508	1439	1410	1337	1288	1379	1605	1907	2133
109	25,000	231.5	.98	1.840	12,000	788	502	1450	1436	1336	1246	1316	1555	1921	2104
110	25,000	231.5	.98	1.849	12,500	774	513	1431	1423	1310	1175	1239	1464	1907	2034
111	25,000	231.5	1.08	2.078	8,000	781	525	1623	1621	1584	1633	1738	1844	1964	2097
112	25,000	231.5	1.08	2.069	9,000	788	526	1630	1630	1574	1647	1760	1907	2076	2245
113	25,000	231.5	1.08	2.072	9,500	781	525	1618	1618	1552	1619	1731	1907	2090	2295
114	25,000	231.5	1.08	2.074	10,000	781	525	1620	1620	1540	1640	1724	1936	2154	2365
115	25,000	231.5	1.08	2.076	10,500	781	525	1621	1624	1530	1562	1675	1900	2140	2393
116	25,000	231.5	1.08	2.078	11,000	781	514	1623	1628	1520	1520	1633	1879	2147	2421
117	25,000	231.5	1.07	2.056	11,500	788	520	1620	1626	1504	1464	1619	1823	2112	2407
118	25,000	231.5	1.08	2.070	12,000	781	511	1617	1623	1489	1393	1478	1738	2041	2358
119	25,000	231.5	1.08	2.076	12,500	781	520	1621	1627	1483	1274	1337	1598	1907	2238
120	25,000	280.4	.25	1.047	9,000	788	444	825	828	790	816	887	985	1077	1189
121	25,000	280.4	.27	1.055	10,000	781	443	824	828	776	788	858	971	1098	1225
122	25,000	280.4	.26	1.051	10,500	781	441	821	829	767	753	809	943	1084	1232
123	25,000	280.4	.28	1.059	11,000	781	442	827	830	762	717	774	901	1056	1210
124	25,000	280.4	.29	1.060	11,500	781	440	828	834	758	682	725	858	1020	1175
125	25,000	280.4	.29	1.060	12,000	781	441	828	835	755	640	675	802	964	1133
126	25,000	280.4	.29	1.060	12,500	781	441	828	834	753	612	633	753	915	1091
127	25,000	280.4	.52	1.204	9,000	788	452	949	952	912	950	1020	1126	1232	1351
128	25,000	280.4	.52	1.205	10,000	781	452	941	945	888	901	985	1112	1253	1393
129	25,000	280.4	.53	1.210	10,500	781	460	945	950	884	873	943	1091	1248	1408
130	25,000	280.4	.52	1.204	11,000	788	456	949	955	880	844	901	1056	1224	1393

[a]Manufacturer's instrumentation.
[b]No data obtained at stator stage 9.

DATA FOR X24C-4B TURBOJET ENGINE

16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
Compressor-stator-stage static pressure, p_3 (lb/sq ft abs.)					Compressor-outlet indicated temperature, $T_{1,4}$ (°R)	Compressor-outlet indicated temperature, $T_{1,4}$ (°R)[a]	Compressor-outlet total pressure, P_4 (lb/sq ft abs.)	Compressor-outlet total pressure, P_4 (lb/sq ft abs.)[a]	Compressor-outlet static pressure, p_4 (lb/sq ft abs.)	Compressor-pressure ratio, P_4/P_2	Corrected engine speed, $N/\sqrt{\theta}$ (rpm)	Compressor Mach number, M_c	Air flow, W_a (lb/sec)	Corrected air flow, $(W_a\sqrt{\theta})/\delta$ (lb/sec)	Compressor efficiency, η_c (percent)	
6	7	8	[b]10	11												Run
2435	2689	3076	3949	4083	742	751	4726	4737	4580	3.277	11,684	0.863	39.00	56.31	84.38	66
2442	2759	3160	4245	4505	764	772	5134	5132	4960	3.536	12,180	.900	40.57	58.24	83.62	67
2407	2766	3224	4512	4899	786	792	5523	5512	5292	3.817	12,675	.937	41.78	60.24	83.20	68
2520	2717	2900	3210	2801	661	668	3416	3414	3271	2.101	9,595	.709	33.88	43.64	78.83	69
2597	2801	3034	3463	3196	679	686	3807	3822	3671	2.346	10,130	.748	36.29	46.71	80.37	70
2661	2914	3182	3797	3703	697	705	4290	4329	4166	2.648	10,658	.788	38.98	50.16	83.44	71
2738	3034	3351	4111	4160	719	728	4793	4822	4650	2.930	11,154	.824	41.53	52.96	84.50	72
2731	3062	3442	4407	4646	743	753	5278	5280	5101	3.260	11,650	.861	43.39	55.98	85.20	73
2724	3083	3470	4674	5075	762	771	5666	5660	5475	3.500	12,168	.900	44.90	57.87	84.04	74
2689	3083	3583	5005	5336	785	791	6120	6110	5872	3.815	12,688	.938	46.51	60.44	83.00	75
985	1020	1063	1098	1048	533	536	1136	1140	1117	1.374	6,324	.467	9.10	22.09	67.23	76
1161	1232	1309	1422	1351	577	583	1529	1534	1486	1.844	8,464	.626	13.69	33.02	78.60	77
1267	1365	1478	1675	1626	614	621	1852	1865	1799	2.248	9,504	.702	16.65	40.49	81.40	78
1337	1464	1598	1893	1872	646	654	2154	2168	2091	2.614	10,550	.780	19.74	48.05	81.85	79
1366	1541	1724	2174	2252	682	691	2585	2604	2505	3.130	11,594	.857	22.80	55.42	83.82	80
1372	1541	1745	2295	2449	700	709	2778	2787	2688	3.343	12,121	.896	23.93	57.80	82.64	81
1344	1527	1753	2400	2625	716	724	2945	2942	2830	3.544	12,660	.936	24.72	59.66	81.27	82
1302	1506	1752	2520	2816	736	742	3130	3118	2982	3.740	13,200	.976	25.33	60.64	78.64	83
1337	1415	1492	1591	1443	578	585	1675	1675	1614	1.784	8,432	.623	16.24	34.71	75.77	84
1443	1555	1668	1851	1696	600	608	1998	1999	1925	2.123	9,504	.702	19.53	41.59	82.71	85
1534	1682	1830	2161	2097	635	642	2441	2464	2364	2.591	10,620	.785	23.43	49.55	82.28	86
1562	1738	1936	2435	2499	666	675	2896	2914	2801	3.071	11,726	.867	26.44	55.66	82.75	87
1541	1731	1957	2569	2731	685	694	3128	3139	3018	3.321	12,213	.903	27.68	58.54	83.75	88
1513	1717	1964	2696	2949	703	710	3322	3315	3194	3.508	12,744	.941	28.52	59.99	81.77	89
1457	1675	1957	2823	3139	720	725	3518	3527	3357	3.715	13,338	.986	29.14	61.01	78.68	90
1703	1837	1957	2154	1893	602	608	2285	2288	2187	2.053	9,495	.702	23.39	42.15	78.24	91
1788	2006	2119	2449	2266	635	643	2704	2724	2608	2.445	10,550	.780	26.76	48.52	80.34	92
1844	2027	2224	2689	2625	653	660	3081	3111	2986	2.766	11,130	.822	29.55	52.94	81.71	93
1844	2041	2266	2801	2816	679	688	3283	3308	3180	2.950	11,517	.852	30.43	55.25	83.24	94
1837	2083	2302	2956	3048	694	703	3551	3562	3428	3.162	12,064	.991	32.01	57.49	82.93	95
1781	2020	2302	3076	3308	711	721	3779	3773	3634	3.408	12,588	.930	33.05	60.11	82.94	96
1731	1978	2281	3238	3604	728	734	4025	4041	3851	3.607	13,150	.972	33.82	60.95	80.28	97
1964	2119	2252	2478	2126	653	660	2600	2604	2479	2.036	9,681	.715	26.57	43.21	73.69	98
2006	2175	2344	2647	2358	667	675	2865	2879	2748	2.265	10,210	.755	28.37	46.49	77.61	99
2069	2288	2492	2921	2752	685	693	3278	3301	3161	2.569	10,742	.794	31.85	51.62	81.34	100
1978	2330	2555	3083	3020	699	706	3546	3576	3428	2.766	11,264	.832	33.38	53.83	81.95	101
2090	2344	2569	3308	3351	714	724	3933	3963	3602	3.070	11,834	.874	35.67	57.27	82.74	102
2069	1689	2569	3400	3576	734	743	4130	4146	3988	3.252	12,288	.908	36.14	58.80	83.08	103
1992	2252	2611	3569	3893	754	764	4424	4407	4251	3.473	12,788	.945	37.16	60.34	81.89	104
2288	2478	2654	2970	2583	669	676	3165	3175	3023	2.190	10,150	.750	31.92	46.04	76.79	105
2337	2555	2703	3210	2935	697	703	3544	3562	3410	2.463	10,626	.786	34.55	50.19	78.44	106
2386	2618	2879	3449	3336	707	714	3943	3970	3807	2.731	11,187	.827	37.19	53.57	81.54	107
2372	2633	2914	3611	3625	732	739	4239	4266	4092	2.946	11,627	.859	38.42	55.86	81.79	108
2372	2654	2970	3822	3942	741	750	4601	4625	4443	3.173	12,204	.902	40.60	58.25	81.85	109
2302	2604	2949	3935	4231	770	778	4841	4836	4655	3.383	12,575	.930	40.78	59.95	82.55	110
2210	2315	2386	2379	1647	615	620	2148	2146	2009	1.323	7,954	.588	24.75	32.46	48.60	111
2407	2555	2682	2816	2161	650	657	2744	2745	2584	1.683	8,940	.661	29.94	39.13	68.14	112
2471	2654	2816	3034	2471	664	671	3074	3076	2911	1.900	9,446	.698	32.24	42.41	76.09	113
2583	2780	2970	3301	2823	692	699	3473	3470	3307	2.144	9,943	.734	35.10	46.10	76.61	114
2618	2858	3041	3527	3146	710	717	3851	3865	3692	2.376	10,440	.771	37.48	49.19	79.65	115
2682	2942	3217	3801	3618	718	725	4302	4329	4148	2.651	11,053	.817	40.82	52.98	81.03	116
2682	2977	3280	4040	4012	742	750	4679	4737	4551	2.888	11,488	.849	42.43	55.47	82.34	117
2654	2964	3315	4245	4350	750	760	5095	5118	4919	3.151	12,094	.894	44.68	58.03	82.38	118
2541	2879	3259	4350	4653	777	786	5351	5357	5153	3.301	12,488	.923	45.64	59.62	81.71	119
1295	1400	1520	1724	1640	600	604	1898	1921	1842	2.301	9,729	.719	18.14	43.04	76.58	120
1358	1492	1640	1950	1900	618	624	2215	2238	2150	2.688	10,830	.800	21.04	49.89	82.73	121
1372	1527	1696	2083	2105	635	642	2447	2464	2365	2.981	11,393	.841	22.85	54.27	83.36	122
1365	1527	1710	2183	2245	652	659	2605	2625	2523	3.150	11,924	.881	23.86	56.33	81.75	123
1344	1513	1724	2295	2442	665	673	2802	2801	2702	3.384	12,489	.922	25.17	59.24	81.56	124
1302	1485	1717	2407	2647	686	693	2981	2985	2856	3.600	13,020	.962	25.70	60.54	79.64	125
1260	1420	1710	2499	2794	706	709	3124	3111	2972	3.773	13,563	1.003	25.82	60.83	76.88	126
1464	1576	1682	1865	1661	590	595	1998	1999	1918	2.105	9,639	.712	20.43	42.54	77.69	127
1541	1675	1830	2140	2020	625	633	2394	2414	2315	2.544	10,710	.792	23.76	49.89	79.98	128
1555	1717	1893	2288	2231	654	661	2623	2647	2539	2.776	11,151	.824	25.12	52.96	80.41	129
1569	1745	1943	2421	2449	664	672	2863	2886	2772	3.017	11,737	.867	26.95	56.32	81.43	130

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TABLE I. - CONTINUED. COMPRESSOR PERFORMANCE

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Run	Altitude (ft)	Exhaust-nozzle-outlet area (sq in.)	Flight Mach number M_0	Ram-pressure ratio, P_2/p_0	Engine speed, N (rpm)	Tunnel-static pressure, p_0 (lb/sq ft abs.)	Compressor-inlet indicated temperature, $T_{1,2}$ (°R)	Compressor-inlet total pressure, P_2 (lb/sq ft abs.)	Compressor-inlet total pressure, P_2 (lb/sq ft abs.)[a]	Compressor-inlet static pressure, p_2 (lb/sq ft abs.)	Compressor-stator-stage static pressure, p_3 (lb/sq ft abs.)				
											1	2	3	4	5
131	25,000	280.4	0.53	1.210	11,500	781	453	945	951	868	788	837	992	1168	1358
132	25,000	280.4	.53	1.210	12,000	781	455	945	951	863	753	788	943	1126	1323
133	25,000	280.4	.53	1.210	12,500	781	455	945	951	860	711	739	880	1070	1267
134	25,000	280.4	.73	1.424	9,000	788	471	1122	1124	1079	1119	1196	1302	1443	1584
135	25,000	280.4	.72	1.403	10,000	781	473	1096	1099	1038	1070	1147	1302	1457	1619
136	25,000	280.4	.72	1.404	10,500	788	471	1106	1110	1037	1034	1112	1281	1464	1647
137	25,000	280.4	.72	1.415	11,000	781	472	1105	1109	1027	1006	1077	1253	1443	1640
138	25,000	280.4	.73	1.421	11,500	781	471	1110	1116	1023	957	1020	1197	1408	1619
139	25,000	280.4	.73	1.419	12,000	781	470	1108	1114	1014	908	957	1133	1344	1569
140	25,000	280.4	.73	1.424	12,500	781	469	1112	1119	1015	851	887	1056	1274	1499
141	25,000	280.4	.86	1.618	10,000	788	490	1275	1278	1210	1239	1337	1309	1682	1872
142	25,000	280.4	.86	1.627	10,500	781	491	1271	1275	1197	1210	1302	1302	1689	1893
143	25,000	280.4	.86	1.622	11,000	781	491	1267	1273	1182	1168	1253	1316	1668	1893
144	25,000	280.4	.86	1.622	11,500	788	479	1278	1283	1180	1112	1182	1337	1555	1872
145	25,000	280.4	.86	1.626	12,000	788	482	1281	1288	1175	1070	1126	1330	1576	1830
146	25,000	280.4	.86	1.624	12,500	788	489	1280	1287	1169	1013	1063	1267	1520	1774
147	25,000	280.4	.98	1.840	8,000	781	502	1437	1437	1402	1450	1541	1647	1760	1879
148	25,000	280.4	.98	1.840	9,000	781	504	1437	1438	1386	(c)	(c)	(c)	(c)	(c)
149	25,000	280.4	.98	1.843	10,000	781	504	1439	1442	1370	1386	1506	1682	1872	2076
150	25,000	280.4	.98	1.839	10,500	788	503	1449	1453	1366	1386	1492	1696	1921	2147
151	25,000	280.4	.98	1.841	11,000	781	505	1438	1444	1345	1330	1436	1647	1900	2140
152	25,000	280.4	.98	1.839	11,500	788	501	1449	1456	1343	1295	1379	1605	1874	2140
153	25,000	280.4	.98	1.841	12,000	781	503	1438	1446	1324	1232	1309	1541	1808	2090
154	25,000	280.4	.98	1.836	12,500	788	503	1447	1458	1327	1175	1224	1337	1738	2034
155	25,000	280.4	1.08	2.070	8,500	781	507	1617	1618	1569	1633	1591	1572	2041	2175
156	25,000	280.4	1.08	2.069	9,000	781	509	1616	1617	1560	1619	1724	1886	2048	2231
157	25,000	280.4	1.08	2.072	10,000	781	509	1618	1627	1541	1584	1710	1914	2126	2351
158	25,000	280.4	1.08	2.070	10,500	781	512	1617	1622	1526	1555	1661	1893	2140	2393
159	25,000	280.4	1.07	2.062	11,000	788	521	1625	1631	1525	1548	1591	1886	2154	2421
160	25,000	280.4	1.07	2.061	11,500	788	519	1624	1631	1508	1464	1562	1823	2112	2407
161	25,000	280.4	1.08	2.066	12,000	788	517	1628	1636	1503	1416	1499	1760	2062	2379
162	25,000	280.4	1.08	2.079	12,500	781	513	1624	1633	1489	1316	1408	1647	1985	2316
163	25,000	330.4	.26	1.050	8,000	781	445	820	823	798	830	894	957	1027	1098
164	25,000	330.4	.26	1.051	9,000	781	445	821	824	787	823	894	985	1084	1175
165	25,000	330.4	.27	1.055	10,000	781	441	824	828	775	788	851	971	1098	1232
166	25,000	330.4	.27	1.057	11,000	788	441	833	839	768	725	774	908	1063	1217
167	25,000	330.4	.28	1.059	11,500	781	440	827	834	758	685	725	858	1020	1182
168	25,000	330.4	.28	1.059	12,000	781	440	827	834	755	647	675	802	971	1133
169	25,000	330.4	.29	1.060	12,500	788	442	835	843	761	619	640	760	929	1098
170	25,000	330.4	.53	1.207	8,000	781	450	943	919	918	943	1013	1084	1168	1260
171	25,000	330.4	.52	1.202	9,000	788	451	947	951	909	929	999	1105	1210	1337
172	25,000	330.4	.53	1.207	10,000	781	462	943	949	891	908	978	1105	1246	1386
173	25,000	330.4	.53	1.208	10,500	774	452	935	940	873	866	929	1077	1239	1394
174	25,000	330.4	.52	1.202	11,000	781	449	939	945	869	830	887	1041	1210	1386
175	25,000	330.4	.53	1.207	11,000	781	453	943	950	873	837	894	1041	1210	1386
176	25,000	330.4	.53	1.211	11,500	781	449	946	952	867	788	837	985	1168	1351
177	25,000	330.4	.53	1.209	11,500	781	454	944	950	867	788	837	992	1168	1358
178	25,000	330.4	.53	1.209	12,000	781	457	944	863	951	760	795	943	1133	1323
179	25,000	330.4	.52	1.206	12,000	781	454	942	950	861	753	795	936	1126	1309
180	25,000	330.4	.53	1.207	12,000	788	446	951	959	868	746	781	929	1119	1309
181	25,000	330.4	.53	1.213	12,500	788	450	956	964	871	711	739	880	1070	1267
182	25,000	330.4	.73	1.423	9,000	781	470	1111	1068	1112	1119	1196	1295	1436	1569
183	25,000	330.4	.73	1.423	10,000	781	472	1111	1114	1051	1077	1161	1288	1478	1640
184	25,000	330.4	.72	1.415	10,500	788	469	1115	1119	1046	1048	1133	1288	1478	1661
185	25,000	330.4	.72	1.415	11,000	781	465	1105	1110	1025	999	1070	1246	1443	1640
186	25,000	330.4	.73	1.423	11,500	774	467	1101	1107	1014	943	999	1182	1386	1605
187	25,000	330.4	.73	1.424	12,000	781	464	1112	1119	1018	901	950	1126	1344	1562
188	25,000	330.4	.73	1.420	12,500	781	460	1109	1116	1011	844	873	1041	1267	1485
189	25,000	330.4	.86	1.621	9,000	788	486	1277	1282	1228	1295	1379	(c)	1654	1802
190	25,000	330.4	.86	1.622	10,000	781	487	1267	1273	1202	1246	1330	(c)	1675	1858
191	25,000	330.4	.86	1.626	11,000	788	485	1281	1289	1193	1161	1246	1323	1675	1900
192	25,000	330.4	.86	1.624	11,500	788	485	1280	1289	1183	1126	1189	(c)	1632	1872
193	25,000	330.4	.86	1.626	12,000	781	485	1270	1281	1166	1070	1119	1323	1569	1816
194	25,000	330.4	.86	1.625	12,500	781	485	1269	1280	1159	1006	1041	1246	1492	1753
195	25,000	330.4	.98	1.844	9,000	781	509	1440	1445	1389	1464	1541	1696	1837	1992

[a]Manufacturer's instrumentation.
[b]No data obtained at stator stage 9.
[c]Data not available.

NACA

DATA FOR X24C-4B TURBOJET ENGINE

16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
Compressor-stator-stage static pressure, p_3 (lb/sq ft abs.)					Compressor-outlet indicated temperature, $T_{1,4}$ (°R)	Compressor-outlet indicated temperature, $T_{1,4}$ (°R)a	Compressor-outlet total pressure, P_4 (lb/sq ft abs.)	Compressor-outlet total pressure, P_4 (lb/sq ft abs.)a	Compressor-outlet static pressure, p_4 (lb/sq ft abs.)	Compressor-pressure ratio, P_4/P_2	Corrected engine speed, $N/\sqrt{\theta}$ (rpm)	Compressor Mach number, M_c	Air flow, W_a (lb/sec)	Corrected air flow, $(W_a\sqrt{\theta})/\delta$ (lb/sec)	Compressor efficiency, η_c (percent)	
6	7	8	b_{10}	11												Run
1541	1724	1950	2555	2682	680	688	3098	3125	3001	3.278	12,317	0.910	28.04	58.62	80.68	131
1506	1703	1950	2654	2886	695	704	3285	3280	3158	3.476	12,816	.947	28.77	60.31	81.16	132
1457	1668	1936	2780	3090	716	721	3468	3484	3313	3.670	13,350	.986	29.14	61.09	78.52	133
1710	1837	1950	2126	1816	603	610	2226	2224	2119	1.984	9,450	.698	23.30	41.85	77.24	134
1781	1936	2097	2407	2189	643	651	2642	2661	2540	2.411	10,470	.774	26.52	48.91	79.63	135
1823	1999	2196	2611	2485	657	666	2953	2977	2852	2.670	11,025	.815	28.92	52.69	82.12	136
1830	2027	2238	2738	2717	675	682	3184	3210	3077	2.981	11,539	.852	30.38	55.46	82.17	137
1823	2041	2281	2921	2999	692	700	3504	3520	3386	3.157	12,075	.893	32.09	58.25	82.97	138
1788	2013	2295	3062	3287	708	718	3771	3766	3626	3.403	12,612	.932	33.17	60.28	82.82	139
1724	1964	2273	3210	3548	731	738	3986	3998	3814	3.585	13,150	.972	33.91	61.34	78.89	140
2048	2224	2386	2703	2358	659	666	2924	2935	2796	2.293	10,290	.760	29.79	48.06	77.67	141
2076	2288	2478	2886	2640	677	685	3203	3224	3082	2.520	10,794	.804	31.62	51.21	79.88	142
2105	2323	2555	3090	3006	697	704	3554	3583	3434	2.805	11,308	.836	33.54	54.49	81.77	143
2090	2337	2604	3308	3358	702	712	3951	3977	3814	3.092	11,972	.884	36.22	57.62	81.83	144
2069	2330	2632	3470	3653	721	731	4241	4252	4082	3.311	12,456	.921	37.40	59.52	82.34	145
2027	2302	2618	3590	3907	745	754	4454	4442	4281	3.480	12,875	.952	37.99	60.97	81.85	146
1992	2090	2168	2189	1534	596	602	2014	2013	1890	1.402	8,136	.602	23.29	33.73	54.14	147
(c)	(c)	(c)	(c)	(c)	633	638	(c)	(c)	(c)	(c)	9,135	.675	27.90	40.49	(c)	148
2259	2442	2625	2935	2485	670	676	3105	3111	2958	2.158	10,150	.750	32.05	46.45	74.71	149
2351	2569	2787	3224	2907	692	698	3540	3569	3412	2.443	10,668	.788	34.91	50.17	77.48	150
1738	2597	2865	3414	3259	709	715	3884	3914	3749	2.701	11,154	.824	36.76	53.33	81.36	151
2386	2661	2949	3660	3660	727	736	4296	4329	4154	2.965	11,707	.866	39.18	56.19	80.82	152
2358	2640	2956	3808	3921	745	752	4593	4611	4433	3.194	12,192	.900	40.46	58.58	81.54	153
2309	2618	2970	3991	4294	761	770	4921	4920	4736	3.401	12,700	.938	41.78	60.12	81.05	154
2316	2449	2555	2633	1858	618	625	2461	2464	2308	1.522	8,602	.636	28.66	37.07	58.29	155
2386	2534	2668	2816	2090	632	638	2728	2731	2567	1.688	9,090	.672	30.77	39.88	66.82	156
2548	2759	2949	3287	2766	675	682	3458	3470	3295	2.137	10,100	.746	35.89	46.48	74.39	157
2625	2865	3027	3569	3182	701	707	3916	3928	3754	2.422	10,574	.781	38.37	49.88	78.00	158
2654	2928	3189	3759	3491	724	731	4220	4245	4070	2.597	10,979	.812	40.06	52.26	80.24	159
2654	2970	3280	4033	3977	742	749	4676	4730	4540	2.879	11,500	.850	42.81	55.78	81.52	160
2654	2977	3329	4231	4294	757	765	5058	5075	4891	3.107	12,024	.888	44.53	57.77	81.82	161
2625	2956	3337	4442	4709	774	782	5403	5456	5247	3.327	12,575	.930	46.18	59.81	79.97	162
1175	1253	1337	1443	1302	560	566	1528	1534	1483	1.863	8,640	.638	14.50	34.64	75.39	163
1288	1379	1499	1682	1555	590	597	1836	1844	1777	2.236	9,720	.718	17.93	42.78	79.44	164
1358	1492	1633	1943	1872	618	625	2203	2224	2139	2.674	10,850	.802	21.40	50.65	80.94	165
1372	1534	1717	2189	2238	650	658	2624	2640	2535	3.150	11,935	.882	24.30	56.89	81.96	166
1344	1513	1710	2281	2414	665	673	2788	2794	2687	3.371	12,489	.922	25.14	59.24	81.27	167
1302	1478	1710	2379	2583	684	690	2935	2935	2821	3.549	13,032	.963	25.67	60.49	78.74	168
1267	1457	1710	2492	2766	707	710	3109	3125	2972	3.723	13,550	1.001	26.20	61.25	76.13	169
1344	1415	1499	1591	1372	555	561	1643	1640	1576	1.742	8,592	.635	17.14	35.81	73.72	170
1450	1555	1668	1844	1612	589	596	1969	1971	1890	2.079	9,657	.714	20.22	42.10	76.08	171
1520	1654	1802	2097	1914	636	644	2321	2337	2237	2.461	10,600	.783	23.44	49.62	78.01	172
1548	1710	1886	2274	2196	641	648	2610	2640	2524	2.791	11,246	.831	25.48	53.84	81.61	173
1555	1731	1929	2421	2442	659	668	2872	2900	2780	3.059	11,825	.874	27.05	56.69	80.56	174
1555	1731	1929	2428	2435	660	669	2870	2886	2774	3.043	11,781	.870	27.07	56.72	82.01	175
1534	1717	1950	2555	2675	672	681	3125	3125	3005	3.303	12,363	.914	38.30	58.89	82.02	176
1534	1724	1943	2555	2668	681	689	3112	3118	3000	3.297	12,294	.908	28.26	59.27	81.32	177
1506	1703	1943	2647	2851	697	705	3273	3266	3147	3.467	12,792	.945	28.81	60.59	81.30	178
1499	1696	1943	2661	2872	695	704	3291	3280	3162	3.494	12,828	.948	28.91	60.74	81.05	179
1499	1696	1943	2696	2921	687	694	3333	3322	3204	3.505	12,948	.957	29.02	59.84	79.85	180
1457	1675	1950	2808	3111	712	717	3508	3527	3351	3.669	13,425	.992	29.74	61.28	77.34	181
1696	1816	1929	2097	1738	603	610	2165	2168	2059	1.949	9,459	.699	23.27	42.18	74.31	182
1816	1964	2126	2435	2168	641	648	2665	2668	2556	2.399	10,490	.775	27.04	49.11	79.39	183
1830	2013	2196	2604	2435	656	663	2930	2949	2830	2.628	11,046	.816	29.06	52.43	79.81	184
1830	2034	2256	2787	2759	670	677	3259	3280	3151	2.949	11,616	.859	30.84	55.93	82.22	185
1802	2020	2266	2914	2992	689	696	3512	3527	3390	3.190	12,121	.896	32.04	58.43	82.75	186
1781	2006	2295	3090	3301	703	711	3804	3801	3657	3.421	12,696	.938	33.43	60.13	81.85	187
1710	1957	2266	3231	3541	721	727	4015	4041	3842	3.620	13,275	.981	34.17	61.39	78.39	188
1950	2076	2203	1661	1851	619	625	2401	2407	2274	1.880	9,297	.687	26.12	41.90	72.31	189
2034	2196	2372	2682	2266	652	659	2885	2886	2756	2.277	10,320	.763	29.63	47.94	78.31	190
2112	2330	2576	3139	3027	694	700	3629	3660	3509	2.833	11,374	.840	34.43	55.01	80.51	191
2104	2365	2611	3294	3294	709	718	3925	3949	3794	3.066	11,891	.878	35.78	57.20	81.77	192
2062	2309	2611	3449	3583	727	736	4209	4217	4054	3.314	12,408	.917	36.95	59.53	81.90	193
1999	2266	2604	3583	3857	743	752	4447	4435	4270	3.504	12,925	.956	37.94	61.17	81.07	194
2147	2281	2407	2541	1851	638	645	2460	2478	2335	1.722	9,090	.672	27.69	40.27	66.38	195

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TABLE I. - CONCLUDED. COMPRESSOR PERFORMANCE

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Run	Altitude (ft)	Exhaust-nozzle-outlet area (sq in.)	Flight Mach number, M_0	Ram-pressure ratio, P_2/p_0	Engine speed, N (rpm)	Tunnel-static pressure, p_0 (lb/sq ft abs.)	Compressor-inlet indicated temperature, $T_{1,2}$ (°R)	Compressor-inlet total pressure, P_2 (lb/sq ft abs.)	Compressor-inlet total pressure,[a] P_2 (lb/sq ft abs.)	Compressor-inlet static pressure, p_2 (lb/sq ft abs.)	Compressor-stator-stage static pressure, p_3 (lb/sq ft abs.)				
											1	2	3	4	5
196	25,000	330.4	0.98	1.845	10,000	781	501	1441	1447	1370	1415	1527	1703	1900	2097
197	25,000	330.4	.98	1.835	11,000	788	506	1446	1455	1352	1337	1767	1661	1907	2154
198	25,000	330.4	.98	1.838	11,500	788	507	1448	1458	1344	1302	1393	1619	1879	2147
199	25,000	330.4	.98	1.836	12,000	788	505	1447	1457	1333	1246	1323	1337	1802	2104
200	25,000	330.4	.98	1.837	12,500	781	505	1435	1446	1314	1175	1225	(c)	1738	2027
201	25,000	330.4	1.08	2.072	8,500	781	521	1618	1621	1572	1626	1731	1858	2006	2161
202	25,000	330.4	1.08	2.068	9,000	781	523	1615	1620	1561	1626	1731	1886	2048	2217
203	25,000	330.4	1.07	2.063	10,000	788	526	1626	1633	1552	1626	1760	1936	2168	2372
204	25,000	330.4	1.07	2.062	11,000	788	525	1625	1635	1524	1534	1591	1886	2175	2428
205	25,000	330.4	1.07	2.052	11,500	781	525	1603	1615	1492	1450	1555	1809	2090	2386
206	25,000	330.4	1.07	2.044	12,000	788	523	1611	1623	1489	1415	1499	1760	2062	2365
207	25,000	330.4	1.07	2.046	12,500	788	521	1612	1625	1480	1344	1408	1668	1992	2302
208	35,000	183.1	.52	1.205	8,000	493	448	594	595	579	599	641	690	739	789
209	35,000	183.1	.52	1.197	9,000	493	444	590	590	566	592	641	704	768	845
210	35,000	183.1	.52	1.200	10,000	500	451	600	602	568	577	627	711	796	958
211	35,000	183.1	.53	1.210	11,000	500	444	605	606	559	535	584	683	789	908
212	35,000	183.1	.53	1.210	11,500	500	440	605	607	554	507	549	648	768	901
213	35,000	183.1	.52	1.205	11,900	493	452	594	598	544	479	514	613	739	873
214	35,000	231.5	.52	1.204	9,000	500	453	602	602	577	599	641	711	775	852
215	35,000	231.5	.52	1.199	10,000	493	453	591	593	558	570	620	704	789	880
216	35,000	231.5	.53	1.211	11,000	493	456	597	599	553	528	570	669	775	887
217	35,000	231.5	.52	1.198	11,500	500	456	599	602	551	500	542	634	746	859
218	35,000	231.5	.52	1.206	12,000	500	453	603	606	552	486	514	606	725	838
219	35,000	231.5	.52	1.206	12,500	500	454	603	605	548	451	472	556	676	796
220	35,000	280.4	.52	1.201	9,500	493	448	592	595	565	585	634	704	783	859
221	35,000	280.4	.52	1.206	10,000	500	445	603	606	569	577	627	711	803	894
222	35,000	280.4	.52	1.203	10,500	493	444	593	596	554	542	592	676	634	880
223	35,000	280.4	.53	1.208	11,000	500	443	604	608	559	528	570	662	775	887
224	35,000	280.4	.52	1.205	11,500	493	443	594	597	545	493	521	620	732	845
225	35,000	280.4	.51	1.192	12,000	500	444	596	608	552	465	500	592	704	824
226	35,000	280.4	.53	1.209	12,500	493	443	596	601	543	430	458	542	662	782
227	35,000	330.4	.52	1.203	8,000	493	440	593	594	577	599	641	690	739	789
228	35,000	330.4	.52	1.199	10,000	493	436	591	595	557	556	606	690	782	873
229	35,000	330.4	.52	1.203	11,000	493	435	593	598	547	507	549	641	753	866
230	35,000	330.4	.53	1.208	11,500	500	436	604	609	555	500	528	627	739	852
231	35,000	330.4	.52	1.206	12,000	500	436	603	609	551	465	493	584	704	817
232	35,000	330.4	.52	1.204	12,500	500	439	602	609	549	444	465	549	662	789
233	45,000	183.1	.53	1.215	7,500	303	444	368	368	362	-366	395	423	444	465
234	45,000	183.1	.51	1.192	9,000	317	439	378	378	363	373	416	451	493	535
235	45,000	183.1	.53	1.210	9,000	310	436	375	375	361	373	409	437	486	528
236	45,000	183.1	.53	1.211	10,000	303	437	367	368	346	345	380	430	493	549
237	45,000	183.1	.50	1.186	10,500	317	440	376	377	351	352	387	444	514	577
238	45,000	183.1	.51	1.192	10,500	317	438	378	379	354	352	394	444	514	577
239	45,000	183.1	.52	1.201	11,000	303	440	364	365	337	324	359	423	493	556
240	45,000	183.1	.52	1.205	11,400	303	437	365	365	335	317	345	416	486	563
241	45,000	231.5	.52	1.205	9,500	303	447	365	366	348	359	387	437	486	528
242	45,000	231.5	.52	1.200	10,000	310	453	372	373	353	352	394	437	493	542
243	45,000	231.5	.52	1.203	11,000	310	451	373	375	346	331	366	423	493	563
244	45,000	231.5	.52	1.206	11,500	310	448	374	375	344	310	338	402	472	542
245	45,000	231.5	.52	1.203	12,000	310	447	373	374	340	289	324	380	451	528
246	45,000	231.5	.52	1.206	12,500	310	446	374	375	340	268	303	352	430	514
247	45,000	280.4	.52	1.195	9,000	303	454	362	365	352	359	395	430	472	507
248	45,000	280.4	.51	1.194	10,000	310	462	370	373	352	352	387	437	486	542
249	45,000	280.4	.52	1.203	10,500	310	451	373	375	350	352	387	437	500	556
250	45,000	280.4	.52	1.206	11,000	296	460	357	360	331	324	352	409	472	535
251	45,000	280.4	.52	1.202	11,500	317	456	381	384	351	324	352	416	486	556
252	45,000	280.4	.52	1.200	12,000	310	454	372	375	341	296	324	380	451	528
253	45,000	280.4	.52	1.201	12,500	303	452	364	368	333	275	303	352	423	500
254	45,000	330.4	.51	1.189	9,000	317	454	377	378	363	373	409	437	486	521
255	45,000	330.4	.53	1.209	10,000	296	455	358	359	339	338	373	416	472	521
256	45,000	330.4	.51	1.189	10,500	317	453	377	380	353	352	380	437	500	556
257	45,000	330.4	.52	1.202	11,000	317	450	381	384	354	338	366	423	493	556
258	45,000	330.4	.52	1.200	11,500	310	449	372	375	343	317	345	402	472	542
259	45,000	330.4	.51	1.194	12,000	310	447	370	373	338	389	310	366	444	514
260	45,000	330.4	.52	1.202	12,500	317	446	381	385	349	282	303	352	437	514

[a]Manufacturer's instrumentation.

[b]No data obtained at stator stage 9.

[c]Data not available.

NACA

DATA FOR X24C-4B TURBOJET ENGINE

16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
Compressor-stator-stage static pressure, p_3 (lb/sq ft abs.)					Compressor-outlet indicated temperature, $T_{1,4}$ (°R)	Compressor-outlet indicated temperature, $T_{1,4}$ (°R)[a]	Compressor-outlet total pressure, P_4 (lb/sq ft abs.)	Compressor-outlet total pressure, P_4 (lb/sq ft abs.)[a]	Compressor-outlet static pressure, p_4 (lb/sq ft abs.)	Compressor-pressure ratio, P_4/P_2	Corrected engine speed, $N/\sqrt{\theta}$ (rpm)	Compressor Mach number, M_c	Air flow, W_a (lb/sec)	Corrected air flow, $(W_a\sqrt{\theta})/\delta$ (lb/sec)	Compressor efficiency, η_c (percent)	Run
6	7	8	[b]10	11												
2281	2478	2647	2963	2464	670	675	3141	3139	2991	2.180	10,180	0.752	32.59	47.00	74.03	196
2379	2541	2808	3435	3252	714	721	3918	3942	3782	2.710	11,143	.823	37.10	53.58	80.25	197
2393	2647	2942	3639	3583	734	742	4264	4294	4121	2.945	11,638	.860	38.86	56.10	80.52	198
2372	2640	2956	3794	3836	746	755	4559	4576	4404	3.151	12,168	.899	40.25	58.03	81.08	199
2302	2590	2942	3956	4195	764	772	4873	4871	4687	3.396	12,675	.937	41.48	60.34	80.93	200
2302	2407	2527	2576	1717	628	635	2379	2372	2226	1.470	8,484	.627	27.96	36.64	56.72	201
2379	2527	2661	2780	1971	649	655	2665	2668	2504	1.650	8,966	.663	29.70	39.06	63.93	202
2576	2773	2963	3259	2661	690	695	3399	3400	3231	2.090	9,933	.734	34.64	45.37	75.27	203
2675	2928	3203	3780	3512	730	736	4259	4287	4106	2.621	10,937	.808	40.03	52.42	80.92	204
2647	2928	3238	3956	3850	747	753	4599	4625	4433	2.869	11,434	.844	41.70	55.36	82.53	205
2654	2942	3294	4167	4195	764	772	4965	4991	4799	3.082	11,954	.883	43.72	57.62	81.75	206
2597	2921	3294	4350	4547	780	788	5328	5336	5130	3.305	12,476	.922	45.06	59.28	81.33	207
845	901	965	1049	1000	566	572	1129	1134	1099	1.901	8,608	.636	10.31	34.13	76.46	208
922	1000	1091	1246	1232	596	604	1390	1401	1357	2.356	9,729	.719	12.64	41.93	80.89	209
993	1091	1211	1464	1500	641	653	1701	1704	1652	2.835	10,730	.793	14.77	48.55	82.15	210
1035	1169	1331	1767	1915	678	687	2110	2112	2041	3.488	11,891	.879	17.30	55.98	81.23	211
1042	1197	1408	1950	2119	700	704	2337	2323	2238	3.863	12,489	.923	18.16	58.49	79.40	212
1021	1190	1415	1985	2176	726	729	2380	2366	2263	4.007	12,745	.942	17.85	59.37	79.96	213
922	993	1077	1197	1120	588	596	1301	1310	1262	2.161	9,639	.712	12.65	41.52	82.75	214
971	1063	1169	1366	1359	630	637	1559	1570	1516	2.638	10,710	.792	14.59	48.77	81.83	215
1000	1113	1246	1563	1626	669	679	1870	1873	1806	3.132	11,737	.868	16.84	55.93	82.66	216
986	1105	1253	1662	1781	688	697	2017	2020	1949	3.367	12,271	.907	17.69	58.57	81.56	217
965	1098	1267	1732	1908	696	704	2130	2133	2046	3.532	12,852	.950	18.20	59.63	81.02	218
929	1077	1267	1852	2063	728	731	2295	2281	2179	3.806	13,363	.988	18.50	60.73	77.15	219
944	1021	1113	1260	1183	611	617	1394	1401	1350	2.355	10,222	.755	13.76	45.70	76.31	220
993	1084	1190	1394	1345	617	624	1573	1591	1525	2.609	10,800	.798	15.49	50.33	81.66	221
979	1084	1204	1465	1465	637	644	1700	1718	1649	2.867	11,351	.839	16.07	53.04	80.86	222
1000	1112	1253	1584	1640	655	662	1901	1908	1835	3.147	11,913	.880	17.53	56.70	81.07	223
965	1084	1246	1641	1767	674	682	2014	2014	1943	3.391	12,455	.921	17.89	58.84	80.17	224
944	1084	1253	1732	1908	691	698	2145	2147	2058	3.599	12,972	.958	18.48	60.69	79.51	225
908	1056	1253	1824	2028	713	717	2268	2260	2153	3.805	13,538	1.000	18.57	60.87	76.37	226
845	894	951	1014	901	546	553	1055	1056	1016	1.779	8,688	.642	10.67	35.06	74.35	227
965	1056	1155	1373	1310	611	618	1545	1563	1499	2.614	10,910	.806	15.46	50.73	78.80	228
972	1091	1232	1570	1612	645	652	1883	1894	1818	3.175	12,012	.888	17.51	57.21	81.09	229
979	1098	1246	1655	1767	663	670	2030	2028	1954	3.361	12,547	.928	18.38	59.01	79.60	230
951	1084	1246	1753	1915	683	689	2160	2168	2079	3.582	13,092	.967	18.74	60.27	77.74	231
915	1056	(c)	1838	2035	708	710	2285	2274	2167	3.796	13,588	1.004	18.76	60.66	75.80	232
500	528	563	599	578	551	558	643	648	627	1.747	8,108	.599	5.30	28.19	71.70	233
599	641	711	817	824	601	609	921	922	899	2.437	9,783	.722	8.08	41.61	78.37	234
585	634	697	803	803	593	603	895	901	874	2.387	9,819	.726	7.92	40.96	78.20	235
613	683	768	951	1000	638	650	1111	1113	1080	3.027	10,900	.806	9.10	48.14	80.76	236
655	732	838	1070	1155	666	673	1261	1267	1226	3.354	11,403	.842	10.20	52.86	80.26	237
655	732	838	1077	1162	666	675	1265	1267	1227	3.347	11,435	.844	10.13	52.07	79.04	238
641	732	852	1134	1225	687	694	1341	1338	1291	3.684	11,946	.883	10.22	54.70	80.25	239
655	761	901	1225	1331	709	714	1446	1443	1379	3.962	12,426	.918	10.67	56.75	77.27	240
585	641	704	810	796	611	621	906	915	881	2.482	10,232	.756	8.37	45.05	80.95	241
606	662	739	873	873	636	647	999	1007	973	2.685	10,710	.792	9.03	47.96	80.82	242
627	704	803	1014	1084	671	681	1211	1211	1173	3.247	11,803	.872	10.26	54.25	82.10	243
613	704	803	1077	1176	693	701	1302	1310	1259	3.481	12,374	.914	10.91	57.37	78.37	244
613	697	824	1155	1274	710	715	1395	1401	1342	3.740	12,950	.957	11.40	59.94	77.50	245
599	697	852	1232	1359	726	728	1489	1486	1413	3.981	13,500	.998	11.59	60.76	76.60	246
556	599	648	718	648	601	607	769	775	747	2.124	9,621	.711	7.26	39.70	74.24	247
599	655	725	845	824	645	653	957	965	929	2.586	10,600	.783	8.74	47.16	78.82	248
627	683	754	922	922	651	661	1063	1077	1033	2.850	11,267	.833	9.62	50.86	78.74	249
606	676	768	965	1000	680	688	1154	1155	1117	3.232	11,682	.863	9.94	55.48	83.34	250
634	718	810	1070	1148	696	702	1296	1303	1254	3.402	12,271	.907	11.05	57.52	79.67	251
606	690	796	1098	1197	713	718	1342	1345	1290	3.608	12,828	.948	11.14	59.28	77.72	252
585	676	810	1169	1267	736	736	1423	1415	1351	3.909	13,388	.989	11.15	60.52	75.89	253
570	613	669	732	662	600	605	787	789	763	2.088	9,621	.711	7.59	39.85	72.89	254
585	634	697	824	789	638	643	928	937	906	2.592	10,680	.789	8.80	48.70	77.85	255
620	690	768	922	922	651	658	1073	1084	1041	2.846	11,246	.832	9.91	51.94	79.78	256
620	697	789	993	1014	668	675	1177	1183	1139	3.089	11,814	.873	10.65	55.07	78.59	257
620	697	796	1049	1120	685	693	1270	1274	1226	3.414	12,363	.913	10.98	58.10	80.04	258
599	683	796	1113	1218	706	712	1358	1366	1307	3.670	12,924	.955	11.21	59.53	77.74	259
599	690	831	1197	1310	728	730	1463	1457	1390	3.840	13,488	.996	11.60	59.71	74.22	260

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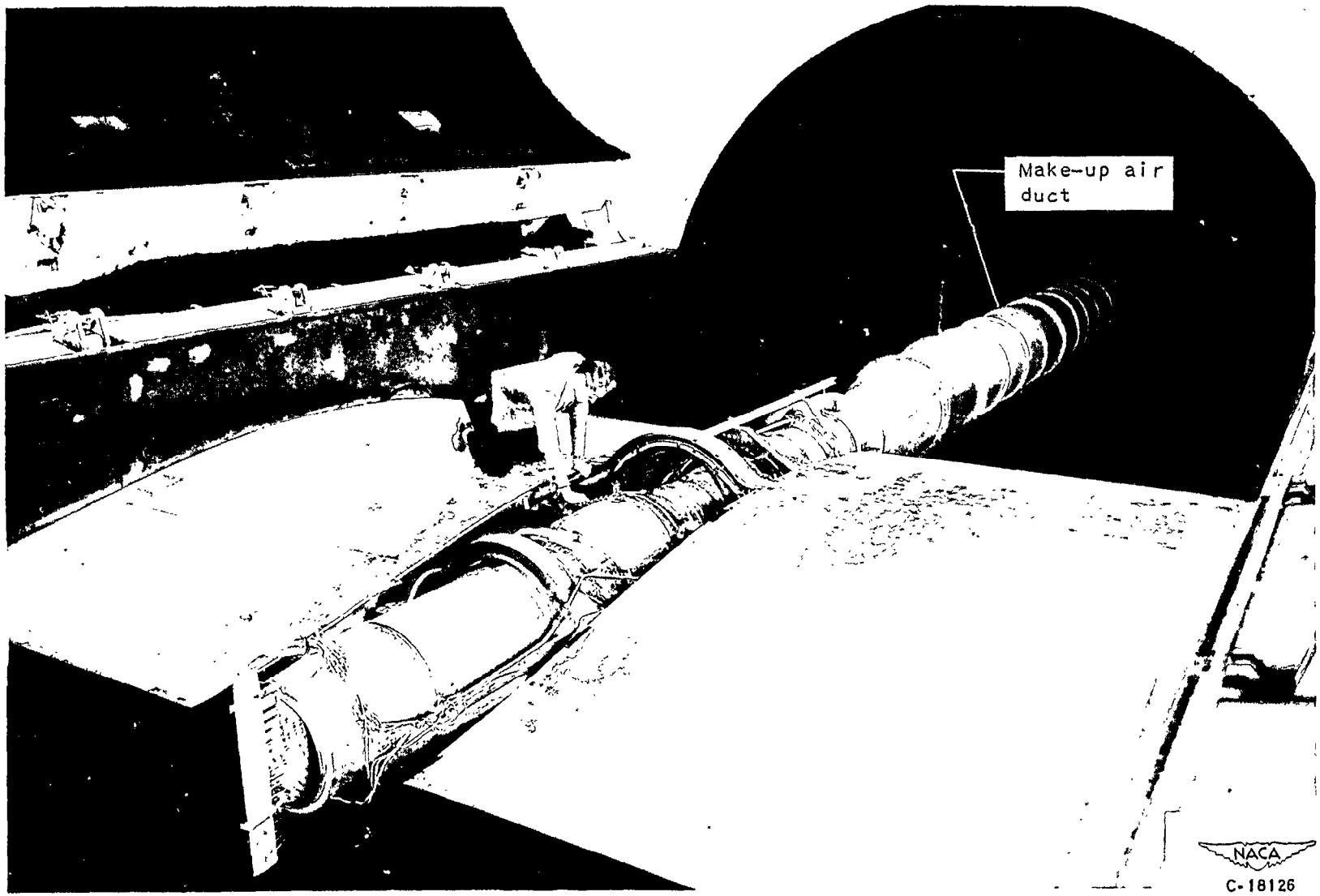

Figure 1. - Installation of X24C-4B turbojet engine in altitude wind tunnel.

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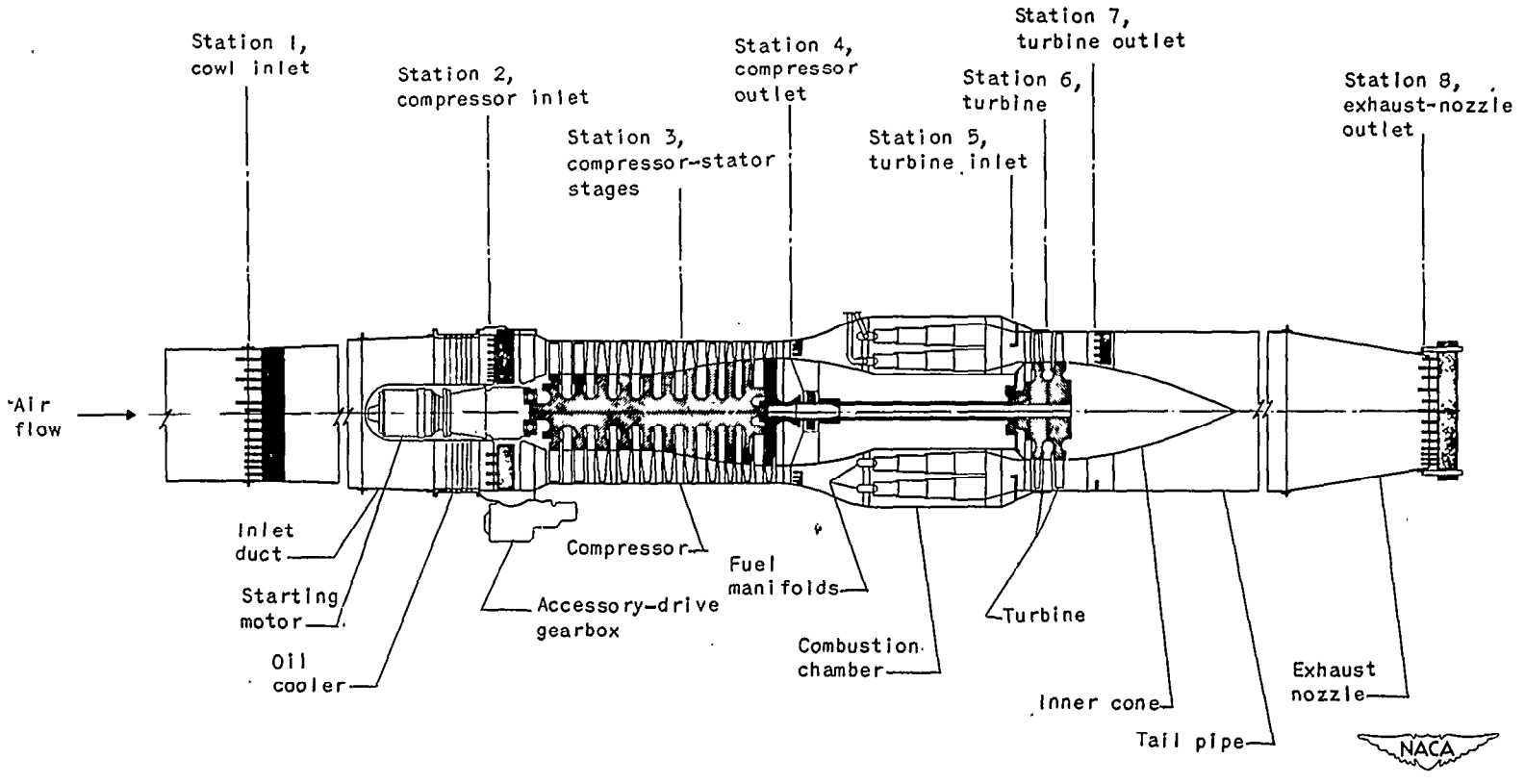

Figure 2. - Location of instrumentation installed in X24C-4B turbojet engine.

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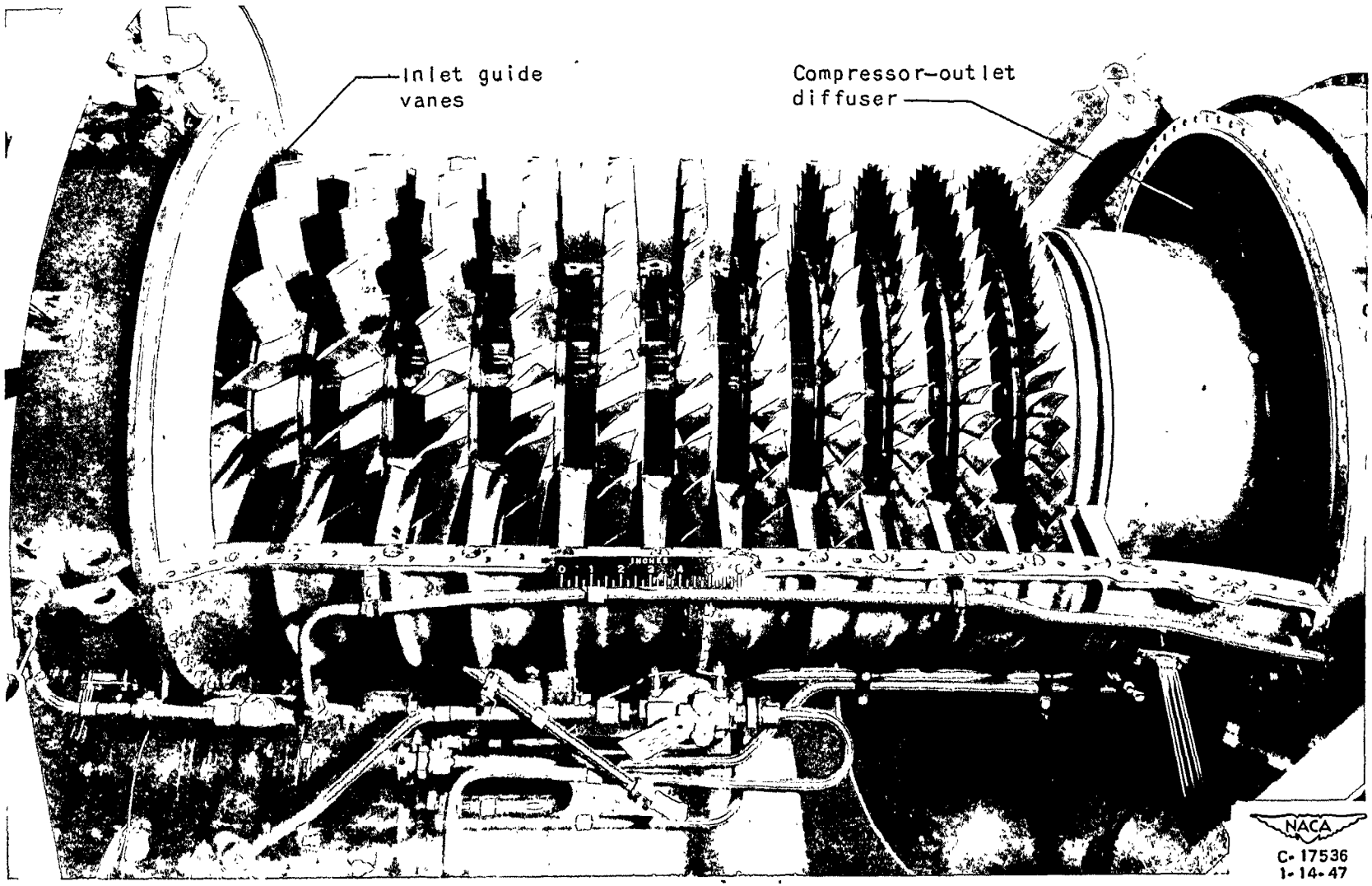

Figure 3. - Compressor of X24C-4B turbojet engine with top half of casing removed.

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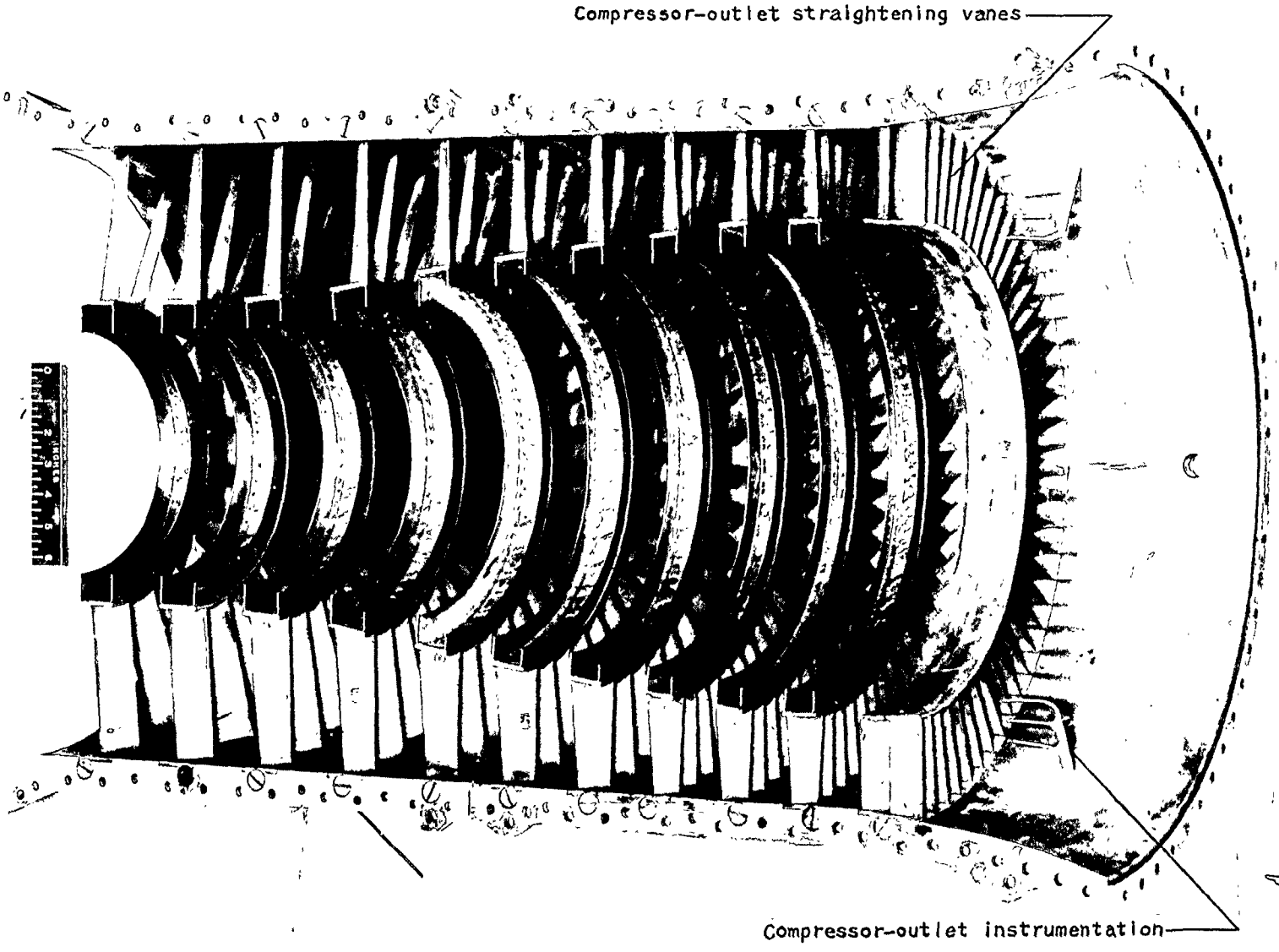
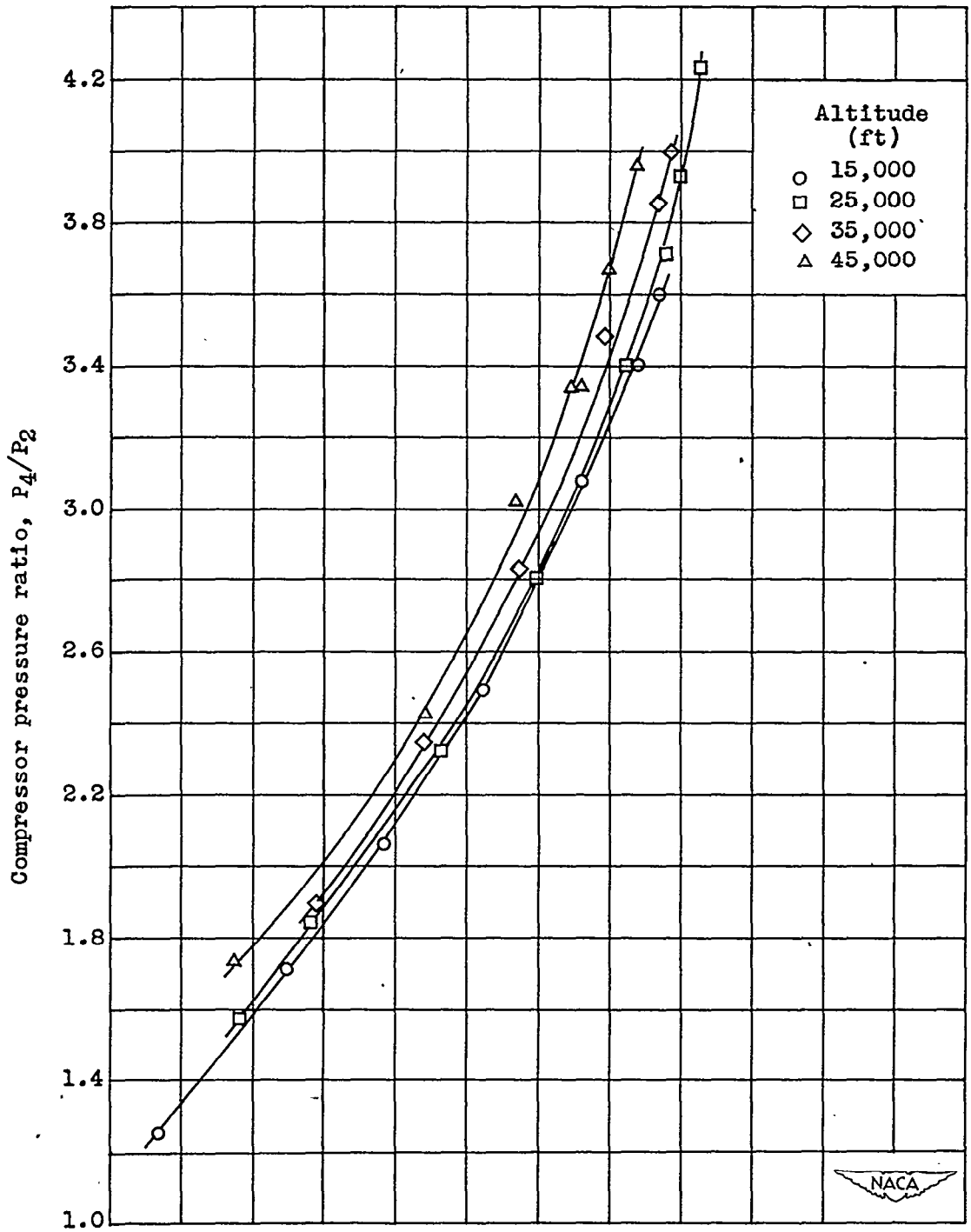
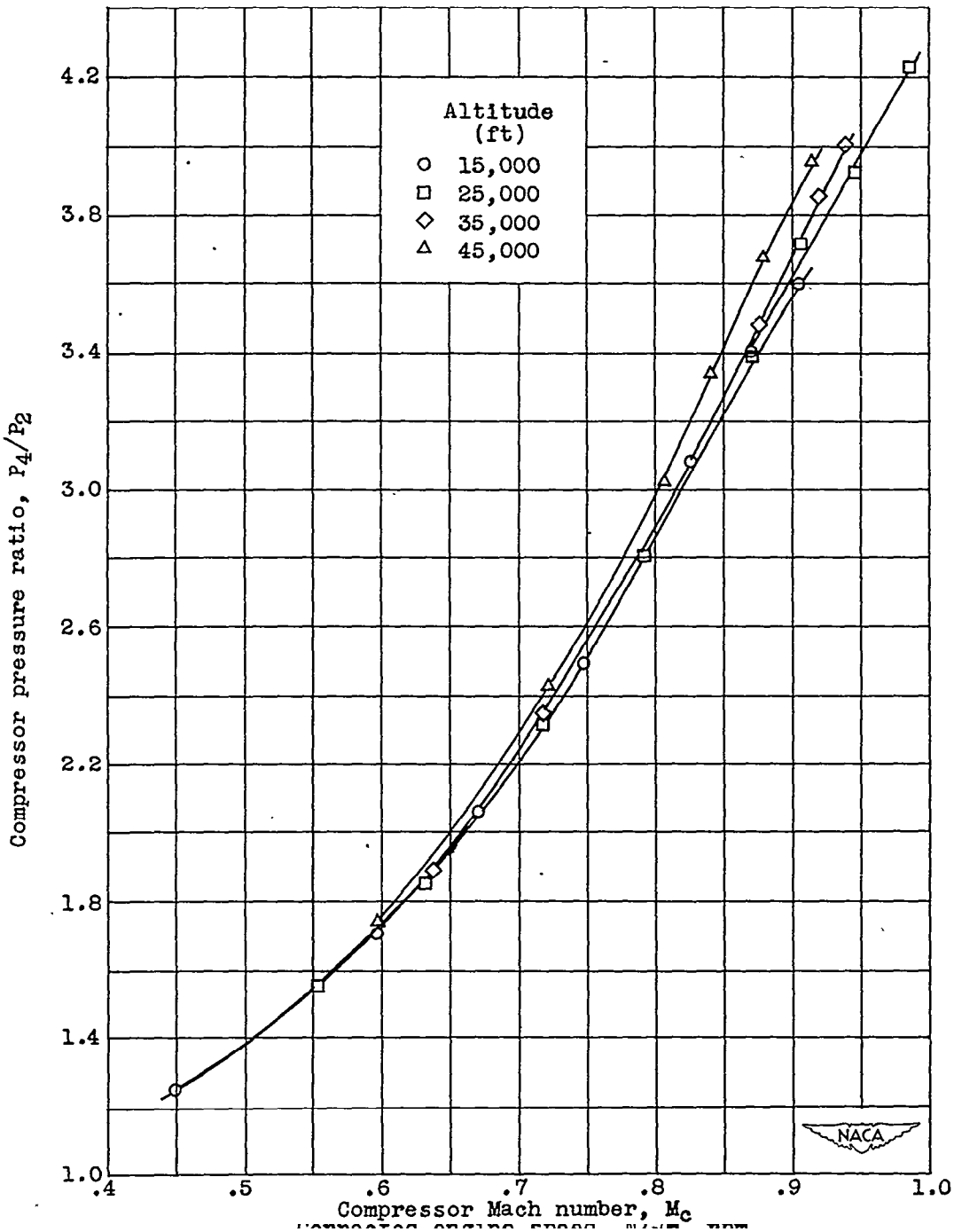
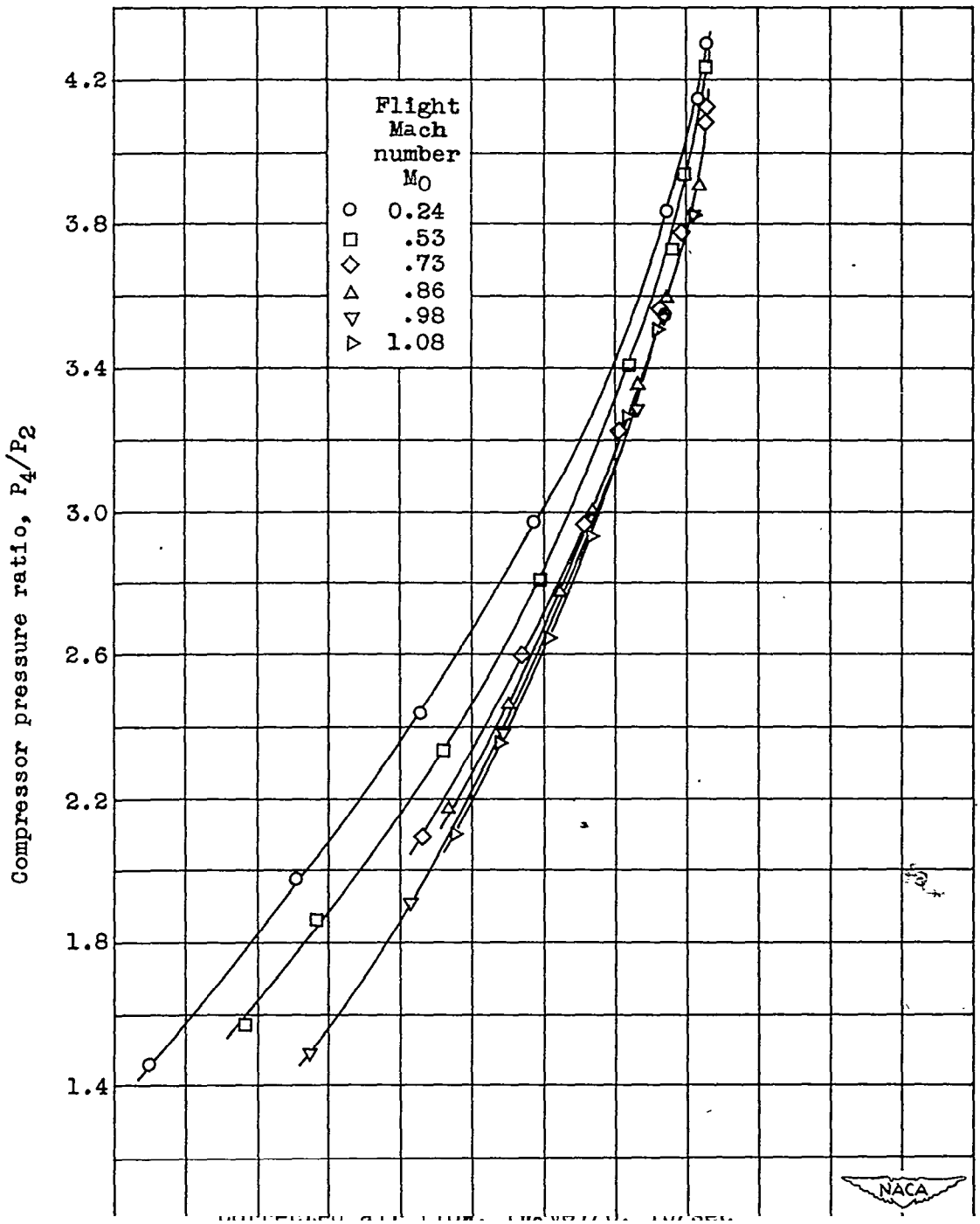
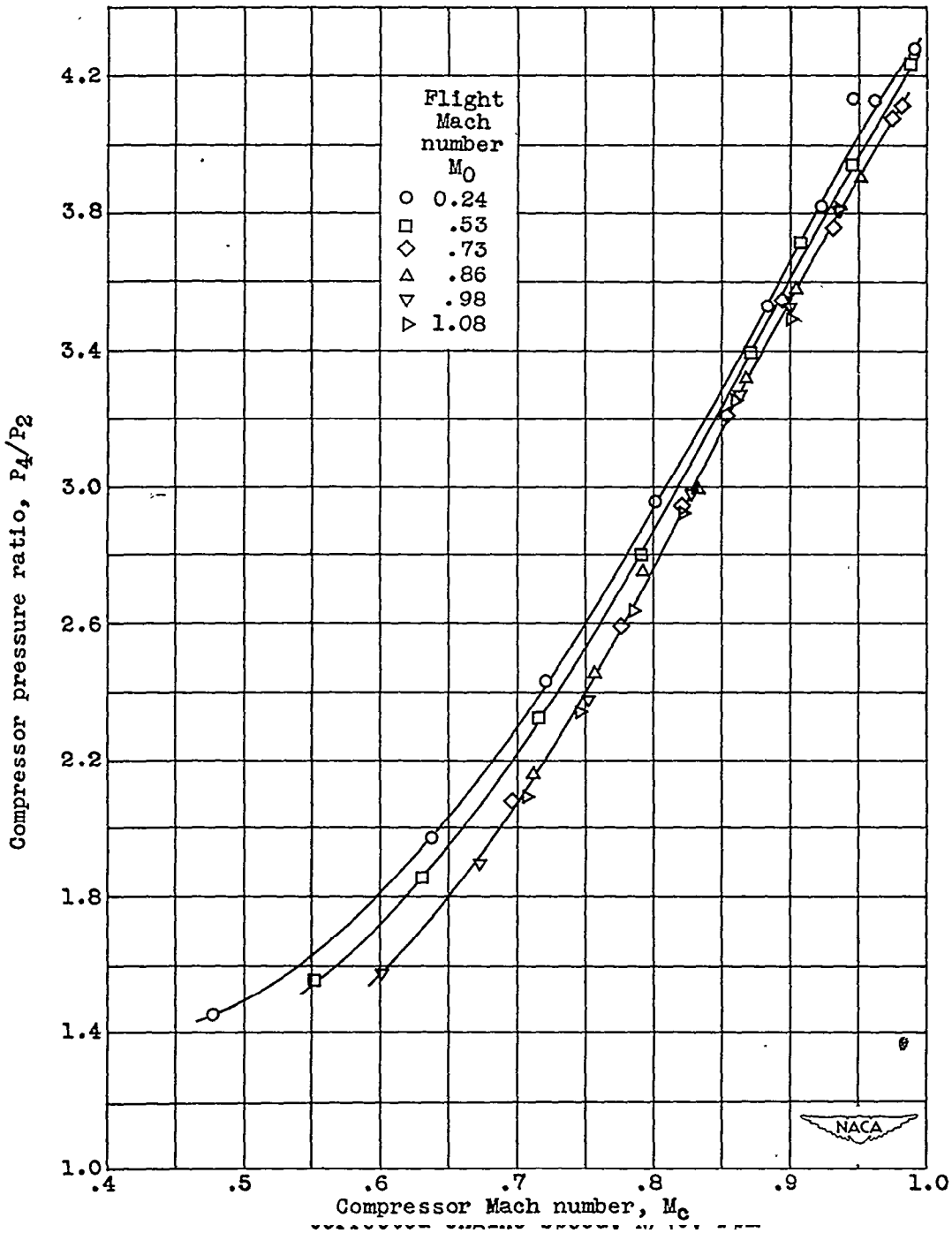


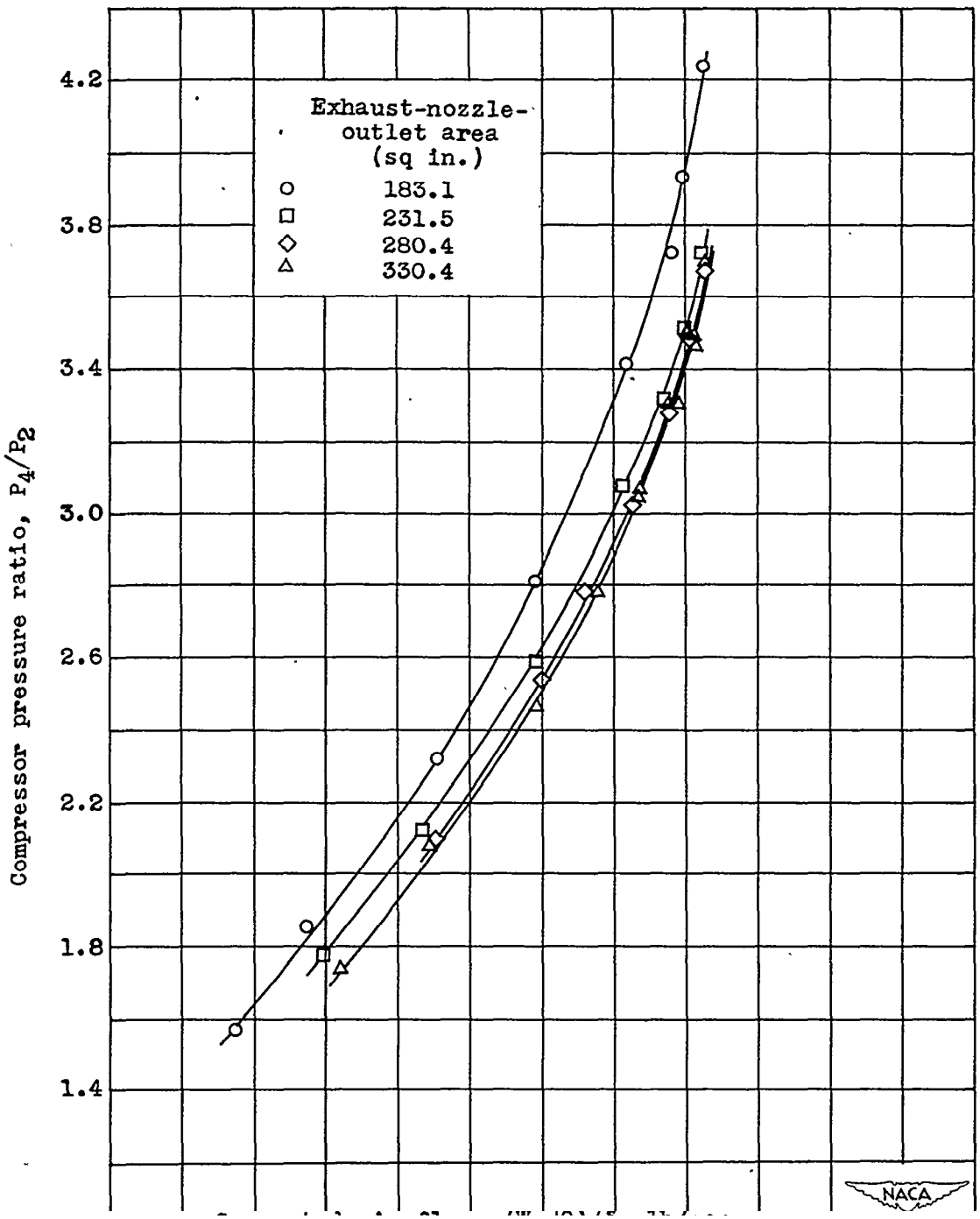
Figure 4. - Top half of compressor casing of X24C-4B turbojet engine with stator stages installed.

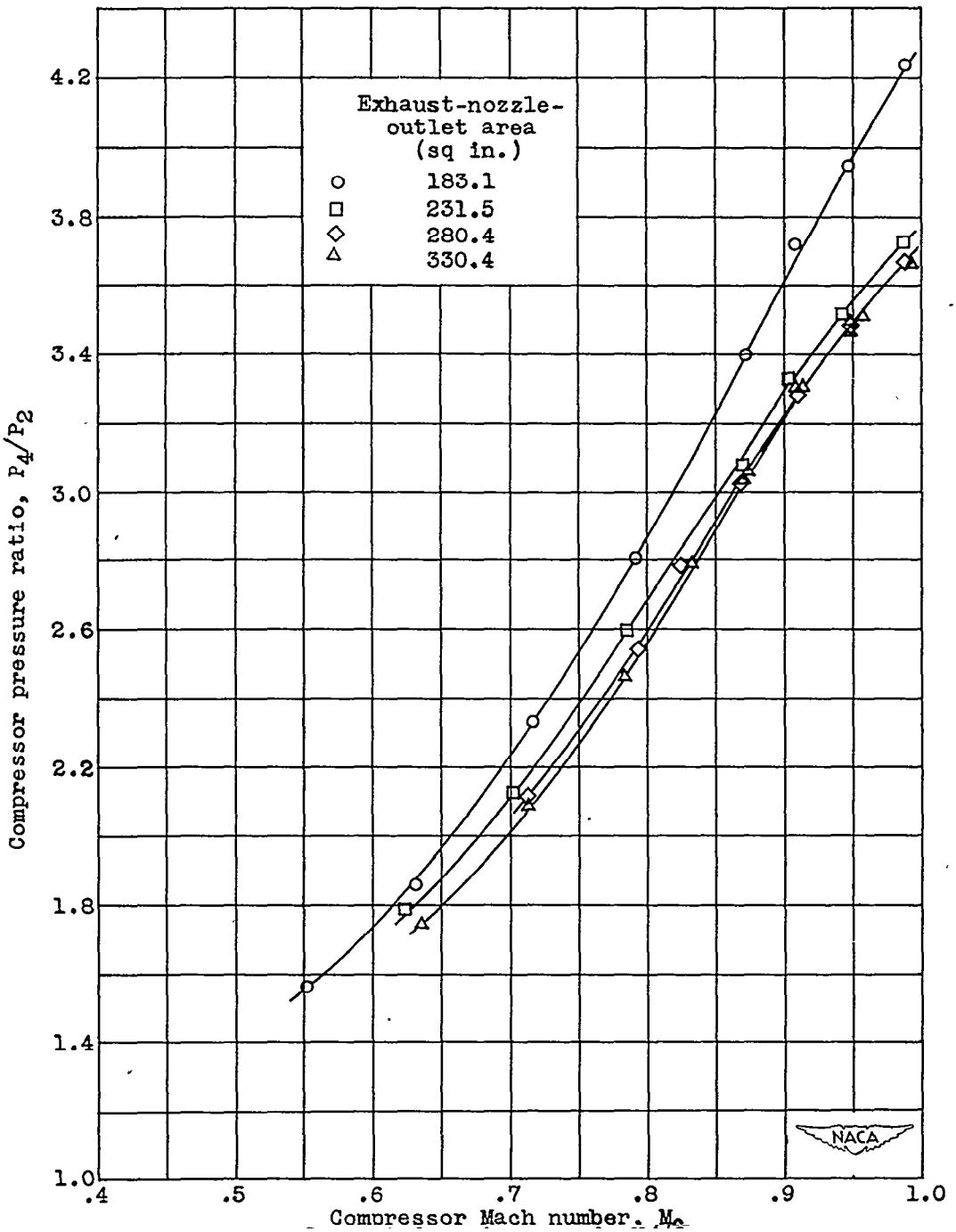

Compressor pressure ratio, P_4/P_2
4.2
3.8
3.4
3.0
2.6
2.2
1.8
1.4
1.0
Altitude (ft)
15,000
25,000
35,000
45,000
NACA

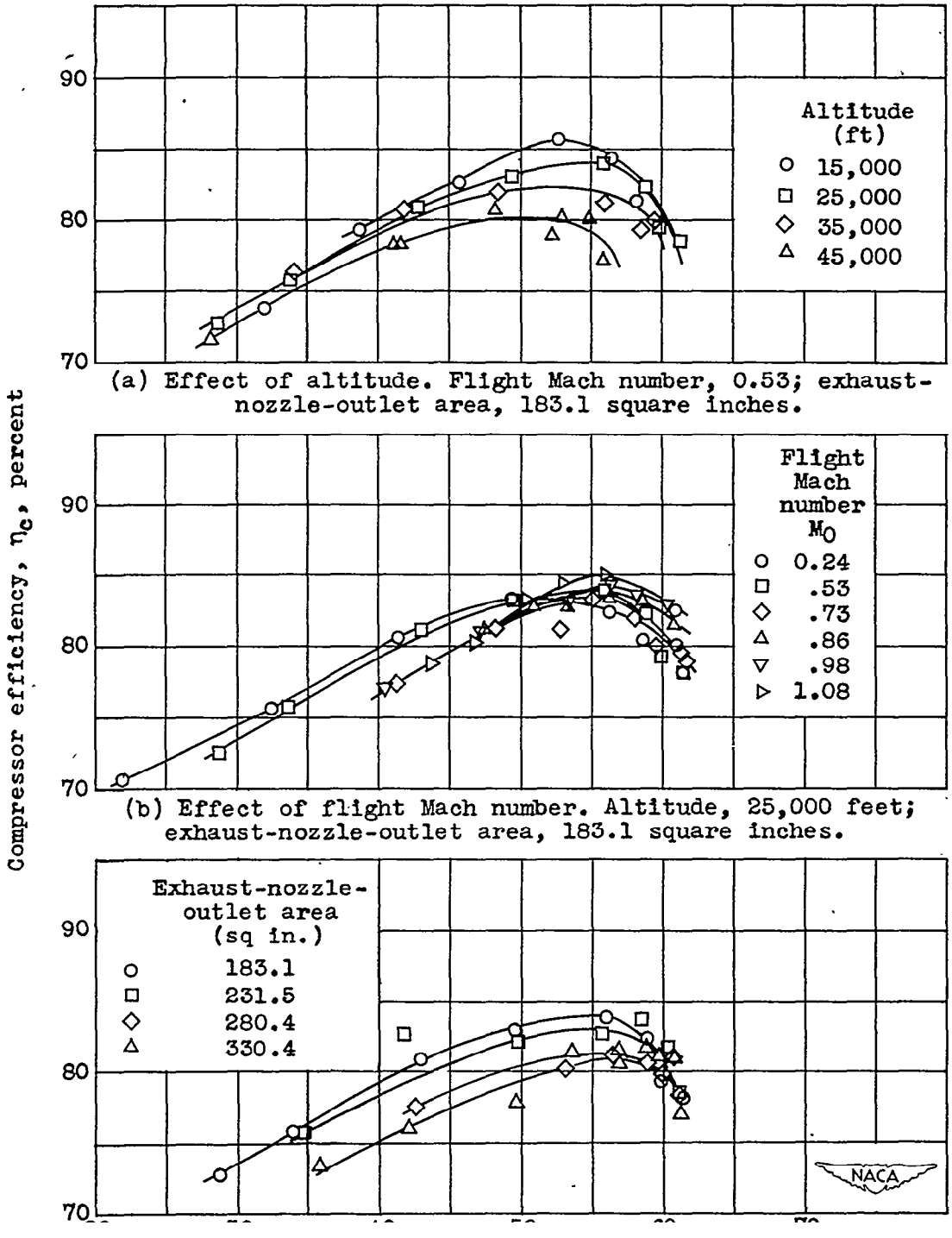

Altitude
(ft)
15,000
25,000
35,000
45,000
Compressor pressure ratio, P_4/P_2
4.2
3.8
3.4
3.0
2.6
2.2
1.8
1.4
1.0
.4
.5
.6
.7
.8
.9
1.0
Compressor Mach number, M_c
NACA


Flight
Mach
number
M_0
0.24
.53
.73
.86
.98
1.08
Compressor pressure ratio, P_4/P_2
4.2
3.8
3.4
3.0
2.6
2.2
1.8
1.4
NACA


Flight
Mach
number
M_0
0.24
.53
.73
.86
.98
1.08
Compressor pressure ratio, P_4/P_2
Compressor Mach number, M_c
4.2
3.8
3.4
3.0
2.6
2.2
1.8
1.4
1.0
.4
.5
.6
.7
.8
.9
1.0
NACA

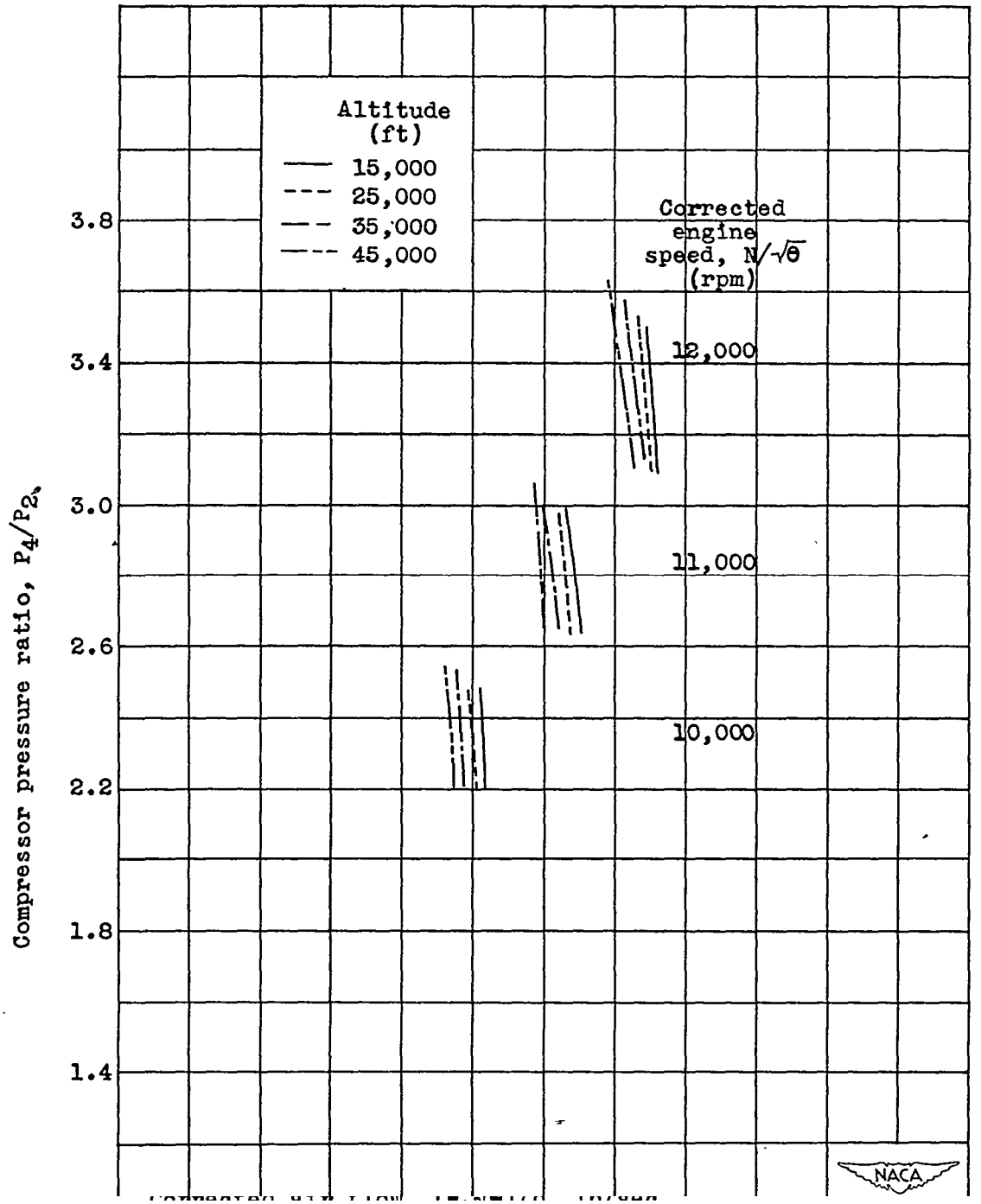

Exhaust-nozzle-outlet area (sq in.)
183.1
231.5
280.4
330.4
Compressor pressure ratio, P_4/P_2
4.2
3.8
3.4
3.0
2.6
2.2
1.8
1.4
NACA

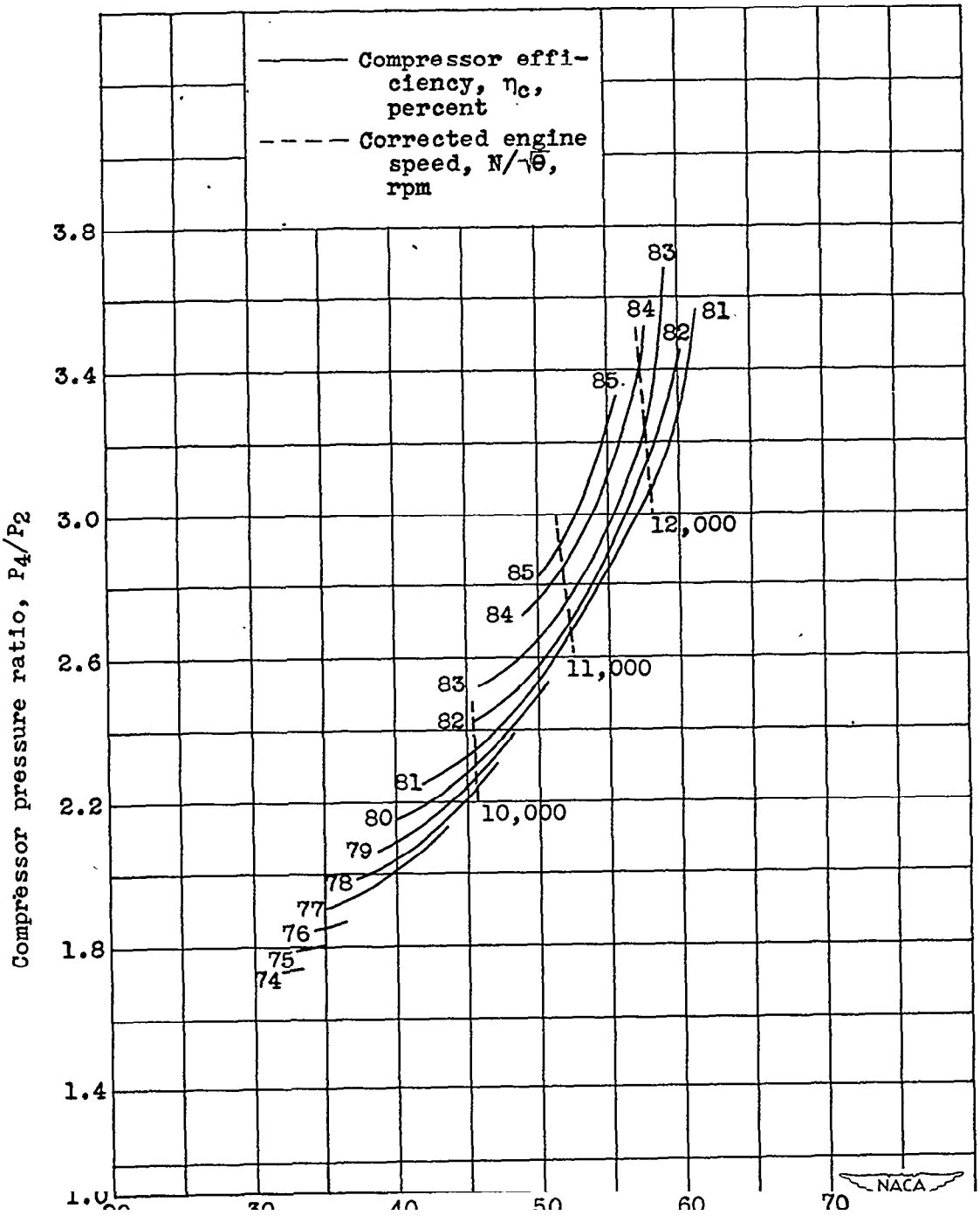

Exhaust-nozzle-outlet area (sq in.)
183.1
231.5
280.4
330.4
Compressor pressure ratio, P_4/P_2
Compressor Mach number, M_0
4.2
3.8
3.4
3.0
2.6
2.2
1.8
1.4
1.0
.4
.5
.6
.7
.8
.9
1.0
NACA

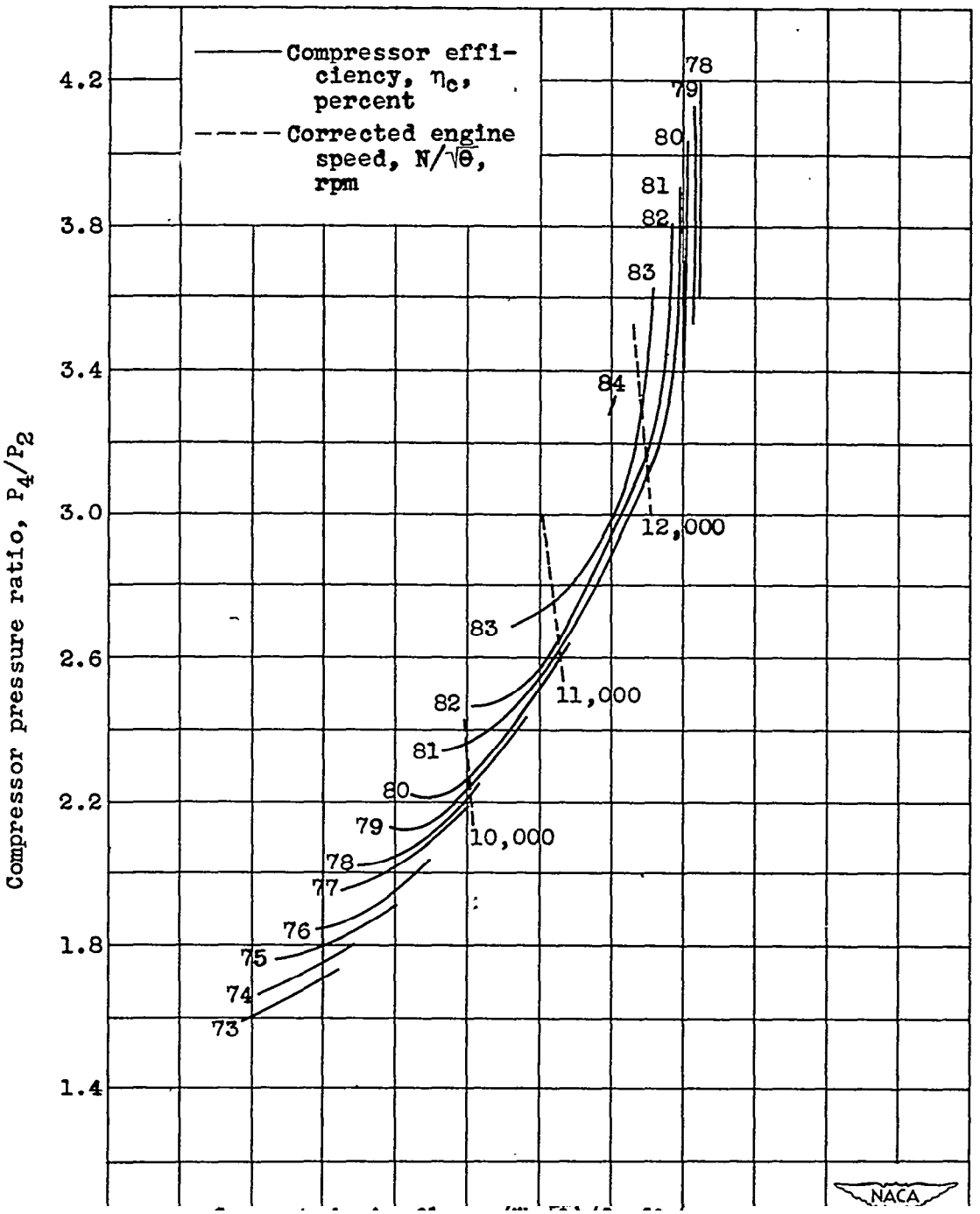


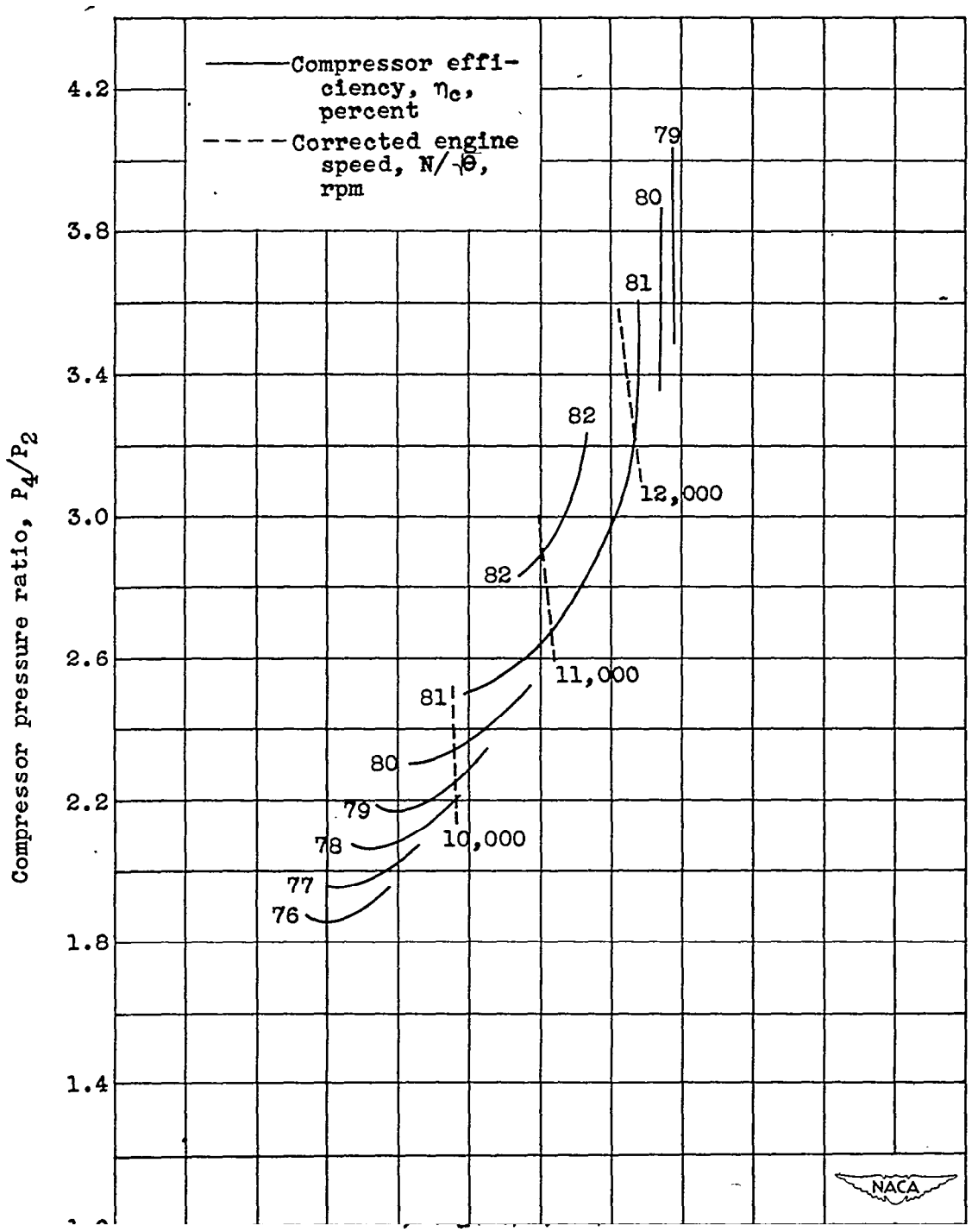
(a) Effect of altitude. Flight Mach number, 0.53; exhaust-nozzle-outlet area, 183.1 square inches.

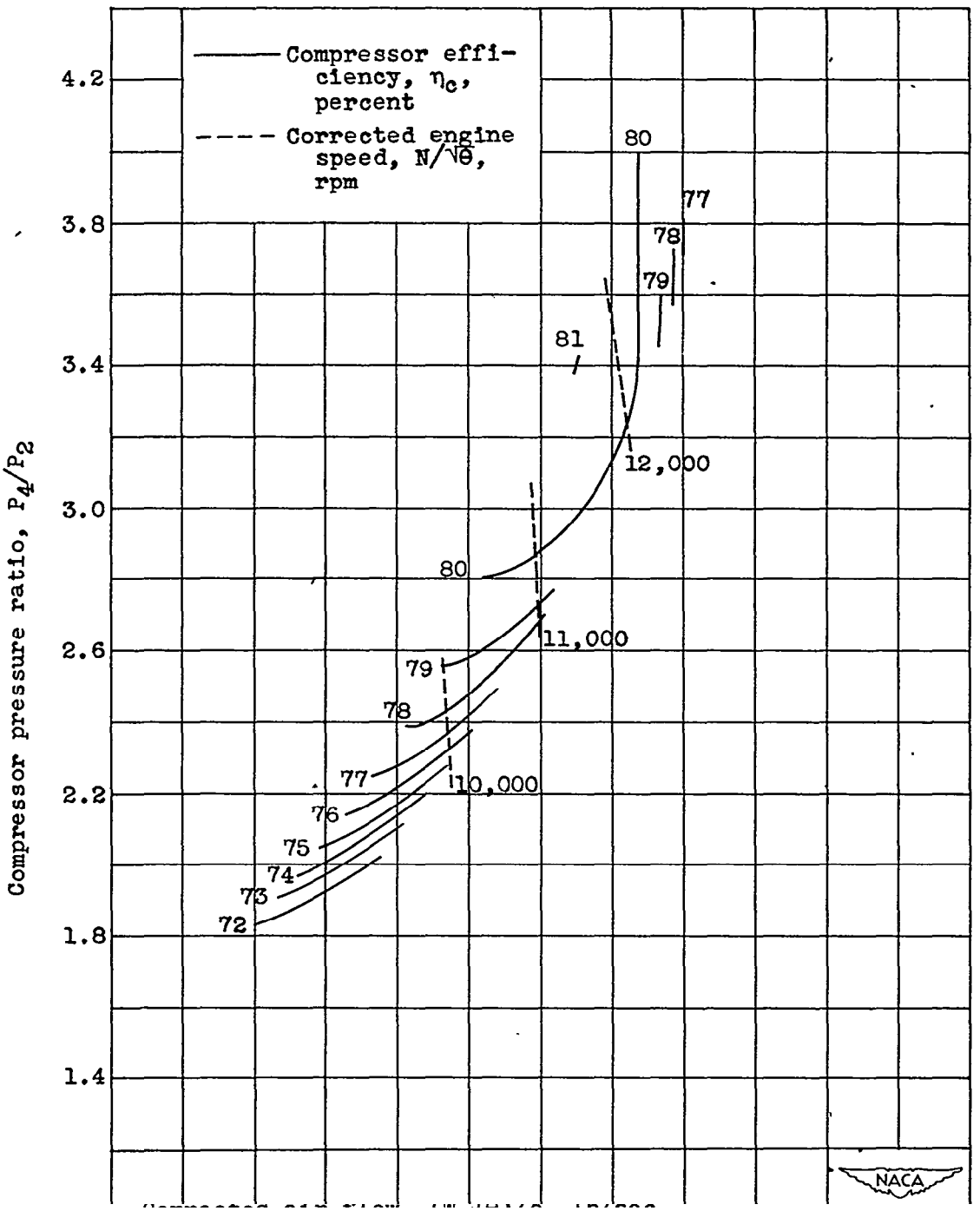
(b) Effect of flight Mach number. Altitude, 25,000 feet; exhaust-nozzle-outlet area, 183.1 square inches.

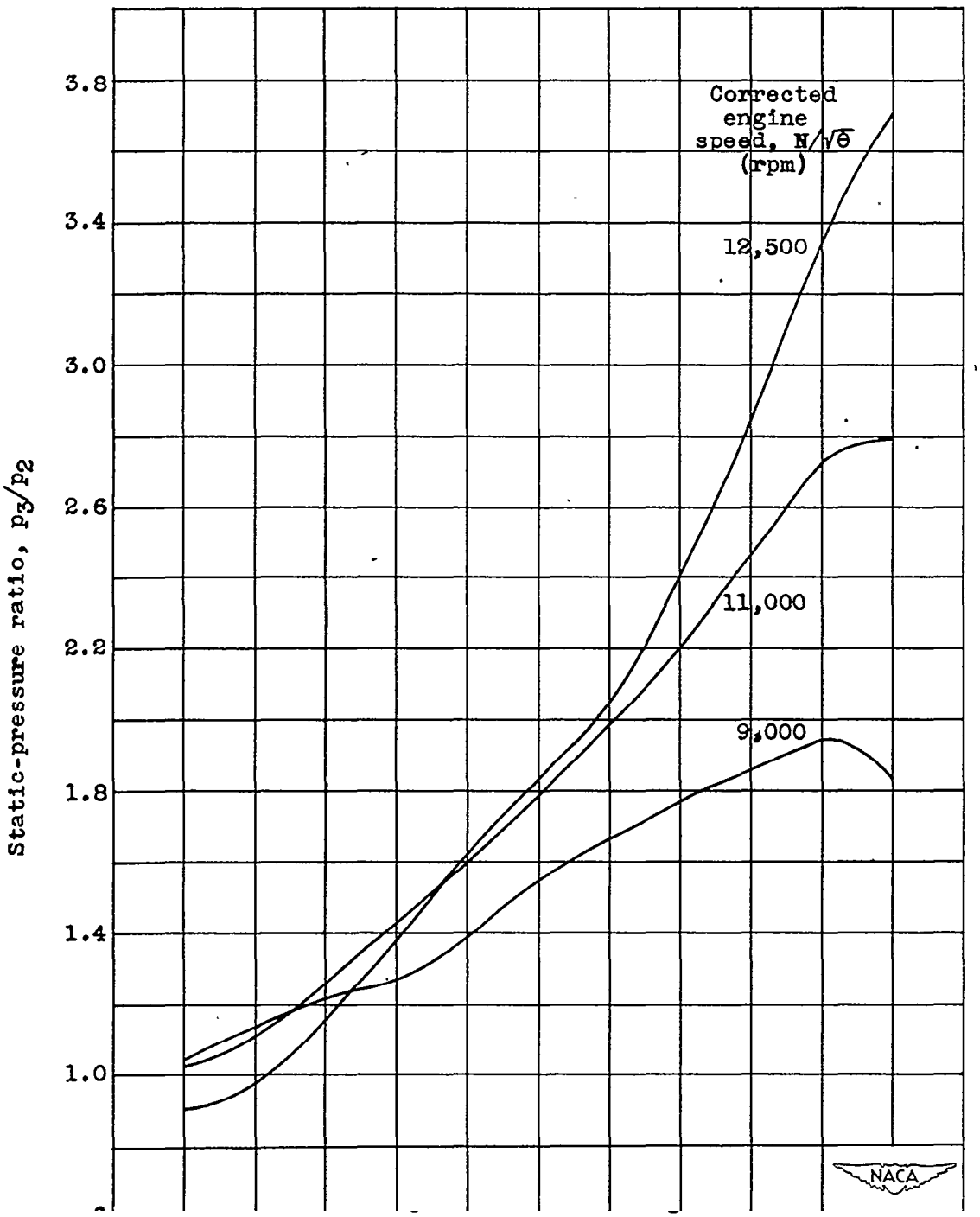

Altitude (ft)
15,000
25,000
35,000
45,000
Corrected engine speed, N/√θ (rpm)
12,000
11,000
10,000
Compressor pressure ratio, P4/P2
3.8
3.4
3.0
2.6
2.2
1.8
1.4
NACA

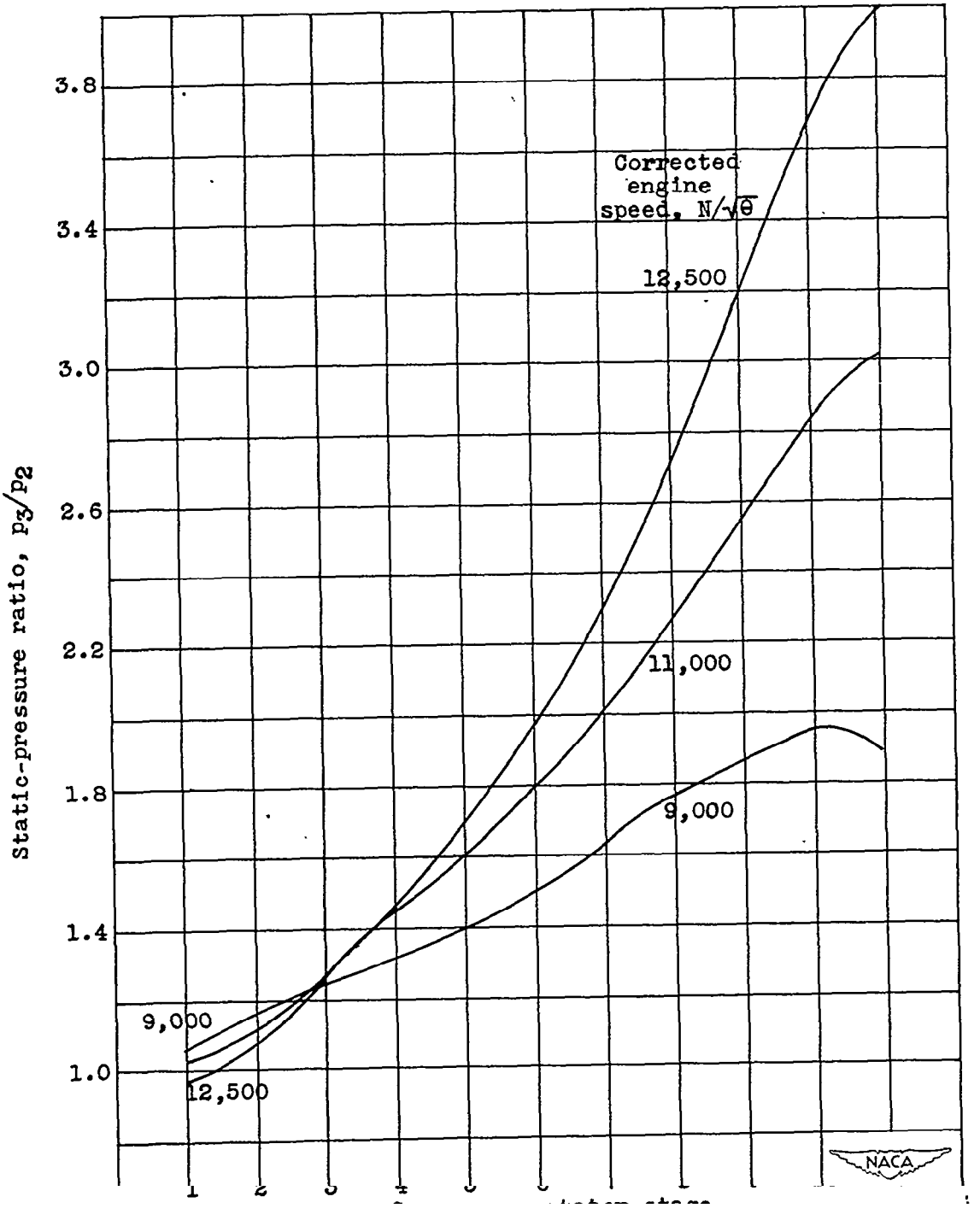

Compressor efficiency, η_c, percent
Corrected engine speed, $N/\sqrt{\theta}$, rpm
Compressor pressure ratio, P_4/P_2
3.8
3.4
3.0
2.6
2.2
1.8
1.4
1.0
30
40
50
60
70
83
84
81
82
85
12,000
85
84
11,000
83
82
81
80
10,000
79
78
77
76
75
74
NACA


Compressor efficiency, η_c, percent
Corrected engine speed, $N/\sqrt{\theta}$, rpm
Compressor pressure ratio, P_4/P_2
4.2
3.8
3.4
3.0
2.6
2.2
1.8
1.4
78
79
80
81
82
83
84
12,000
11,000
10,000
83
82
81
80
79
78
77
76
75
74
73
NACA

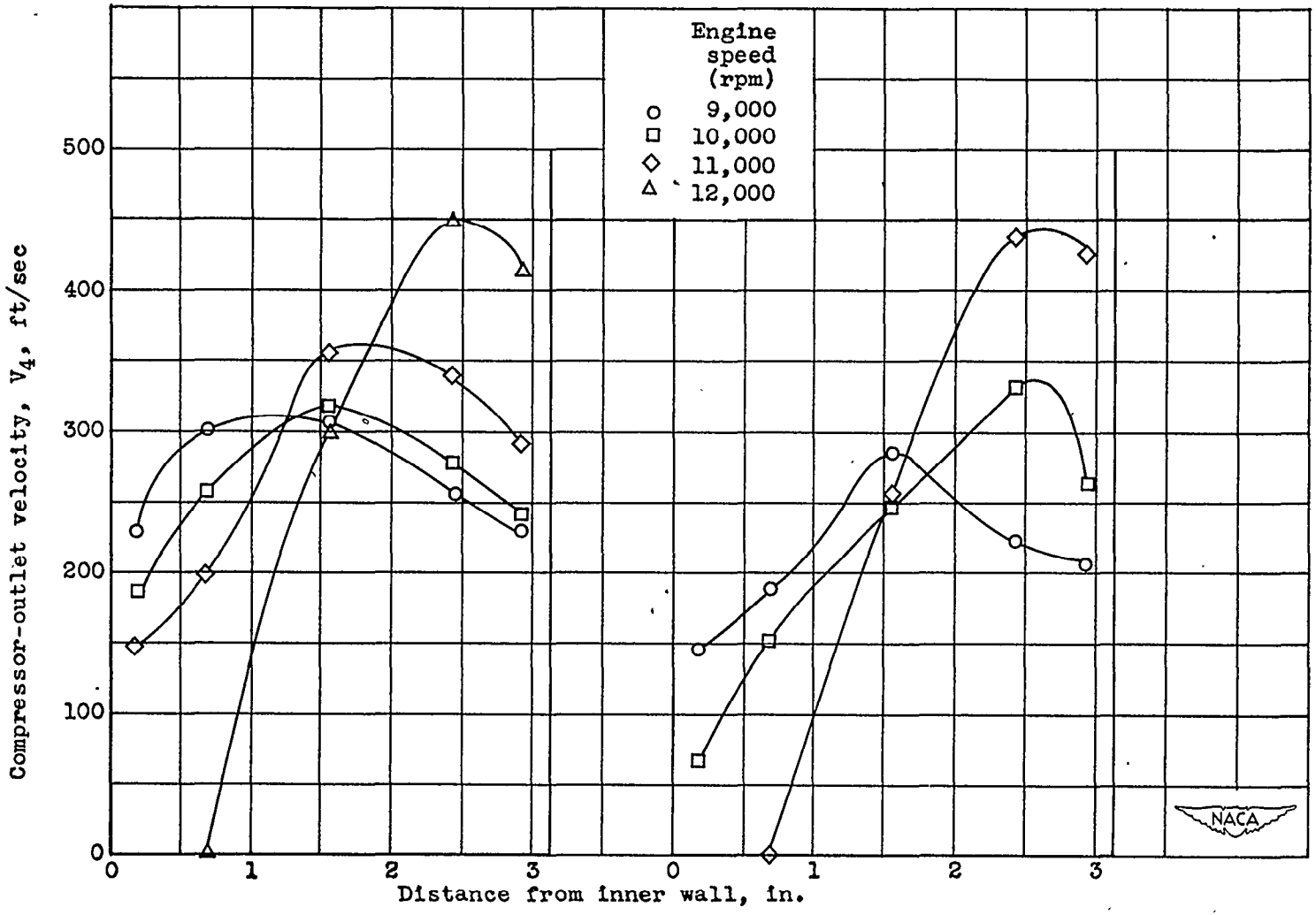

Compressor efficiency, η_c, percent
Corrected engine speed, $N/\sqrt{\theta}$, rpm
Compressor pressure ratio, P_4/P_2
4.2
3.8
3.4
3.0
2.6
2.2
1.8
1.4
79
80
81
82
12,000
82
11,000
81
80
79
78
10,000
77
76
NACA


Compressor efficiency, η_c, percent
Corrected engine speed, $N/\sqrt{\theta}$, rpm
Compressor pressure ratio, P_4/P_2
4.2
3.8
3.4
3.0
2.6
2.2
1.8
1.4
80
77
78
79
81
12,000
80
11,000
79
78
77
10,000
76
75
74
73
72
NACA


Static-pressure ratio, p_3/p_2
3.8
3.4
3.0
2.6
2.2
1.8
1.4
1.0
Corrected engine speed, $N/\sqrt{\theta}$ (rpm)
12,500
11,000
9,000
NACA


Static-pressure ratio, p_3/p_2
3.8
3.4
3.0
2.6
2.2
1.8
1.4
1.0
Corrected engine speed, $N/\sqrt{\theta}$
12,500
11,000
9,000
9,000
12,500
NACA

[redacted]



(a) Altitude, 15,000 feet. (b) Altitude, 45,000 feet.

Figure 12. - Velocity profile at compressor outlet. Flight Mach number, 0.53; exhaust-nozzle-outlet area, 183.1 square inches.

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